GOVERNMENT OF KARNATAKA

EVALUATION STUDY ON USAGE OF THE E-HOSPITAL SOFTWARE DEVELOPED BY NIC, KARNATAKA

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Karnataka Evalution Authority

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DEPARTMENT OF PLANNING, PROGRAMME MONITORING AND STATISTICS

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FEBRUARY 2020

EVALUATION STUDY ON USAGE OF THE E-HOSPITAL SOFTWARE DEVELOPED BY NIC, KARNATAKA

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PAN INDIA NETWORK. BENGALURU

NATIONAL HEALTH MISSION (NHM)

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CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA,

having solemnly resolved to constitute India into a

SOVEREIGN SOCIALIST

SECULAR DEMOCRATIC REPUBLIC

and to secure to all its citizens:

JUSTICE, social, economic and political;

LIBERTY of thought , expression,

belief, faith and worship;

EQUALITYof status and of opportunity;

and to promote among them all

FRATERNITYassuring the dignity of the

individual and the unity and

integrity of the Nation;

IN OUR CONSTITUENT ASSEMBLY

this twenty-sixth day of November, 1949, do

HEREBY ADOPT, ENACT AND GIVE TO

OURSELVES THIS CONSTITUTION.

Foreword

National Health Mission is a flagship programme of Government of India that has led to increased access to health care and strengthening of public health care system. To enhance the quality and efficiency of health care and to provide transparent health services to the community, the Government has launched the e-hospital programme in the State. The project was initially implemented as pilot in three hospitals in Bengaluru and from 2015-16 it is being scaled up to other district hospitals in the State. To assess the implementation of the software, its utility and problems encountered if any, a study was initiated by Department of Health and Family Welfare through Karnataka Evaluation Authority. The study was carried out by M/s. PAN India Network, under the guidance and monitoring of KEA.

The study is taken up in the pilot hospitals of K C General Hospital, Sanjay Gandhi Trauma Centre and Jayanagar General Hospital covering the technical, managerial and efficiency aspects and the usage of the scheme. The study has used questionnaires, interview schedules, focused group discussions and desk review as tools to collect the necessary primary and secondary data for analysis. The findings of the study indicate that though 57 percent of the patients expressed satisfaction about the system, yet they have very limited awareness about the system. The doctor's felt that it causes disruption in the patient care. There were differences in work flow management across the institutions. The level of understanding and ease of use also differed across different stakeholders and clinical decision making is also not largely supported. by the system. The major recommendations are - software needs to be optimised for local needs, training and capacity building of the stakeholders, appropriate hardware enhancements and introduction of Tablets and Smart Digital PEN, awareness among beneficiaries to use mobile apps, reduction in time at registration and consultation and ensuring integration of e-health systems from different programs on a common platform.

I expect that the findings and recommendations of the study will be useful to the Government and Department of Health and Family Welfare for taking up the mid-course corrections in the implementation of the programme.

The study received support and guidance of the Additional Chief Secretary/ Principal Secretary Planning, Programme Monitoring and Statistics Department, Government of Karnataka. The report was approved in 45th Technical Committee meeting. The review of the draft report by KEA, members of the Technical Committee and an Independent Assessor, has provided useful comments and inputs to improve the report. I duly acknowledge the assistance rendered by all in successful completion of the study.

Chief Evaluation Officer
Karnataka Evaluation Authority

ACKNOWLEDGEMENT

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Executive Summary

An evaluation study on the Usage of the e-hospital software developed by NlC, Karnataka was undertaken in three hospitals of Bangalore. The study employed multiple questionnaires, interviews and focus group discussions information to pertaining to hardware, software, willingness to use, perceived ease of use, actual use, implementation challenges, and beneficiary experience was captured and analyzed.

The major findings of this study are as follows:

Provider (Doctors') Responses

- Majority of the doctors perceive e-hospital system causes disruption in the patient care since the volume overload does not permit them to enter the required clinical care details in the OPD

- Non availability of computers at the point of care is another impediment for the successful utilization of the system

- Doctors are of the opinion that if there are simpler ways of capturing the clinical components like tablet based written OCR or transcription of the data by data entry operators then the system can be helpful.

Data Entry Outsourced Vendor:

- Third party vendor is responsible for allotting resources across the technology and data operators end.

- Minimal prior training is provided to the resources deployed for the tasks and they are seldom monitored/documented for transition.

- Delayed salary payments are responsible for high attrition of staff especially data operators.

- Data operators require detailed training and capacity building to optimize the usage of the systems.

Other Hardware and software issues

- Improved or upgraded desktops are required to overcome redundancy. Restricted access and permissions to oversee the smooth flow of the system.

- Minimal opportunity at the local level to modify the critical workflow.

- Program manager to monitor usage of the e-Hospital module to its full extent and guide doctors/data entry operators etc. in case of any need.

- The lab reports and their dispatch in a more systematic and user friendly interface. Presently, the data entry operators are manually entering the records once they are validated.

- The upgrading of all the lab and other related systems to keep up with the patient input.

Training and capacity of key personnel

- Inadequacy of training and supportive IT systems are also adding to the implementation challenges for the clinical modules and other systems

- Data entry operators require hand holding and periodic training

- Call centre support for minor issues required

- Create short video training modules for use in training of new staff as well as reinforcement to existing staff.

Patients / Attendants

- Awareness is low across the spectrum and hence obtaining valid responses to perceived benefits was difficult.

- Patients are coming in direct contact with the e-hospital solutions during the registration and discharge. (Partially lab report collection)

- Waiting time at the registration is considerably long due to high loads.

- Discharge summary needs to be validated by competent authorities and the delay is being reported in all the hospitals due to inadequate manpower for the same (which the patients are perceiving as inefficiency of the system).

Recommendations:

1. Short Term Recommendations

- Software needs to be optimized for the local needs

- Coordination and presence of local help centre would smoothen the problem resolution and ease of use of software

- Training and capacity building of all major users required

- Appropriate Hardware enhancements and introduction of Tablets and Smart digital PEN inputs would enhance uptake of usage by doctors

- Mobile ORS is operational and may be publicized to book advance appointments. .

2. Long term Recommendations

a. To reduce waiting time at the registration counters

Provision of token machines where the patients or caretakers can generate time-stamped tokens for appointments.

Decentralize registration and distribute it to major areas of the hospital. For example, all maternal and child cases can be registered at a different location, and general outpatient cases can be registered at a different location. Differential registration would also help to segregate the infectious and non-infectious patients, during registration and avoid cross-contamination.

b. To reduce the total consultation time with senior consultants

Owing to large caseloads, senior consultants often find very little time to spend with the patients. Most doctors complain that they are understaffed to serve patient needs. Junior residents and/or qualified nurses can Pre-screen the patients by recording anthropometry, vital parameters, personal history, drug history, blood pressure, etc. Pre-screening would help the senior consultants to focus on clinical diagnosis and treatment.

c. **Use of Mobile applications for specific components**

Recent advances in mobile computing and improvement in both hardware and software have enabled complex activities to be accomplished using mobile phones. The development of mobile applications for user-specific functions will help doctors to quickly access the critical information and avoid re-typing of patient data. Capturing of crucial information for patient care such as provisional diagnosis, lab tests, and pharmacological treatment would help in minimizing the amount of data entry.

The use of mobile applications would reduce the need for costly hardware and the supportive data entry workforce required for patient data capture.

The capture of handwritten notes using an electronic pen (stylus) in pre-structured mobile forms can be explored to avoid data entry of critical information.

d. **To improve in-patient record maintenance and discharge summary**

A daily capture of critical progress and treatment notes for each patient in the structured format helps in building the in-patient record. The integration of the lab reports and consumables would help in adding the care components to the patient records. Upon discharge, the concerned doctor needs to add the discharge advice and generate the summary rather than create the entire in-patient the course of the patient.

Customization of the software to meet the local needs and local process

Each hospital has a unique system and method of functioning. In this context, having a generic solution often poses challenges for the efficient and effective operation of the hospitals. Hence before installation, it is essential to understand the workflow and requirements of the individual hospitals and customize the software with minimal changes to suit the needs.

Changes in human resources also necessitate the modification of the reporting templates and details. Having local software administrators capable of making these minor changes would help in maintaining the smooth operations of the software.

e. **Ensure inter-operatability among the different solutions provided so that the e-health systems from different programs are integrated on a common platform.**

1. Introduction

1.0 Title:

Evaluation study on Usage of the e-hospital software developed by NlC, Karnataka

1.1 Department implementing the scheme:

The scheme is being implemented by the National Health Mission, as a part of the e-hospital program

1.2 Background and Context:

The advent of NHM in the state led to the adequate strengthening of the public health care system and various system process streamlining has been in progress. Still essential service package, accountability, & transparency in health care to the public are not present. The diseases need to be classified based on ICD 10 updated version to have uniformity in diagnosis across the globe to meet the global health awareness. This is a key step towards achieving Universal Health Coverage (UHC). At present for accessing health care, Community is dependent more on the unorganized, and at times, unqualified private providers leading to heavy out of pocket expenses.

Realizing this significant gap during the economic survey, state has decided to improve access for public health care; the Government of Karnataka has launched the e-hospital program to provide accountable & transparent health services to the community. The Hon'ble Chief Minister of Karnataka has announced in his budget speech to implement the project across the state. Even though state government has implemented the project in KC General Hospital, Jayanagar General Hospital and Sanjay Gandhi Institute of Trauma & Orthopaedic Centre as pilot project under NIC guidance through department of Deity still the complete version is not yet implemented. The software has been provided by NlC, Tripura with storage of data on local servers. Realizing the challenges and constraints over benefit to the community, in financial year 2015-16, with directives of Hon'ble Health Minister, state government is scaling-up the project to other district hospitals & selected General hospital which are under health department with guidance of NlC, Bengaluru under secured connectivity from Karnataka State Wide Area Network (KSWAN) of e-governance department.

Information systems, such as electronic health records (EHRs) and mobile phones and handheld computers (m-health), are now part of urban health movement, they are providing support to health worker to perform clinician duties & keep track of patients. In Karnataka, SMS services for Maternal Child health-related events, tracking to improve accountability at grass root level workers like ASHA & ANM level is being used.

In the proposed e-hospital program, ICT software allows health care providers to collect, store, retrieve, and transfer information electronically (computerized provider order entry (CPOE), which can minimize handwriting or other communication errors by having physicians or other providers enter orders into a computer system. The following technologies will be practiced in the e-hospital program in the state for strengthening efficient health care in state.

It is visioned that "A well-functioning health information system is one that ensures the production, analysis, dissemination and use of reliable and timely information on health determinants, health systems performance and health status"

Increased demand for health care services in developing countries and lack of resources to meet this demand has focused efforts on the use of modern technology[1,2].Information and Communication Technology (ICT) has the potential to improve equity in underserved areas.[3] Telemedicine (TM) is upcoming field in health science arising out of effective fusion of Information and Communication Technology (ICT) with medical science having enormous potential in meeting challenges of healthcare delivery to rural and remote areas besides several other applications in education, training, and management in health care.[4] The World Health Organization (WHO) has identified Telemedicine as a possible application to strengthen health systems and improve the quality of health care delivery (Nwabueze et al, 2009).[5]The readiness, acceptance, and perspective of healthcare worker play an important role in success of such health information system.[6]

1.3 Research introduction:

Introduction of digitization in different facets of health care is intended to bring in both efficiency and effectiveness. In this context, e-hospital systems were conceptualized to enhance the quality of services and ensure administrative ease of functioning across government hospitals. Any new change brings its own set of challenges for implementation. The present study is focused to assess the working of the e-hospital systems in meeting the

stated objectives and identify the GAPS for further enhancing their adoptability in the overall health care delivery systems.

1.4 The main objectives of implementing the e-hospital scheme in the hospitals are focused on:

- To improve the patient-centric health services& quality of care in Government health system.

- Improve the efficiency of Health care professionals along with a decrease in burden of workload using user-friendly software.

- To have accurate & valid facility-based reports from the hospitals

- To develop appropriate referral services for the needy community

1.5 The benefits that were expected out of the project:

- Improve patient care by streamlining clinical processes and creating a seamless flow of information.

- Computer-based patient records, portable computers, and expert information systems, to provide clinicians with real-time access to patient information at the point of care.

- Scaled up Telemedicine services to reduce traditional costs and increase the productivity of medical professionals.

- Teleradiology expatriation as a basis for branded healthcare chain, linking rural Hospitals with super-specialty hospitals

1.6 Additional benefits that were envisioned:

- Exclusive online registration can be implemented along with assured referral services (MCH care) in all the hospitals along with regular registration, billing, discharge summary writing and assistance services including management of beneficiary schemes.

- At the state level a consolidated single data generator monitoring along with incorporation of other existing monitoring tools like HMIS, RBSK, Nikshay, IDSP, NCD, e-Aushadi {DVDMS) and Civil registration, the system can be initiated

Moreover, the scale-up of the services can be done to private medical establishments for referral services of Government schemes like Vajpayee Arogya Scheme, Yeshaswini, PMSSY, etc. with monitoring of notifiable diseases through private Hospitals

With the incorporation of the above specified salient features, it is expected that the execution of the e-hospital program be smooth with little or no burden to the technical staffs at hospital level and better implementation, monitoring, and management at district & state level.

2. Log Frame Theory of Change

Components	Project Summary	Indicators	Means of Verification	Assumptions
Goals for • Structure evaluation • Functional evaluation • Beneficiary evaluation	• Evaluation of the e-hospital system in tertiary care government hospitals	• Assessments of • Total hardware deployed • Total personnel sanctioned and appointed • Total patients (OPD/IPD) during specified period	• Infrastructure deployed • Dedicated manpower used • Usage of modules and functions of the system for beneficiaries	• All the modules and system is in place along with the requisite manpower
Activities	• E-hospital system being deployed for the entire patient cycle in the hospital	• Module usage and efficiency assessments • Structured functional assessments • Assessment of safety and security of health data as per the extant standards for patient data management • Deployment and breakdown log for assessing the success of implementation	• Review and assess the utilization of the individual modules for the functions described using observational checklist. • Check the compliances with the applicable health data standards such as HL7, HIPPA and DICOM as applicable	• All activities required for the evaluation are uniform for the entire year with minimal seasonal and temporal variations

Outputs	• Efficient implementation of the e-hospital system	• Documented improvements in waiting time and processing time for common process- registration, lab results and discharge summary • Dept./activities covered, records created, documentation and quality check parameters as per the operational manual of the e-hospital systems	• Reports from time-motion and reports from the HMIS • Dept. activities stratified by modules as clinical / OT/ Admin assessed for availability, accuracy, relevance and completeness. • Quality assessment parameters as per the manual assessed	• Variations across the departments are within the acceptable range of normalcy
Outcomes	• Effective health system providing quality health care to the patients attending the hospitals for services children	• Optimal health outcomes for patients attending the hospitals for services • time management, quality of services- improvement in diagnosis and treatment, improvement in data management and ultimately the health index of the community	• Assess the beneficiary satisfaction for overall services at the centre with specific emphasis on the process and systems separate from the clinical quality of care. • Using Time motion studies average time for	• Respondents are appropriately aware of the systems deployed for the various components of the services provided. • Based on the assumption that comparative data is available before and after implementation.

			critical activities documented and compared with pre-implementation time (whenever available) or non- implemented areas of the facility. • Assessment of health index of community is through indirect measurement of burden of specific disease ex. Reported tuberculosis cases before and after implementation. This would have certain biases and requires care during interpretation.	

3. Progress Review

The e-hospital system has been implemented in India through the National Informatics Center. A total of 322 installations have been done since 2015.

According to e-hospital implementation authority, GOK, e-Hospital (Madhya Pradesh) as of now is performing well with patient experience compared with other states. Specifics of the implementation modalities and other performance parameters are not readily available.

In Karnataka there are 68 installations since September 2015. The three hospitals selected for the present evaluations, namely K C General Hospital, Sanjay Gandhi Trauma Center, Jayanagar General Hospital were chosen as pilot installations. The e-hospital installations are done on local servers, and integration to the NIC cloud is pending. Hence the real-time data from these hospitals are not depicted.

Table 1: The details of the installation are as follows:

Sr. No.	Hospitals	Total Transaction	Percentage (%)	Daily Average	No. of Days
1	Chigateri District Hospital Davangere Karnataka	1021518	3.91	1256	813
2	Mims Teaching Hospital Mandya	968823	3.71	1446	670
3	Mcgann District Teaching Hospital Shivamogga	962118	3.69	1655	581
4	(Gims) Gulbarga Institute Of Medical Sciences Hospital, Kalaburagi, Karnataka	875391	3.35	1265	692
5	Karnataka Institute Of Medical Sciences Hubli Karnataka	853052	3.27	1517	562
6	Bidar Institute Of Medical Sciences Teaching Hospital Bidar	823529	3.16	1112	740
7	District Hospital Chamarajnagara Karnataka	822795	3.15	1020	806
8	Aralaguppe Mallegowda District Hospital	803111	3.08	1109	724
9	Sri Chamarajendra Hims Teaching Hospital Hassan Karnataka	785456	3.01	1344	584

10	District Hospital Dharwad Karnataka	761474	2.92	1020	746
11	District Hospital Chitradurga Karnataka	759426	2.91	895	848
12	Krishna Rajendra Hospital	684665	2.62	1528	448
13	Sri Narasimha Raja ,Karnataka	652108	2.50	735	887
14	District Hospital Tumkur Karnataka	588512	2.26	823	715
15	District Hospital Gadag Karnataka	588510	2.26	854	689
16	District Hospital Chikkaballapura Karnataka	586844	2.25	786	746
17	Raichur Institute Of Medical Science Teaching Hospital Raichur	538437	2.06	1107	486
18	Distrtict Hospital Ramanagara Karnataka	534229	2.05	697	766
19	Karwar Institute Of Medical Sciences Teaching Hospital, Karwar, (Karnataka)-581301	526785	2.02	642	820
20	Wenlock District Hospital Dakshina Kannada Karnataka	496652	1.90	607	817
21	Kodagu Institute Of Medical Sciences Teaching Hospital Madikeri Kodagu Karnataka	496066	1.90	673	737
22	General Hospital Sira Tumkur Karnataka	453845	1.74	549	826
23	District Hospital Vijayapura Karnataka	449806	1.72	780	576
24	District Teaching Hospital Kims, Koppal Karnataka	446832	1.71	575	777
25	General Hospital Malur Kolar Karnataka	444923	1.71	596	746
26	District Hospital Haveri Karnataka	436328	1.67	643	678
27	District Hospital Udupi,Karnataka	432778	1.66	472	916
28	Belagavi Institute Of Medical Science Belagavi Karnataka	432172	1.66	1059	408
29	District Hospital Yadgir Karnataka	401390	1.54	506	793
30	Medical College Hospital Vijayanagar Institute Of Medical Sciences Ballari	400164	1.53	1108	361
31	District Hospital Bagalkot Karnataka	358759	1.37	523	685
32	Sir C V Raman General Hospital Bangalore Karnataka	341874	1.31	421	812
33	General Hospital Kadur Chickmagalur Karnataka	335662	1.29	466	720
34	Blcmc&Ri	325262	1.25	765	425

35	General Hospital Mulbagal Kolar Karnataka	322953	1.24	427	756
36	Govt General Hospital Shahapur	302733	1.16	416	726
37	General Hospital KGF, Kolar Karnataka	297942	1.14	398	748
38	General Hospital Kollegal, Chamarajanagara Karnataka	296879	1.14	374	792
39	Government General Taluka Hospital Shorapur Yadgiri Karnataka	290572	1.11	398	730
40	General Hospital T Narsipura Mysore Karnataka	269895	1.03	449	600
41	Taluk General Hospital Kundapura Udupi Karnataka	267853	1.03	318	840
42	Taluk General Hospital Gundlupete Tq Chamarajanagara District Karnataka	256633	0.98	364	705
43	Crawford General Hospital Sakaleshapura Hassan Karnataka	242128	0.93	313	772
44	Bangarpet General Hospital Kolar Karnataka	218543	0.84	421	518
45	Victoria Hospital Bengaluru Karnataka	218369	0.84	504	433
46	General Hospital Srinivaspura Kolar Karnataka	217413	0.83	291	746
47	Taluk General Hospital Karkala Udupi District Karnataka	215518	0.83	268	804
48	Sub Divisional Hospital, Sagar, Karnataka	205930	0.79	348	591
49	Bangalore Medical College And Research Institute	193138	0.74	426	453
50	Cheluvamba Hospital	167926	0.64	383	438
51	HSIS Gosha Hospital Shivajinagar Bangalore Urban Karnataka	160782	0.62	200	802
52	Taluka Hospital Maddur Mandya, Karnataka	147295	0.56	179	820
53	Taluka Hospital Bilagi Bagalkot Karnataka	130472	0.50	239	545
54	Taluka Hospital Hungund	129949	0.50	229	566
55	Govt Lady Goschen Hospital Mangalore Dakshina Kannada Karnataka	128623	0.49	153	840
56	Regional Institute Of Ophthalmology Minto Ophthalmic Hospital	127669	0.49	290	440
57	Taluk Hospital Yelandur Chamarajanagara Karnataka	120845	0.46	165	728

58	General Hospital Badami Bagalkote Karnataka	111932	0.43	250	446
59	General Hospital Muddebihal Vijayapura Karnataka	102071	0.39	226	451
60	Government of Karnataka Koosamma Shambhu Shetty Memorial Haji Abdullah Mother And Child Hospital	97241	0.37	273	356
61	General Hospital Jamkhandi Bagalkote Karnataka	90019	0.34	187	480
62	Dharwad Institute Of Mental Health And Neurosciences	85187	0.33	185	459
63	Trauma And Emergency Care Centre	69792	0.27	162	429
64	SDS TRC and Rajiv Gandhi Institute of Chest Diseases Bengaluru	64888	0.25	132	488
65	Government Dental College and Research Institute Bengaluru Karnataka	56839	0.22	124	456
66	Princess Krishnajammanni TB and Chest Diseases Hospital	40860	0.16	91	448
67	General Hospital Mudhol	34957	0.13	105	331
68	Rajiv Gandhi Superspeciality Opec Hospital Raichur	20791	0.08	46	443
		26093933			

Table 2: Hospitals in Karnataka using online reservation systems (ORS):

1	All India Institute of Speech Hearing	779
2	Bidar institute of medical Sciences Teaching Hospital Bidar	32
3	District Hospital Kalaburagi	179
4	District Hospital, Udupi	64
5	GENERAL HOSPITAL JAYANAGAR	189
6	K.C. General Hospital, Bengaluru, Karnataka	294
7	NIMHANS, Bengaluru, Karnataka	123185
8	Samvaad Institute of Speech and Hearing, Bengaluru, Karnataka	296
Source: https://dashboard.ehospital.gov.in/dashboard-testing2/EhospitalCount.xhtml		

As per the e-hospital implementation authority, GOK, to create an awareness and to book the appointments through e-Hospital application to the citizens of Karnataka IEC materials and modules are developed and in the process of reaching out to the citizens.

Graph 1: Month wise Patient Registration of Karnataka, all Hospital

Month wise Patient Registration of Karnataka

Month	Value
Nov 18	1218767
Dec 18	1297657
Jan 18	1270026
Feb 18	1225141
Mar 19	1360828
Apr 19	1264630
May 19	1357067
Jun 19	1356999
Jul 19	1468760
Aug 19	1346187
Sep 19	1435826
Oct 19	1400583
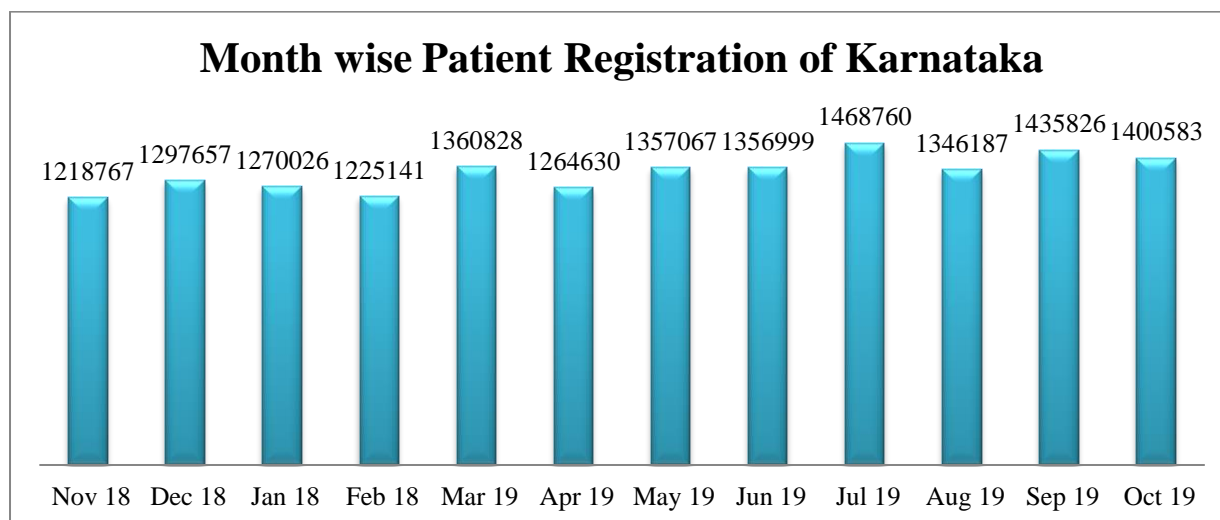
Hospital Name	2017			2018			2019		
	OPD	revisit	IPD	OPD	revisit	IPD	OPD	revisit	IPD
KCG	257884	81644	17035	281311	81644	17035	254555	16792	105050
GH_Jayanagar	202059	84818	13317	201023	95014	12713	192408	78565	12577
SGITO	29431	19474	3624	35001	26636	4051	32120	32777	4198
Total	489374	185936	33976	517335	203294	33799	479083	128134	121825

Graph 2: Digitization of Health Records Trend lines
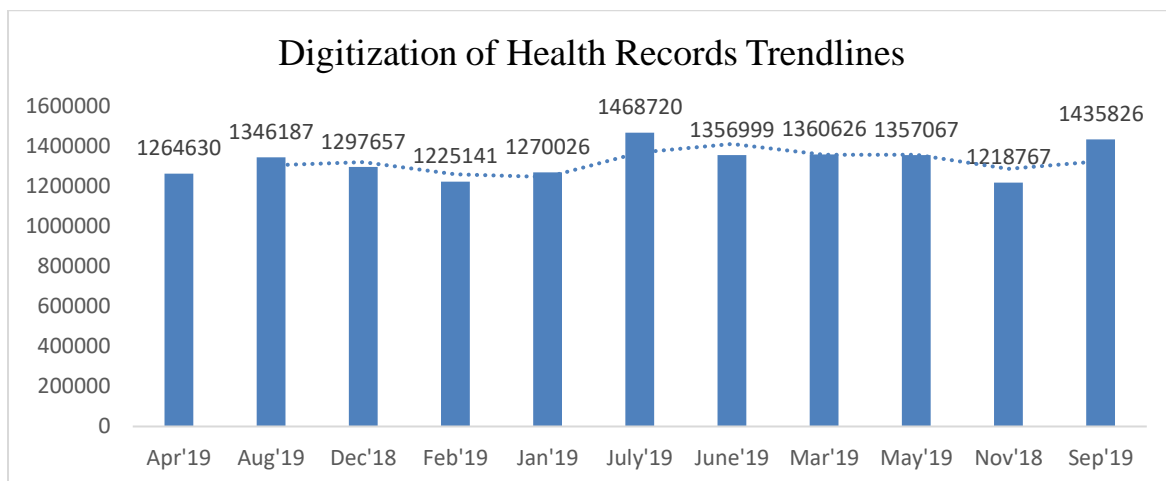
Impression form the available data on the NIC website and the dashboards:

Despite having the e-hospital systems for over five years, the information that is available from the software is aggregate numbers. The dashboards provide very little information regarding the clinical components of patient care. Administrative and decision-making parameters are also mostly missing.

4. Problem Statement

With e-hospital system, it was expected that the execution of the e-hospital programme would be smooth with little or no burden to the technical staff at the hospital level and better implementation, monitoring, and management at district & state level.

After the pilot phase, the system has been replicated in 68 installations across the state.

It is now essential to assess the functioning of the e-hospital system for delivering benefits to improve patient care. Also, the improvement in efficiency of the health care personnel requires evaluation.

Hence the present study envisages to assess the status of fulfillment of the objectives of the e-hospital system and identify the GAPS and scope for improvisation of its utilization.

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5. Evaluation Scope, Purpose and Objectives

An evaluation of the implementation of the scheme needs to be carried out. The e-hospital software how implemented in select Hospitals since the year 2014. It is imperative at this juncture to understand how the software is being implemented and study the various aspects of its utility, success stories, challenges and hence the need to undergo the evaluation. Presently out of 322 total installations in India, 68 installations of the e-hospital system are in Karnataka state. (Source:https://dashboard.ehospital.gov.in/dashboard-testing2/Ehospital Count.xhtml)

5.1 Objectives and the Issues for the Evaluation

The objectives of the present evaluation study were to:

1. Understand the status of adaptability of the e-hospital software developed by NIC
2. Study the implementation experience by the users
3. Assess the impact leading to system process streamlining and improving the efficiency of the hospital as purposed
4. Study the extent of data flow, consolidation, and incorporation
5. Bring out the problem and issues involved in the implementation of the scheme

6. Review of Literature

Electronic Health Records (EHR) consists of a repository of information concerning the health status of individuals. In an EHR, health records are created and managed in digital formats.

The history of clinical documentation is based on paper based records, and they are cumbersome and ineffective. Efficient data retrieval is possible from EHR systems in ways that paper documentation is unable to do. Traditional medical records have restrictions in allowing a global vision of the patient's health conditions. An EHR instead, aims to gather health data, potentially generated by different sources at different times, and share those data with relevant healthcare systems. The sharing of healthcare information between providers using EHR has led to improved outcomes of care and reduced clinical errors. (Handel DA, Hackman JL (2010) "Implementing electronic health records in the emergency department." J Emerg Med 38: 257-263.)

The ability of EHR to share information electronically provides a boost in quality in healthcare management. The main goals of EHR include providing a secure, reliable, and efficient way to register, gather and process all the clinical data related to the patient. Also, it supports the actions related to the clinical practice and patient treatment [8]. When optimally implemented, EHR holds a tremendous potential benefit for healthcare systems, and can enhance how patient data are documented and organized. It is therefore important to study and find out the current issues regarding EHR to make it more efficient and useful. (N M, Mf S, F S. Electronic Health Record Management: Expectations, Issues, and Challenges. Journal of Health & Medical Informatics. 2017 June 26; 8(3):1–5.)

In a study by Dornan et al (2019), that reviewed the medical literature of EHR implementations across 15 countries in Asia, it was concluded that "progress and capacity of EHR systems is far-reaching and effective. Understanding broader and local contexts, access to available resources, addressing organizational challenges, and implementing well thought-out approaches in the development of EHR projects should go a long way to address potential barriers to EHR implementation. The values of EHR are significant and go beyond individual clinical decision-making in its ability to identify disease patterns, seasonal and global trends,

and the potential risks to vulnerable populations as well as to strengthen coordination of care between different sectors. Understanding the potential capabilities and preparing for potential challenges of EHR as highlighted in this study will help facilitate the development and implementation of public health initiatives in Asia to address current needs and identify future risks." (Dornan L, Pinyopornpanish K, Jiraporncharoen W, Hashmi A, Dejkriengkraikul N, Angkurawaranon C. Utilization of Electronic Health Records for Public Health in Asia: A Review of Success Factors and Potential Challenges [Internet]. BioMed Research International. 2019 [cited 2019 Dec 26]. Available from: https://www.hindawi.com/journals/bmri/2019/7341841/)

Technology Adoption Model (TAM) has been widely used in technology adoption studies. The strength of the model lays in its simplicity as it has only two constructs, namely, "perceived usefulness" and "perceived ease of use" for predicting extent of adoption of new technologies at individual level as shown below

These constructs are derived from Bandura's Self Efficacy Theory (1982) which defines perceived ease of use as "the judgments of how well one can execute courses of action required to deal with prospective situation" and from Rogers and Shoemaker (1971) paper which defines complexity (interpreted as ease of use) as "the degree to which an innovation is perceived as relatively difficult to understand and use". The definitions of these constructs are depicted in Table 3.TAM was originally tested in the context of adoption of email service and file editor at IBM Canada with 14 items on each of 2 constructs. The results of the survey on sample of 112 users validated the model with the finding that perceived usefulness is a stronger factor than perceived ease of use that drives technology adoption. In next ten years, TAM became well-established as a robust, powerful, and parsimonious model for predicting user acceptance. King and He (2006) presented a meta-analysis of TAM and found that it is a valid and robust model with applications in a wide range of areas. Dwivedi et al (2010) carried out a comparison of TAM and UTAUT (Venkatesh et al. 2003) and found that focus is now shifting away from TAM to UTAUT while citing in the research articles. In another study, Benbasat & Barki (2007) have criticized TAM especially on the grounds of its limitations in the fast-changing IT environment.

Table 3: TAM Model by Davis 1989

Construct	Definitions
Perceived usefulness	The degree to which a person believes that using a particular system would enhances his or her job performance
Perceived ease of use	The degree to which a person believes that using a particular system would be free of effort.

6.1 Unified Theory of Acceptance and Use of Technology (Venkatesh, 2003)

This theory, popularly referred as UTAUT was postulated in 2003 by Venkatesh et.al. by a systematic review and consolidation of the constructs of earlier eight models (TRA, TAM, MM, TPB, TAM2, DOI, SCT and model of personal computer use). It is meant to serve as a comprehensive model that can be applied across a range of applications. It has four key constructs namely "performance expectancy, effort expectancy, social influence and facilitating conditions" which are depicted in below Figure.

For developing the unified model, the authors have compiled and tested all the constructs that were used in previous models and theorized that out of the seven constructs used earlier, four constructs shown above are most significant as determinants of intention to use information technology. They have hypothesized that remaining three constructs, namely, attitude toward using technology, self-efficacy, and anxiety are theorized not to be the direct determinants of intention as they are fully mediated by ease of use which has been considered in the unified model as performance expectancy. Therefore, these three constructs have been removed from the UTAUT model. The constructs in the unified model are defined as in table 4.

Table 4 : Constructs used in UTAUT (Venkatesh et.al. 2003)

Construct	Definition	Root source of the construct	Moderators
Performance expectancy	Performance expectancy is defined as the degree to which an individual believes that using the system will help him or her to attain gains in job performance.	The five constructs from the different models that pertain to performance expectancy are perceived usefulness (TAM/TAM2), extrinsic motivation (MM), job-fit (MPCU), relative advantage (IDT), and outcome expectations (SCT).	Gender, Age
Effort expectancy Effort	Effort expectancy is defined as the degree of ease associated with the use of the system	three constructs from the existing models capture the concept of effort expectancy: perceived ease of use (TAM/TAM2), complexity (MPCU) and ease of use (IDT)	Gender, Age, Experience
Social influence Social	Social influence is defined as the degree to which an individual perceives that important others believe he or she should use the new system.	The three constructs related to social influence: subjective norm (TRA, TAM2/IDTPB, TPB), social factors (MPCU), and image (IDT)	Gender, age, voluntariness and experience
Facilitating conditions (no effect on use intention but direct effect on use behaviour)	Facilitating conditions are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.	Three different constructs used in earlier models are: perceived behavioural control (TPB, DTPB, C-TAM-TPB), facilitating conditions (MPCU) and compatibility (IDT).	Age and experience

6.2 Scope of work:

The evaluation study would intend to evaluate different the aspects of the scheme in line with the technical, managerial and usage of the scheme. The audit would comprise of functional assessment, utilization of the scheme and managerial audit"

While undergoing the evaluation, following need to be captured:

a. Efforts were made to bring up and highlight the major issues and concerns pertaining to:

➢ Computers & other Hardware

- Computers, printers
- Server machine
- Network
- Maintenance
- Back up and inventory

➢ Software Issues

- Software package evaluation
- Software module usage
- Maintenance and warranty (what is the SLA)
- Backup support

➢ Installation

- Software installation
- Hardware installation
- Network verification

➢ Human Resource Management

- Implementation by the existing manpower
- Appointment of additional manpower
- Training and Capacity building
- Adaptability and change management

➢ Operational Aspects

- Operational efficiency

- Module adoptability and acceptability (departmental level, service points)

- CPOE support for users

Users perspectives

- Implementation experience (doctors/ nurses/ other admin staffs)

- Management of beneficiary schemes (insurance, Tap's, Government schemes etc.)

Beneficiary perspective

- Beneficiary experience while availing the service

➢ Operational Aspects

7. Evaluation Methodology

7.1 Health Care Informatics

Health care Informatics

Informatics			pHealthcare			
Structure	**Function**	**Semiotics**	**Stakeholders**	**Care**	**Value**	
Hardware	Acquisition	Data	Recipients	Avoidance	Life	[value of healthcare]
Sensors	Storage	Static	Individuals	Prevention	Psychological	
Devices	Encrypted	Streaming	Families	Treatment	Economic	
Software	Non-Encrypted	Health Records	Communities	Cure	Social	
Platform	Analysis	Current	Societies	Elimination	Cultural	
Applications	Quantitative	Historical	Providers	Rehabilitation	Ethical	
Networks	Qualitative	Knowledge	Payers		Spiritual	
Local Wireless	Interpretation	Current	Researchers			
Telecommunication	Diagnostic	Traditional	Pharmaceuticals			
Processes	Predictive		Governments			
Manual	Interventional		Regulators			
Automated	Application					
Policies	Adoptive					
Privacy	Prescriptive					
Regulation	Scholastic					
	Distributive					
	Deletion/Erasure					
	Local					
	Systemic					

Rotated bracket labels: [for mobile], [of], [of/for/by], [for personalized], [of illness for]

7.2 Study Area: Bangalore urban district.

Presently the e-hospital initiative has been piloted in KC General Hospital and Jayanagar General Hospital and Sanjay Gandhi Institute of Trauma & Orthopaedic Centre All centers were evaluated.

Table 5: Study Population

	Jayanagar	KC General	Sanjay Gandhi
	Average patient	Average patient	Average patient
OPD	22461	22500	5951
IPD	1000	1500	434
Doctors	52	52	48
Staff	176	93	120

Source: Secondary data

8. Evaluation Design

8.1 Study Setting and Sample Size

Table 6: Sample size determination for the evaluation:

Particulars	Sampling Determination
Hospital evaluation	The three hospitals where it got piloted namely, KC General Hospital, Jayanagar General Hospital and Sanjay Gandhi Institute of Trauma & Orthopaedic Centre
Beneficiary Interview	5%o of average monthly patient flow (OPD and IPD respectively) An exit interview to be conducted. The response should be able to bring out the experience undergone during the various service points while availing the service (Eg. appointment scheduling, turnaround time, report dispatch etc.)

The instrument is semi-structured questionnaire which will be pre-tested, the questionnaire has three parts.

I.   **Part –A:** consists of basic demographic details of the respondent like name, age, and gender, mobile no etc.
II. **Part-B:** consist of 9 questions to know computer literacy of the respondent
III. **Part-C:** Consist of 33 questions adopted from UTAUT model described above.

Evaluation study on Usage of the e-hospital software developed by NlC, Karnataka
Facility Description

- Name of the health care facility:
- Services offered:
- List all the general and specialty services
- Infrastructure and resources available on the health care facility (Report as per the structured KEA format)
- Bed capacity
- Manpower resources details

8.2 Sample Method

Qualitative responses from the key respondent interviews will be summarized for action

User experience	For Users' experience, details to be collected from each of the Module implementers. At least 25% of the staffs from every department (end users) to be interviewed for the evaluation Respondents both from clinical and clinical department should be chosen. Doctors using CPOE to be included in the sampling frame
	Departments covered:
	1. OPD Patient Registration personnel
	2. Emergency Registration personnel
	3. Admission and Discharge
	4. Billing and Accounts Personnel
	5. Laboratory technician
	6. Radiology technician
	7. OT nurse
	8. OT technician
	9. Pharmacy Personnel
	10. Blood bank Personnel
	11. Medical Records Personnel
	12. Stores and Inventory Personnel
	13. Laundry Personnel
	14. Dietary Personnel
	15. Telemedicine technician
	16. Ward nurse
	17. Doctors using CPoE (suggested a mix of OPD and IPD as applicable),

9. Methods of Data Collection and Analysis

At each hospital based on the PPP (population proportional probability sampling will be used to choose an appropriate representative sample for each stratum under study)

	Evaluation Headers for Domains	Approaches to Response
1.	System analysis- Hardware and software	Observational checklist and visual inspection of key components, record analysis, Time motion studies in sample activities
2.	Operational parameters	Sample surveys among key stakeholders using technology adaptation model (TAM)
3.	Human Resource	Training assessments, records, questionnaires survey, Key respondent interviews
4.	User acceptance and Beneficiary perceptions	Questionnaires, Focus group discussions,

o Qualitative assessment of focus group discussions with narrative summaries and triangulation for key outcomes and inferences.

o Quantitative data to be summarized using measures of central tendency and deviations (Mean ± SD), percentage and proportions.

o Test of significance for testing the differences between categories of patients, gender and other attributes using Chi Square tests for proportion and independent T test for mean (or non-parametric counterparts as suitable). Level of significance to be fixed at $p < 0.05$

Table 7: Statistical Methods and results:

KC General

Description	Total available	Total interview	Percentage
Doctors	52	14	
Nurses	93		38 %
Lab Technicians	6	44	
X ray technicians	3		
Out Patients (Monthly)	22500	1253	6 %
In Patients (Monthly)	1500	**75**	5 %

Jayanagar General Hospital

Description	Total available	Total interview	Percentage
Doctors	50	15	
Nurses	99		27%
Lab Technicians	7	25	
Out Patients (Monthly)	22461	1091	5 %
In Patients (Monthly)	1000	50	5 %

Sanjay Gandhi Trauma Hospital

Description	Total available	Total interview	Percentage
Doctors	50	16	
Nurses	106		25 %
Lab Technicians	25	30	
Out Patients (Monthly)	5951	300	5 %
In Patients (Monthly)	434	29	7 %

As per the proposed methodology and sample size, 25% of the health care personnel from each hospital and 5% of average monthly OPD and Inpatient respondents were included for the interviews.

10. Findings and Discussion

10.1 Study the implementation experience by the users-

Patients Profile:

Table 8: Distribution of patient respondents across Hospitals

Sl. No	Hospitals	Number Sample patient Respondents	Percent
1	GH-Jayanagar	1141	41
2	KCG-Malleswaram	1328	47
3	SGITO-Jayanagar	329	12
	TOTAL	**2798**	**100**

Both KC General and Jayanagar general hospitals cater to more significant number of patients as compared to Sanjay Gandhi Hospital which is a specialized trauma care center. Hence the proportional contribution of the patient number for the study is limited. However, proportional probability of representation to the average monthly patient numbers has been maintained in each of the hospitals.

Graph 3: Number Sample patient Respondents across Hospitals
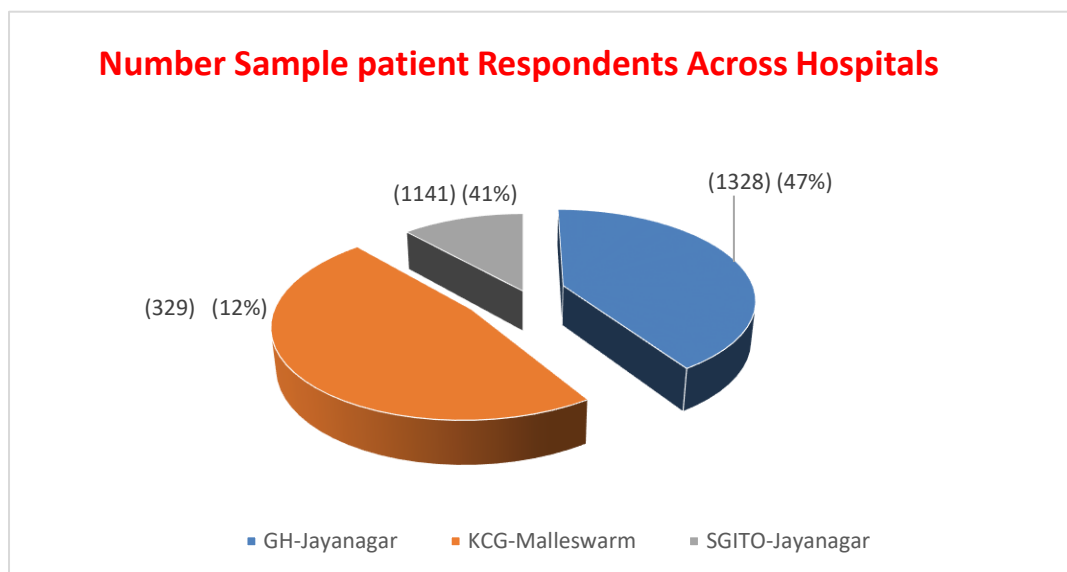
Table 9: Distribution of patient Respondents by Gender

Sl. No	Hospitals	Male patient Respondents	Female patient respondents	Total
1	GH-Jayanagar	544 (48%)	597 (52%)	1141
2	KCG-Malleswaram	703 (53%)	625 (47%)	1328
3	SGITO-Jayanagar	198 (60%)	131 (40%)	329
	TOTAL	1445 (52%)	1353 (48%)	2798

All three hospitals have similar gender distribution. KC General Hospital is showing a moderate higher number of female respondents due to maternal and child health focus of services.

Graph 4: Distribution of Patient Respondents by Gender
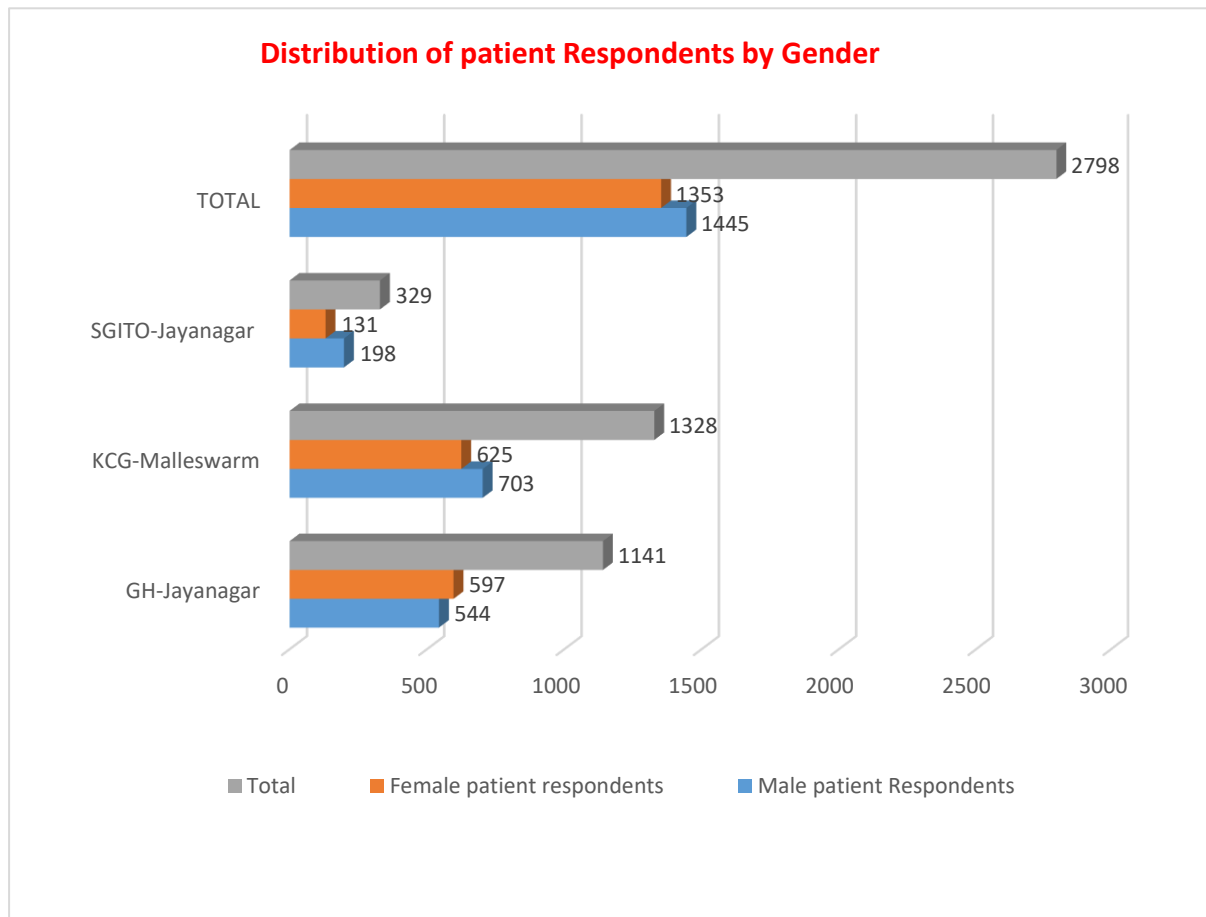
Table 10: Distribution of patient respondents across Hospitals –Urban and Rural

Sl. No	Hospitals	Urban	Rural	Number Sample patient Respondents
1	GH-Jayanagar	1105 (97%)	36 (3%)	1141
2	KCG-Malleswaram	1312 (99%)	16 (1%)	1328
3	SGITO-Jayanagar	312 (95%)	17 (5%)	329
	TOTAL	2729 (98%)	69 (2%)	2798

Predominant numbers of patients in all three hospitals are from urban areas.

Graph 5: Percentage Distribution of patient respondents across Hospitals –Urban and Rural
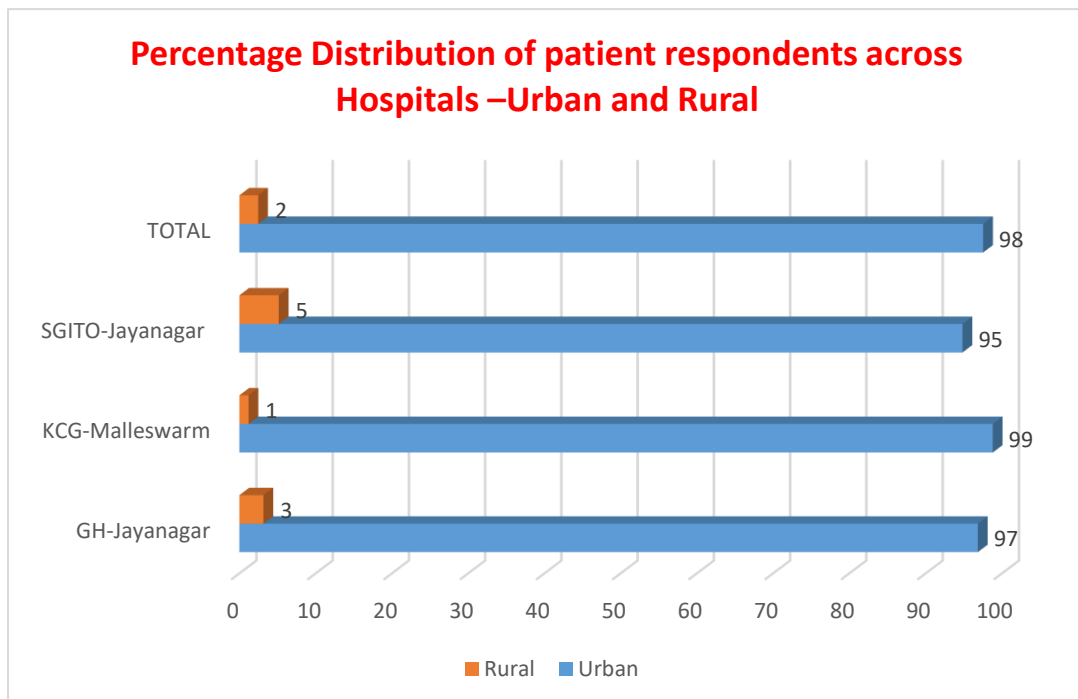
Table 11: Distribution of patient respondents across Hospitals – Out Patient / Inpatient

Sl. No		Out Patient	Inpatient	Number Sample patient Respondents
1	GH-Jayanagar	1091 (96%)	50 (4%)	1141
2	KCG-Malleswaram	1253 (94%)	75 (6%)	1328
3	SGITO-Jayanagar	300 (91%)	29 (9%)	329
	TOTAL	2644 (94%)	154 (6%)	2798

Outpatient to inpatient ratio in K C General and Jayanagar General Hospitals are different from Sanjay Gandhi Institute due to the nature of cases visiting the SGITO. Most of the trauma cases require in-patient interventions and surgeries and hence, a higher inpatient ratio is noticed.

Table 12: Distribution of patient respondents across Hospitals – Income group

Sl. No		APL	BPL	No Ration Card	Number Sample patient Respondents
1	**GH-Jayanagar**	**179** **(16%)**	**905** **(79%)**	**57** **(5%)**	**1141**
2	**KCG-Malleswaram**	**28** **(2%)**	**1300** **(98%)**	**-**	**1328**
3	**SGITO-Jayanagar**	**25** **(8%)**	**291** **(88%)**	**13** **(4%)**	**329**
	TOTAL	**232** **(8%)**	**2496** **(89%)**	**70** **(3%)**	**2798**

Predominantly in all the three hospitals, patients below poverty line outnumber that above poverty line.

Graph 6: Distribution of patient respondents across Hospitals – Income group
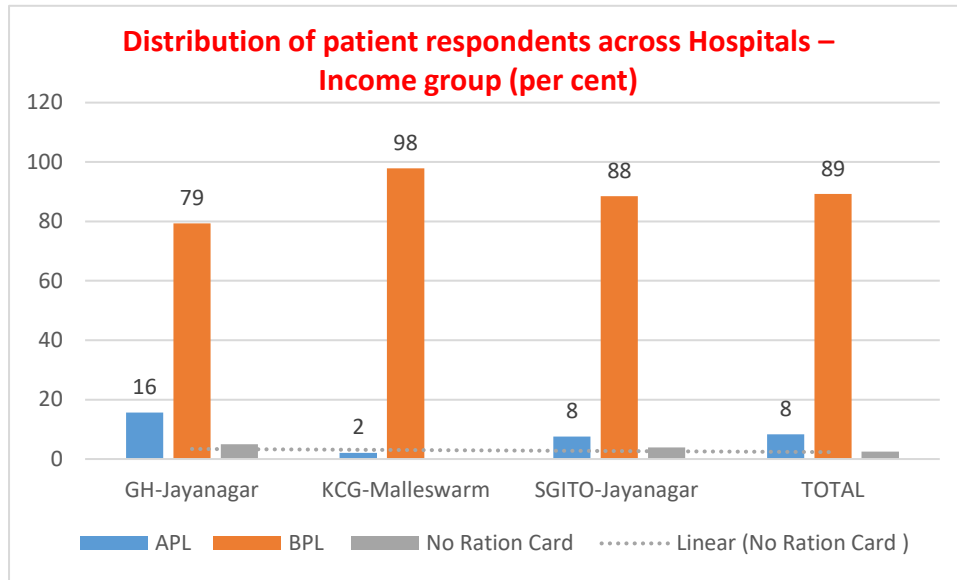
Table 13: Age composition of Patient Respondents across Hospitals

Sl. No	Hospital	0-10	11-20	21-40	41-60	➢ 60	Total
1	GH-Jayanagar	135 (12%)	159 (14%)	478 (42%)	272 (24%)	97 (9%)	1141 (100%)
2	KCG-Malleswaram	206 (16%)	160 (12%)	563 (42%)	279 (21%)	120 (9%)	1328 (100%)
3	SGITO-Jayanagar	3 (1%)	34 (10%)	139 (42%)	109 (33%)	44 (13%)	329 100%)
	TOTAL	344 (12%)	353 (13%)	1180 (42%)	660 (24%)	261 (9%)	2798 (100%)

Source: Primary Data

Graph 7: Age composition of Patient Respondents across Hospitals

Predominantly patients in the age group 21-40 were more in all the three hospitals.
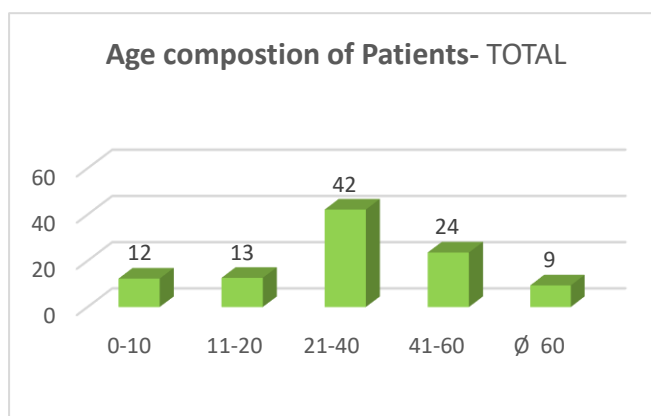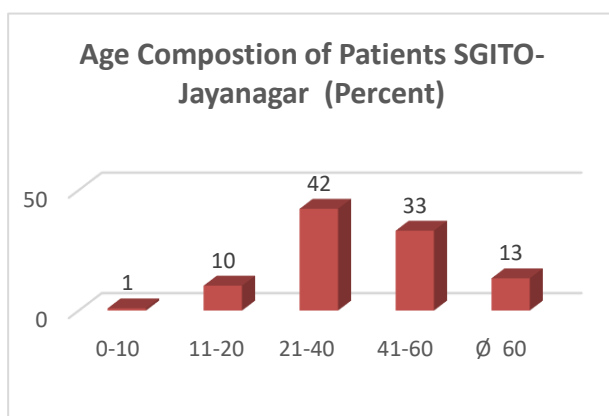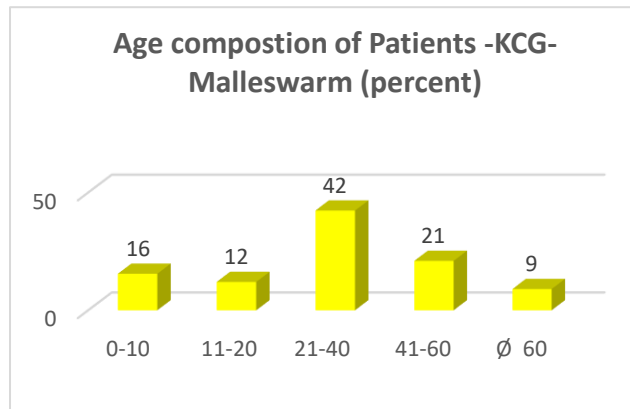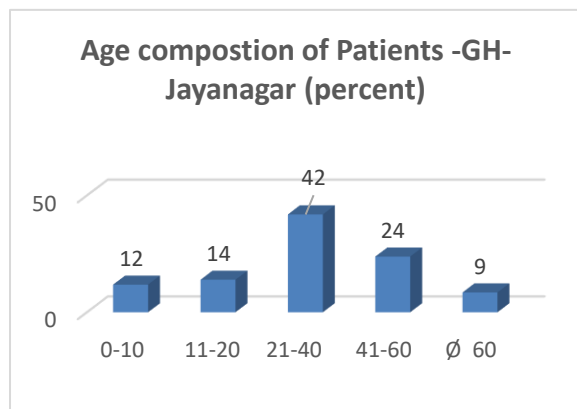
Source: Primary data

Table 14: Education level of Patient Respondents across Hospitals

Sl. No	Hospital	illiterate	Literate	Primary	Middle	Secondary	PUC	Degree & above	Total
1	GH-Jayanagar	16 (1%)	375 (33%)	63 (6%)	100 (9%)	352 (31%)	189 (17%)	46 (4%)	1141 (100%)
2	KCG-Malleswaram	39 (3%)	460 (35%)	61 (5%)	85 (6%)	419 (32%)	197 (15%)	67 (5%)	1328 (100%)
3	SGITO-Jayanagar	7 (2%)	108 (33%)	5 (2%)	22 (7%)	88 (27%)	71 (22%)	28 (9%)	329 (100%)
	TOTAL	62 (2%)	943 (34%)	129 (5%)	207 (7%)	859 (31%)	457 (16%)	141 (5%)	2798 (100%)

Source: Primary data

It is reported that one-third of the patients in all the three hospitals were just literate and less than 5% of them were degree holders. The low level of literacy among the beneficiaries in the hospitals might have a bearing on their understanding and use of technology solutions through the e-hospital system. However, it has been observed that formal literacy seldom precludes technology use. Mobile phones are used extensively for social media applications by not-literate population.

Table 15: Doctors' Profile

Sl. No	Items	
1	Number of Hospitals covered	3(KCG/GHJ/ SGITO)
2	No of Doctors Interviewed	45
3	Gender Composition Male Female	Nos % 26 59.5 % 18 40.5 %
4	Total work Experience (Average Yrs.)	17
5	Experience in Present Hospital (Average yrs.)	5.01
6	Number of years employed in current facility Average (yrs.)	5.01

Table 16: Perceived ease of use of the e-hospital facility by Doctors

(Based on the Index constructed by seeking response on various factors by asking Doctors answer nearly 32 questions pertaining to use of e-hospital facility).

Sl. No	Index of perceived ease of use classified as	Male		Female		Total	
		No. Doctors	Percent	No. Doctors	Percent	No. Doctors	Percent
1	LOW (Xi ≤ Mean – (σ/2))	7	28	4	24	11	26
2	Moderate (Mean –(σ/2) ≤ Xi ≥Mean + (σ/2))	10	40	5	29	15	36
3	High Xi ≥ Mean + (σ/2)	8	32	8	47	16	38
Total		25	100	17	100	42	100

Source: Primary data

10.1.1 Chi-square test of Independent of attributes:

To test the hypothesis HO: perceived ease of using e-hospital facility and Perception across gender is independent.

Chi-Square Calculated $X^2 = \sum\sum [(O_{r,c} - E_{r,c})^2 / E_{r,c}]$

Chi-Square calculated for the above table = 0.9972

Chi-Square Table value @ (r-1) (c-1) df = 2 = 5.991 @ 5% level of significance

Chi-square=Calculated I less than Chi-square Table value = We Accept Ho.

Inference: Perceived ease of using e-hospital facility and Perception across gender is independent.

Table 17: Distribution of Doctors according to exposure to use of computers

Sample size n=23

Sl.NO	Item	No. Doctors	Percentage
1	Doctors who computer literate	20	48
2	Doctors who are not-computer literates	13	31
3	Doctors who partially exposed computer use	9	21
4	Total	42	100

Source: Primary data

Table 18: Distribution of Doctors who are computer literate according to use
Sample size n=18

Sl.NO	Item	No. Doctors	Percentage
1	Word processing	24	57.1
2	Spread Sheet / Excel	21	50.0
3	Data bases	15	35.0
4	Statistics Packages	9	21.0
5	Presentation software	20	48.0
6	Transferring files	25	60.0
7	Scanning and creating PDF files	19	44.0
8	Use of E-mail	30	70.0
9	E-health solution application	21	50.0

Source: Primary data

Table 19: Doctors who are using other technologies   **Sample size n=23**

Sl.NO	Item	No. Doctors	Percentage
1	Digital cameras to take pictures	25	60.0
2	Smart Mobile phones	37	88.0
3	Owns laptop	23	55.0
4	Owns Personal computer	11	25.5
5	Training on E-health solutions	4	10.0

Source: Primary data

Table 20: Perceived ease of e-hospital facility VS Computer Literacy

Perceived ease	Doctors		
	Computer Literate	**Not Computer literate**	**Total**
Low	4	7	11
Moderate	11	4	15
High	11	5	16
Total	**26**	**16**	**42**

Source: Primary data

10.1.2 Correlation of the individual attributes and inferences:

1.	Correlation between perceived ease Vs. Total work experience	-0.29	A negative correlation indicates that as the years of work experience increases, the perceived ease of technology adaptation decreases. Negative correlation may be confounded by age as both work experience and years at an institution is related.
2.	Correlation between perceived ease Vs. Experience in the present hospital	-0.27	Similar to above as age, experience are related and can influence the perceived ease of use.
3.	Correlation between perceived ease Vs. Computer literate	0.37	Computer literacy confers confidence and easy adaptation of technology use and hence is positively correlated.

| 4. | Correlation between Total experience Vs. Computer literate | -0.14 | A negative correlation indicates that as the years of work experience increases, the perceived ease of technology adaptation decreases. |
| 5. | Correlation between Experience in present hospital Vs. Computer literate | -0.30 | Similar to above as age, experience are related and can influence the perceived ease of use. |

10.2 Profile of supporting staff at selected Hospitals

Table-21: Gender composition of supporting staff at hospitals

SL. NO	Gender	GHJ		KCM		SGITO		Total	
		No	percent	No	Percent	No	Percent	NO	percent
1	Male	6	**24**	20	**45**	11	**37**	37	**37**
2	Female	19	**76**	24	**55**	19	**63**	62	**63**
3	Total	25	**100**	44	**100**	30	**100**	99	**100**

Source: Primary data

Table 22: Total work experience of supporting Staff (in years) at different hospitals

Sl.NO	Gender	KCM	GHJ	SGITO	TOTAL
1	Male	20.5	11.03	2.85	11.32
2	Female	14.68	11.50	4.48	10.21
3	Total	16.14	11.10	4.06	10.58

Source: Primary data

Table 23: Educational Qualification of supporting staff of Hospitals

Sl. No	Qualification	GHJ		KCM		SGITO		Over All		
		Male	**Female**	Male	Female	Male	Female	Male	Female	Total
1	PUC		1	2	4		1	2	6	**8** **(8.0%)**
2	**Graduate** General	2	2	11	12	5	5	18	19	**37** **(37%)**
	Professional (Pharma, Nursing, etc.,)		4		3		7	-	14	**14** **(14%)**
3	**Post Graduate**		2	2	2			2	4	**6 (6%)**
4	Others (Diploma in Pharmacy, ARAY, Radiology, etc.)	4	10	5	3	6	6	15	19	**34** **(34%)**
	Total	6	19	20	24	11	19	37	62	**99** **(100%)**

Source: Primary data

Table-24: Staff classified based on values of Index of Ease, usefulness, attitude and overall index

Index classification	Index of Perceived ease of Use		Index Perceived usefulness		Index Attitude		Overall Index	
	No. of staff	Percent	No. of staff	Percent	No. of staff	Percent	No. of staff	Percent
Low	36	**36**	28	**28**	23	**23**	34	**34**
Moderate	32	**33**	52	**53**	48	**49**	37	**38**
High	31	**31**	19	**19**	28	**28**	28	**28**
Total	99	**100**	99	**100**	99	**100**	99	**100**

Source: Primary data

Table 25: Correlation Matric between Indices

	Index of Perceived ease of Use	Index of Perceived usefulness	Index of Attitude	Overall Index
Index of Perceived ease of Use	1.00			
Index of Perceived usefulness	0.20	1.00		
Index of Attitude	0.18	0.51	1.00	
Overall Index	0.59	0.74	0.84	1.00

Source: Primary data

10.2.1 Results of Multiple Linear Regression Model:

$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon_i$

Y_i = Index of Overall implementation of e-hospital facility

X_1 = Index of perceived ease of use

X_2 = Index of perceived usefulness

X_3 = Index of Attitude

ϵ_I = Random Disturbance term

β are regression coefficients

10.2.2 Estimated regression equation

$Y_{i\ (estimated)}$ = $0.7395^* + 0.0963^{NS} X_1 + 0.0112NS X_2 \ \ -0.5280^* X_3$

         (15.70)   (1.62)   (0.19)   (-7.69)

R^2 =0.45, Fcal = 25.41*

       *Indicate statistical significance

- NS =Non-significant

(Note: regression coefficient of = Index of Attitude is negative and statistically significant, regression equation is explaining nearly 45 percent of variation in overall index, as value of R-square is 0.45 which is statistically significant)

Table-26: Correlation between total work experience and No. of yeas employed in the e-hospital software facility:

	Total work Experience (in Years)	No. of years employed in the current facility (e-Hospital):
Index of Perceived ease of Use	-0.27	0.06
Index of Perceived usefulness	-0.19	0.04
Index of Attitude	0.05	0.26
Overall Index	-0.17	0.25

Source: Primary data

A negative correlation indicates that as the years of work experience increases, the perceived ease of technology adaptation decreases. Negative correlation may be confounded by age as both work experience and years at an institution is related.

Training & Capacity building of Human Resources

As per the responses from the e-hospital implementation authority, GOK, it is a continuous process and a part of e-Hospital, the hands-on training will be given to the technical resources once in every 2 months. In-turn programmers train and handhold doctors, hospital staff and DEO's for which budget has been released to the respective districts.

10.3 Results from the data generated – objective wise:

Understand the status of adoptability of the e-hospital software developed by NIC

Table 27: Status of Hardware and software facilities provided under e-hospital programme

Sl. NO.	E-hospital facilities	KCG Hospital	General Hospital Jayanagar	Sanjay Gandhi Hospital-Jayanagar	Technological gap –identified	Remarks.
				Hardware Report:		
1	-# of Desktop computers:	47	32	10	Old Operating Softwares	Upgrade to the latest OS
2	-Desktop Computers	47 No's (Acer and HP Desktops)	32(11-Dell, 21(Acer)	10	Old and outdated OS desktops.	Tablets/Laptops are mobile and should be considered to ease the use for doctors.
3	- Laser Printers	13	11	5	Outdated printers with Wired connection	Wi-Fi enabled Printers available
4	- Bar Code Reader	6	2	5	No integration with e-hospital module	Integrate the reader with the module to automate processes like lab report generation, revisits etc.
5	- Bar Code Printer.	2	6	5	Very long bar codes.	The bar codes need to be regularized across the e-hospital module to build a strong & Secure DB of patients.
6	- 5 KVA UPS	2	2	2	Old UPS's, no Scheduled AMC.	Upgrade or reduce the no of UPS's by optimizing and upgrading to latest UPS's with higher capacity.
7	- 2 KVA UPS	2	2	2		
8	- 1 KVA UPS	11	11	1		
9	- 700 VA UPS	40	31	5		
10	- LAN Ports	240 I/O Ports			LAN ports can be retained & confined within the server room.	Wi-Fi___33 Routers//Devices should be introduced

11	- Servers	4	4	4	Upgrade OS, move them to the cloud.	On cloud servers are the way forward.
Software Report:						
1	Operating systems on Servers:	Red hat Linux 7.0	Red hat Linux 7.0	Red hat Linux 7.0	Upgrade needed.	Need to update to the latest version or change to a better OS with more functionality.
2	- Operating systems on Desktops:	Windows 7 Professional	Windows 7 Professional	Windows 7 Professional	Outdated operating software	Need to upgrade to latest OS for high functioning and fast runtime.
3	- Mail Server:	Gmail	Gmail	Gmail	Secure licenses should be procured.	Dedicated licenses should be procured by NIC.
4	- Printer Software:	HP- LaserJet Pro 400 M401dn and MFP				
5	- # of Application running:	7 (Any desk /NUDI/Firefox/McAfee/Jboss application/ Tomcat/e-Hospital)	5 (Any desk /Firefox/McAfee/Tomcat / e-Hospital)	5 (Any desk /Firefox/McAfee/Tomcat/ e-Hospital)	Need as basis applications must be downloaded.	All third party applications should be authorized and incorporated across all hospitals evenly. Authorization must be from NHM on need for basis only.
6	- Antivirus:	McAfee	McAfee	McAfee	Traditional software than can be overridden.	Application levels security must be incorporated to keep data and information secured at the highest level
7	- e-Hospital managed by:	NIC	NIC	NIC	All communication has to be routed through mails, Any desk with NIC, Tripura team. Its time consuming and inefficient	NIC can have Special Technical experts for each zone to manage and customize the solution to each of the hospitals needs and magae it locally

						and efficiently.
8	- Server Room-	On Premises	On Premises	On Premises	On premises is traditional way.	Moving the servers to the cloud is the next way forward for its s easy to access data and securely too. No risk of physical damage.
9	- CCTV's	12	8	10	No dedicated resources to monitor the cctv.	There should be number of CCTV's and strategically placed such as in server room, labs; to ensure safety and security across the hospitals.
10	- Biometric Access:	Only for attendance	Only for attendance	Only for attendance	Doctors and Staff use it for Attendance purpose only. Currently hospital uses a traditional lock and key to access server room, inventory room where hardware is kept.	The Biometric must also be placed at important rooms like server room with limited people accesses, this amounts for accountability.
11	- Backup & Secondary Servers:	On Premises at KCG	On Premises	On Premises	On Premises servers not a good practice.	The servers must be moved to cloud.
12	- Backup & Secondary Servers Managed by :	NIC	NIC	NIC	As the servers are on premise, NIC gains access to these via internet (peer-to-peer) connection to backup and transfer data.	There must be a cloud server with secure connection directly from host servers to backup; must be scheduled to auto-backup every hour or 2 hours to keep data safe.
13	- Local (On premises Resource) for any kind of troubleshooting:	**NIL**	NIL	NIL	Unsecure mode of communication (via email) is used to troubleshoot with the NIC team at Tripura.	NIC must have an on premises technician to oversee and troubleshoot premises in case of any issues.

14	- Training on e-Hospital Module:	3 Days	NIL	No Transition	No clarity from NIC team in terms of transition from one employee to another	NIC must appoint a program manager across a zone of hospitals to oversee the transition.
15	-Access management (Login and Password management):	Admin(1 Resource)	Admin and Medical SI	Admin	No clear hierarchy, single point admin determines the login credentials.	Admin in sync with Medical SI or RMO must changes/password and manage them monthly to keep the system secure.
16	- AMC:	Once in 6months or 12 months depending on the need and availability	AMC requirements not scheduled for most hardware.	AMC requirements not scheduled for most hardware.	There is no schedule for AMC across any of the hardware solutions.	Every Hardware purchased must be againg an AMC.
17	- SPOC for troubleshooting:	**NIL**	Data entry Operator	NIL	Unskilled technicians.	There must be a dedicated skilled technician or expert in the module to troubleshoot and resolve the issue instantaneously.

Screenshots of - e Modules of K C General Hospital
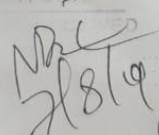
Table 28: Average Time taken for different services as reported by the patient respondents (In minutes)

Sl. No	Different service points	GH-Jayanagar		KCG-Malleswaram		SGITO-Jayanagar	
		Number Patient responded	Average time taken (in minutes)	Number Patient responded	Average time taken (in minutes)	Number Patient responded	Average time taken (in minutes)
1	Registration	136	12.15	90	12.95	17	10.66
2	OPD Consultation	925	12.04	1101	12.60	283	12.96
3	Lab Sample Collection	38	10.54	85	13.50	-	-
4	Lab Report	10	10.55	22	10.50	1	15.00
5	Definitive Treatment	1	15.00	18	18.50	-	-
6	OP to IP admission	2	5.00	7	10.00	-	-
7	In Patient	29	14.58	5	13.50	28	10.00
8	Discharge	-	-	-	-	-	-
	TOTAL	1141	-	1328	-	329	-

Source: Primary data

Table 29: Level of satisfaction expressed by patient respondents on e-hospital services

(Based on Q12 where the respondents were asked give their direct opinion on extent of benefit they got from implementation of the e-hospital facility)

Sl. No	Hospital	Satisfied		Indifferent		Dissatisfied		Total	
		Nos	%	Nos	%	Nos	%	Nos	%
1	GH-Jayanagar	953	84	174	15	14	1	1141	100
2	KCG-Malleswaram	1066	80	174	13	88	7	1328	100
3	SGITO-Jayanagar	324	98	3	1	2	1	329	100
	TOTAL	2343	84	351	13	104	3	2798	100

Source: Primary data

Table 30: Level of satisfaction derived by the beneficiary due to adoption of e-hospital facility

(Index was constructed based on responses obtained to Q5.2, Q5.4, Q6, Q6.1, Q7, Q8, Q9, Q10, Q11, Q13, and Q14)

Index of beneficiary (Patients) satisfaction	GH-Jayanagar		KCG-Malleswaram		SGITO-Jayanagar		Total	
	No. of patients	Per cent	No. of patients	Per cent	No. of patients	Per cent	No. of patients	Per cent
Less	331	29	283	21	24	7	638	23
Moderate	173	15	620	47	305	93	1098	39
High	637	56	425	32	-	-	1062	38
Total	1141	100	1328	100	329	100	2798	100

Source: Primary data

In order elicit the level of satisfaction derived by the beneficiaries due to adoption of e-hospital facility two approaches have been used. First, the beneficiaries were asked to give their direct opinion on extent of benefit they got from implementation of the e-hospital facility (Q12). In order validate direct response obtained from them, eleven different questions were posed to beneficiaries in order seek information how the e-hospital facilities have helped them to ease their transaction right from registration to the exit point. These responses were indexed based on the scores given to above question by respondents (see Table-26), Index has been constructed by taking the overall responses for all the questions mentioned above following the procedure detailed below.

$$SIi = \frac{X_{i-MINI}}{MAX - MINI}$$

SI_i = Satisfaction index of ith beneficiary.

X_i = Actual score of respondent ith respondent

MINI= Minimum score permissible.

MAX = MAX score permissible

No. of questions considered = 11

Index score obtained for each individual have been classified as, less satisfied, moderately satisfied and highly satisfied respondents. If the index value is less than (X-Bar Minus half

standard deviation) they have been classified under less satisfied category, if index value lies between (X-Bar minus half standard deviation and X-Bar plus half standard deviation) they have been classified under moderately satisfied category, those individuals whose index value is more than (X-Bar plus half standard deviation) they have classified under highly satisfied category.

Interestingly when you compare the Index of satisfaction with the direct response (see the other table constructed for Q12) of patients regarding their opinion on e-hospital facility created , most of them have expressed satisfactory performance (84,80 and 98 per cent GHJ,KCG, SGITO respectively), whereas, the index constructed by taking responses for various question on e-hospital asked to patient respondents, only 56 and 32 percent of them have expressed high level of satisfaction in respect of facilities extended at GH-Jayanagar and KCG hospital . Interestingly no respondent has given a high score in case of SGITO hospital.

One may provide two broad reasons for the difference in response observed between the direct and the detail questions asked to elicit the opinion about e-hospital facility extended to them. Firstly, the respondent's exposure and the way they have perceived the concept of e-hospital may not be adequate for them to give direct feedback, and most of answers obtained may be kneejerk responses. On the other hand when attempt was made elicit the opinion on e-hospitals facilities by asking them simpler and various components involved at different levels, their responses appear to be more realistic. The index provides more realistic situation about the way the respondents have perceived the advantage/benefit that has accrued to the due to implementation of e-hospital.

From the open-ended questions, the responses of the patients were summarized and the major inferences drawn are depicted below. It is evident that the understanding and appreciation of the e-hospital system and the services are extremely low among the respondents.

Graph 8: Major Constrains reported by Patients

Major Constrains reported by Patients   **Percent**

Inadequate sitting arrangement for patients → 60

Inadequate Manpower - Doctors/ supporting staff → 55

Long queues @ Registration counter with long waiting → 53

More waiting time for consulting Doctors → 41

Delay in handing over Lab → 25

Less time to interact with doctors/ treatment → 15
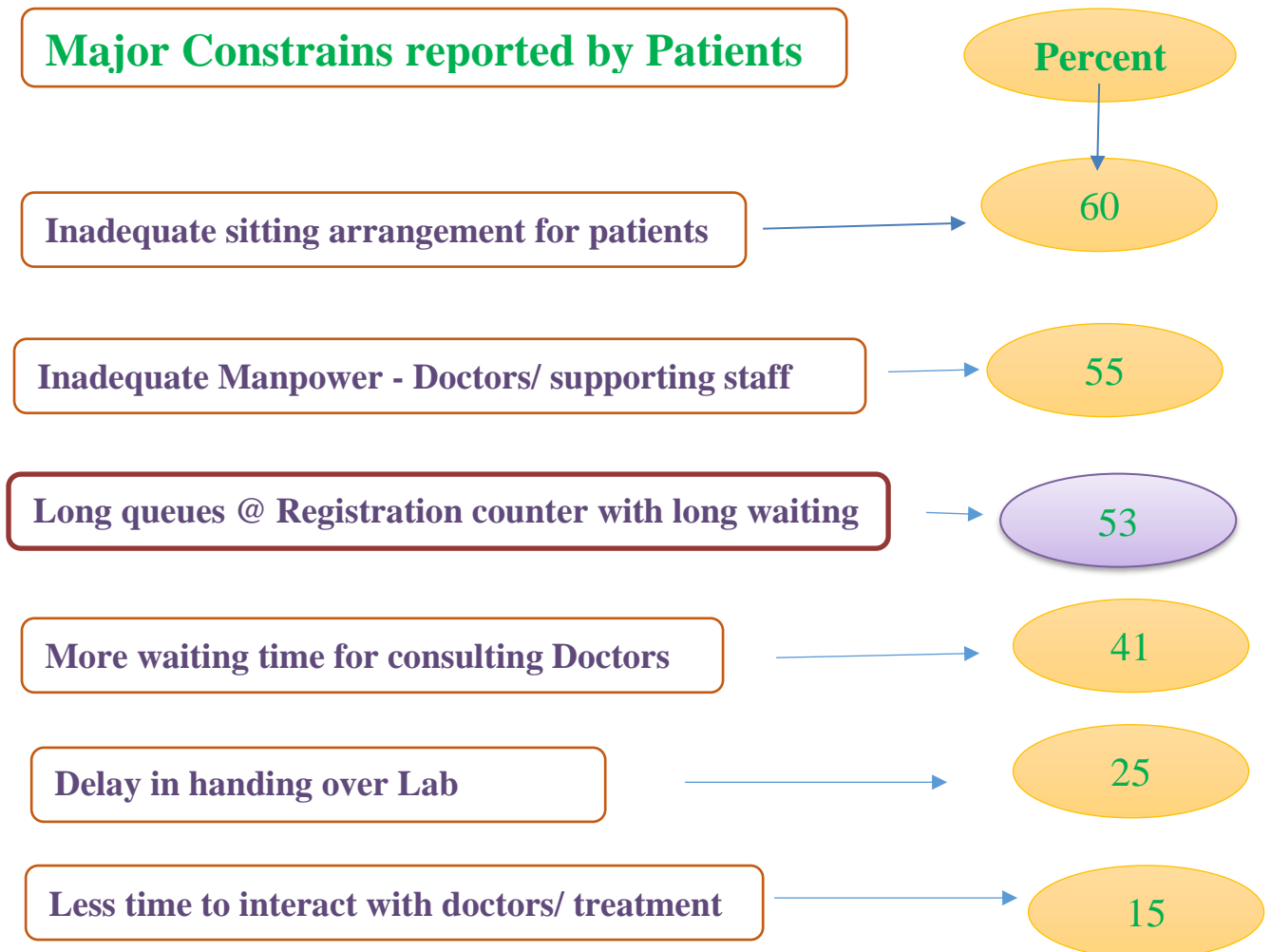
Perceptions of the patients and the how the software can address the bottlenecks identified by the patients and staff

Patients and their caretakers complain of the delay they face while accessing services at the hospitals. Efficiently improving the online reservation of appointments will enable to handle the delays in an effective manner. The discharge summaries can be prepared through the software more efficiently if all the components of the clinical care for the inpatients are updated on daily basis. Providing supportive system for data entry and report generation would help to address the concerns of the patients using the e-hospital system.

Additionally, having clinical data would help the clinicians and administrators to derive health care quality parameters and optimize performance metrics.

10.4 Excerpts from the Key Respondent interviews and focused group discussions with hospital personnel.

- RMO & MSI:
  - o Direct communication with NIC/NHM is lacking
- Regarding the vendor- Keonics:
  - o Keonics- Third party vendor is responsible for allotting resources across the technology and data operators end.
  - o Keonics evaluation process is not up to the mark.
  - o No prior training is monitored/documented for transition.
  - o Delayed payments responsible for majority churn of data operators.
  - o Data operators provided need to trained.
  - o Provide a desktop to each of the doctors
  - o Training on the e-Health module
  - o Dedicated resource to train doctors periodically.
  - o Improved or upgraded desktops.
  - o User friendly e-Hospital module.
  - o Intra department accessibility of records(Pharmacy/Labs/IP records)
- Restricted access and permissions to oversee the smooth flow of the system.
- Program manager to monitor usage of the e-Hospital module to its full extent and guide doctors/data entry operators etc. in case of any need.
- The lab reports and their dispatch in a more systematic and user friendly interface.
- The data entry operators are manually entering the records once they are validated.
- The upgrading of all the lab and other related systems to keep up with the patient input.

10.4.1 Provider (Doctors') Responses

- Majority of the doctors perceive e-hospital system causes disruption in the patient care since the volume overload does not permit them to enter the required clinical care details in the OPD
- Non availability of computers at the point of care is another impediment for the successful utilization of the system
- Doctors are of the opinion that if there are simpler ways of capturing the clinical components like tablet based written OCR or transcription of the data by data entry operators then the system can be helpful

10.4.2 Data Entry Outsourced Vendor:

- Third party vendor is responsible for allotting resources across the technology and data operators end.

- Minimal prior training is provided to the resources deployed for the tasks and they are seldom monitored/documented for transition.

- Delayed salary payments are responsible for high attrition of staff especially data operators.

- Data operators require detailed training and capacity building to optimize the usage of the systems.

10.4.3 Other Hardware and software issues

- Improved or upgraded desktops are required to overcome redundancy. Restricted access and permissions to oversee the smooth flow of the system.

- Minimal opportunity at the local level to modify the critical workflow.

- Program manager to monitor usage of the e-Hospital module to its full extent and guide doctors/data entry operators etc. in case of any need.

- The lab reports and their dispatch in a more systematic and user friendly interface. Presently, the data entry operators are manually entering the records once they are validated.

- The upgrading of all the lab and other related systems to keep up with the patient input.

10.4.4 Training and capacity of key personnel

- Inadequacy of training and supportive IT systems are also adding to the implementation challenges for the clinical modules and other systems

- Data entry operators require hand holding and periodic training

- Call centre support for minor issues required

- Create short video training modules for use in training of new staff as well as reinforcement to existing staff

10.4.5 Patients / Attendants

- Awareness is low across the spectrum and hence obtaining valid responses to perceived benefits was difficult.

- Patients are coming in direct contact with the e-hospital solutions during the registration and discharge. (Partially lab report collection)

- Waiting time at the registration is considerably long due to high loads.

- Discharge summary needs to be validated by competent authorities and the delay is being reported in all the hospitals due to inadequate manpower for the same (which the patients perceive as inefficiency of the system).

10.5 Cost Benefit Analysis:

The e-Hospital program was implemented in 47(23 DH and 24 TH) hospitals across the Karnataka. The cost per patient and time taken per patient is as follows:

Table 31: Cost Benefit Analysis							
Sl. No	FY	No of Beneficiary	Approved Budget (Rs.in lakh)	Cost/ Patient	No of HR	Beneficiary vs. HR(year)	Patient handled by one HR/ shift/ day
1	2018-19	11000000	41.14	2.67	350	31428	86
2	2019-20	18000000	12.6	1.43	350	51428	140

1. Average time taken per patient registration is 1 minute.
2. In the FY 2018-19, the average cost spent per patient to avail the Health care services through e-Hospital in 47 hospitals is Rs.2.67/patient and around 31428 beneficiaries are handled by HR for a year.
3. In the FY 2019-20, the average cost spent per patient to avail the Health care services in 47 hospitals is Rs.1.43 and around 51428 beneficiaries are handled by HR for a year.
4. The cost per patient to avail health care services in 47 hospitals decreased from Rs.2.67 to Rs.1.43.

10.6 Software Modules and usage

Modules Available	Current Status of Use	Comments
Patient Registration	Used	Data entry operators collect basic information. Completeness is not ensured.
Emergency Registration	Used	After the regular OPD hours all patients are registered with this module. Details of morbidity and referral not being captured.
Clinics	Partially used by selective departments	The outpatient departments seldom enter the clinical details and required findings. Hence completeness and use of this module is largely questionable.
Billing and Accounts	Partially used	As most of the services are offered free of cost, collection of bills is not a predominant function.
Path Lab (LIS)	Used	Local configuration is not done to match the workflow. There is no process optimization and efficiency.
Radiology /Imaging (RIS)	Partially used	Patient details are entered to the system. Selective use of the module is done. Integration with PACS is yet to be used fully.
PACS Interface	Not done	Not done
Blood Bank Management	Partial Use	Soft and Hard copies of the register is maintained. Dynamic update of stock and issue status is not available online.
IPD(ADT)	Not used	Data entry of the inpatient records is not being done
OT Management	Not Used	Scheduling and OT components are not being captured
Pharmacy Management	Partially used	Not integrated to stock management and inventory control and dispensing

Electronic Medical Records (EMR)	Not created	No outpatient or inpatient clinical details are being entered
Birth & Death Registration	Not integrated	Separate system is being used
Care Provision	Not used	Discharge summary sheet is at time generated
Stores & Inventory	Not Integrated	Independent systems are being used
Dietary Services	Not used	
Laundry Services	Not Used	
Personnel Management	Not used	
Telemedicine Suite	Not used	

10.7 Reasons for partial implementation / non-implementation of some of the modules

From the interactions and work flow assessments done during the study, it was observed and noted that the software components need to be modified to suit the specific requirements of each hospital. Additionally, the dynamic changes in the staff positions need to be constantly updated. Though the software is capable of accommodating these customizations at the local hospital level, non-availability of technically competent software resource and coordination with the help center poses challenges for implementing all the modules. Also, some of the clinical modules require considerable time and efforts from the consultants, and owing to high number of patients, especially in the outpatient departments, entering of critical data manually is impractical. Details of the specific module use and suggestions are provided in the body of the report.

10.8 Major inferences from the e-module use evaluation:

- Integration with other HMIS system is not evident.
- Clinical care reports at the individual or institutional level is not being generated.
- Clinical decision making is not hugely support by the system in the current format.

11. Reflection and Conclusion

- It was noted that the patients and caretakers had very limited awareness regarding the e-hospital system. Hence, beneficiaries / caretakers need to be educated on the technology adaptation for patient care in hospitals and encouraged to make use of the mobile apps and other features once introduced.

- It was observed during the responses from different section of the hospital that there were differences in the workflow management between the institutions. The lab tests and reporting formats varied. In his context, software needs to be optimized for the local needs

- It was noted that the local software coordinator was finding it difficult to reach to the support center located geographically in a different location. The channels of communication and modalities for problem solving was found to be inefficient. Thus, coordination and presence of local help centre would smoothen the problem resolution and ease of use of software

- There were different level of understanding and ease of use expressed by the different stakeholders. Doctors, nurses, lab technicians need a through overview of the capabilities as well as limitations of the software. At the same time, due to high attrition among the data entry operators, requirement for training and re-training was noted. Hence, training and capacity building of all major users required on a structured and continuous basis.

- The current hardware infrastructure was inadequate to provide a convenient user experience in terms of bot ease of use and connected digital ecosystem. Appropriate Hardware enhancements and introduction of Tablets and Smart digital PEN inputs would enhance uptake of usage by doctors and other stakeholders.

12. Limitations of the study

- The study was undertaken in three purposively selected government hospitals in Bangalore. These hospitals were the initial hospitals where the e-hospital system was first implemented as pilot efforts. In this context, the improvisation to the e-hospital software implementations elsewhere may be missed.

- The hospitals that were selected do not have cloud-based systems and hence dynamic access to real-time data from the dashboards was not possible posing a challenge to assess effective usage.

- Intra and Interstate comparisons were not made to assess the relative comparisons to similar facilities in other districts/ states that were performing differently. Factors promoting the adoption of the system or posing barriers in other settings were not readily available.

13. Recommendations

13.1 Short Term Recommendations

• Software needs to be optimized for the local needs

• Coordination and presence of local help centre would smoothen the problem resolution and ease of use of software

• Training and capacity building of all major users required

• Appropriate Hardware enhancements and introduction of Tablets and Smart digital PEN inputs would enhance uptake of usage by doctors

• Mobile ORS is operational & may be publicized to book advance appointments.

13.2 Long term Recommendations

a. To reduce waiting time at the registration counters

Provision of token machines where the patients or caretakers can generate time-stamped tokens for appointments.

Decentralize registration and distribute it to major areas of the hospital. For example, all maternal and child cases can be registered at a different location, and general outpatient cases can be registered at a different location. Differential registration would also help to segregate the infectious and non-infectious patients, during registration and avoid cross-contamination.

b. To reduce the total consultation time with senior consultants

Owing to large caseloads, senior consultants often find very little time to spend with the patients. Most doctors complain that they are understaffed to serve patient needs. Junior residents and/or qualified nurses can Pre-screen the patients by recording anthropometry, vital parameters, personal history, drug history, blood pressure, etc. Pre-screening would help the senior consultants to focus on clinical diagnosis and treatment.

c. **Use of Mobile applications for specific components**

Recent advances in mobile computing and improvement in both hardware and software have enabled complex activities to be accomplished using mobile phones. The development of mobile applications for user-specific functions will help doctors to quickly access the critical information and avoid re-typing of patient data. Capturing of crucial information for patient care such as provisional diagnosis, lab tests, and pharmacological treatment would help in minimizing the amount of data entry.

The use of mobile applications would reduce the need for costly hardware and the supportive data entry workforce required for patient data capture.

The capture of handwritten notes using an electronic pen (stylus) in pre-structured mobile forms can be explored to avoid data entry of critical information.

d. **To improve in-patient record maintenance and discharge summary**

A daily capture of critical progress and treatment notes for each patient in the structured format helps in building the in-patient record. The integration of the lab reports and consumables would help in adding the care components to the patient records. Upon discharge, the concerned doctor needs to add the discharge advice and generate the summary rather than create the entire in-patient the course of the patient.

Customization of the software to meet the local needs and local process

Each hospital has a unique system and method of functioning. In this context, having a generic solution often poses challenges for the efficient and effective operation of the hospitals. Hence before installation, it is essential to understand the workflow and requirements of the individual hospitals and customize the software with minimal changes to suit the needs.

Changes in human resources also necessitate the modification of the reporting templates and details. Having local software administrators capable of making these minor changes would help in maintaining the smooth operations of the software.

e. **Ensure inter-operatability among the different solutions provided so that the e-health systems from different programs are integrated on a common platform.**

Annexure 1: Terms of Reference of the Evaluation Study

EVALUATION STUDY on USAGE OF THE E- HOSPITAL SOFTWARE DEVELOPED BY NIC, KARNATAKA

1. Title:

Evaluation study on Usage of the e-hospital software developed by NIC, Karnataka

2. Department implementing the scheme:

The scheme is being implemented by the National Health Mission, as a part of e-hospital programme

3. Background and Context:

The advent of NHM in the state led to adequate strengthening of the public health care system and various system process streamlining has been in progress. Still essential service package, accountability, & transparency in health care to the public are not present. The diseases needs to be classified based on ICD 10 updated version to have uniformity in diagnosis across the globe to meet the global health awareness. This is a key step towards achieving of Universal health Coverage (UHC). At present Community is dependent more on the unorganized, and at times, unqualified private providers leading to heavy out of pocket expenses.

Realising this significant gap during economic survey, state has decided to improve access for public health care; the Government of Karnataka has launched the e-hospital programme to provide accountable & transparent health services to the community. The Hon'ble Chief Minister of Karnataka has announced in his budget speech to implement the project across the state. Even though state government has implemented the project in KC General Hospital, Jayanagar General Hospital and Sanjay Gandhi Institute of Trauma & Orthopaedic Centre as pilot project under NIC guidance through department of DeitY still the complete version is not yet implemented. The software has been provided by NIC, Tripura with storage of data in local servers. Realizing the challenges and constraints over benefit to the community, in financial year 2015-16, with directives of Hon'ble Health Minister, state government is scaling –up the project to other district hospitals & selected General hospital which are under health department with guidance of NIC, Bengaluru under secured connectivity from Karnataka State Wide Area Network (KSWAN) of e-governance department.

Information systems, such as electronic health records (EHRs) and mobile phones and hand held computers (m-health), are now part of urban health movement, they are providing support to health worker to perform clinician duties & keep track of patients. In Karnataka, SMS services

for Maternal Child health related events, tracking to improve accountability at grass root level workers like ASHA & ANM level is being used.

In the proposed e-hospital programme, ICT software allows health care providers to collect, store, retrieve, and transfer information electronically (computerized provider order entry (CPOE), which can minimize handwriting or other communication errors by having physicians or other providers enter orders into a computer system. The following technologies will be practiced in the e-hospital programme in state for strengthening efficient health care in state.

It is visioned that *"A well-functioning health information system is one that ensures the production, analysis, dissemination and use of reliable and timely information on health determinants, health systems performance and health status"*.

The benefits that are expected out of the project are:

- Improve patient care by streamlining clinical processes and creating a seamless flow of information.
- Computer-based patient records, portable computers, and expert information systems, to provide clinicians with real-time access to patient information at the point of care.
- Scaled up Telemedicine services to reduce traditional costs and increase the productivity of medical professionals.
- Tele radiology expatriation as a basis for branded healthcare chain, linking rural Hospitals with super speciality hospitals

Additional benefits that are envisioned are:

- Exclusive online registration can be implemented along with assured referral services (MCH care) in all the hospitals along with regular registration, billing, discharge summary writing and assistance services including management of beneficiary schemes.
- At state level an consolidated single data generation for monitoring along with incorporation of other existing monitoring tools like HMIS, MCTS, RBSK, Nikshay, IDSP, NCD, e-Aushadhi (DVDMS) and Civil registration system can be initiated

Moreover, a scale up of the services can be done to private medical establishments for referrals services of government schemes like Vajpayee Arogya Scheme, Yeshaswini, PMSSY etc with monitoring of the notifiable diseases through private hospitals

With the incorporation of the above specified salient features, it is expected that the execution of the e-hospital programme be smooth with little or no burden to the technical staffs at hospital level and better implementation, monitoring and management at district & state level

The main objectives of implementing the e-hospital scheme in the hospitals are focussed on:

- To improve the patient centric health services& quality of care in Government health system.
- Improve the efficiency of Health care professionals along with decrease in burden of work load using user friendly software
- To have accurate & valid facility based reports from the hospitals
- To develop appropriate referral services for the needy community

4. Evaluation Scope, Purpose and Objective

An evaluation of the implementation of the scheme needs to be carried out. The e-hospital software got implemented in Medical College Hospitals since the year 2014. It is imperative at this juncture to understand how the software is being implemented and study the various aspects of its utility, success stories, challenges and hence the need undergo the evaluation.

As the e-hospital software got deployed in three hospitals in the year 2014 and now after its 3 years of implementation is all set to roll out the first phase among the 47 district hospitals.
The objectives of the evaluation study are to:

1. Understand the status of adoptability of the e-hospital software developed by NIC
2. Study the implementation experience by the users
3. Assess the impact leading to system process streamlining and improving the efficiency of the hospital as purposed
4. Study the extent of data flow, consolidation and incorporation
5. Bring out the problem and issues involved in implementation of the scheme

Scope of work:

The evaluation study would intend to evaluate different the aspects of the scheme in line with the technical, managerial and usage of the scheme. The audit would comprise of functional assessment, utilization of the scheme and managerial audit.
While undergoing the evaluation, following need to be captured:

a. The agency should bring up and highlight the major issues and concerns pertaining to:
   - ➤ Computers and other Hardware
     - Computers, printers
     - Server machine
     - Network
     - Maintenance
     - Back up and inventory
   - ➤ Software issues
     - Software package evaluation
     - Software module usage
     - Maintenance and warranty (what is the SLA)
     - Backup support
   - ➤ Installation
     - Software installation
     - Hardware installation

- - Network verification
- ➢ Human resource management
  - - Implementation by the existing manpower
  - - Appointment of additional manpower
  - - Training and Capacity building
  - - Adaptability and change management
- ➢ Operational aspects
  - - Operational efficiency
  - - Module adoptability and acceptability (departmental level, service points)
  - - CPOE support for users
- ➢ User perspective
  - - Implementation experience (doctors/ nurses/ other admin staffs)
  - - Management of beneficiary schemes (Insurance, TPAs, Government schemes etc)
- ➢ Beneficiary perspective
  - - Beneficiary experience while availing the service

b. A detailed analysis of the issues to be undertaken so as to understand the underlying causes for implementation challenges in order to come up with appropriate recommendation to improve the systems.
Tools like Root cause analysis/systems analysis can be adopted.

c. The agency might undertake a sample on the spot time motion assessment based on the defined specifications and propose a work plan for the same.
(Refer Annexure -I for the expected delivery time of services/facilities at various service points post adoption of the software)

5. Evaluation Questions:

While designing the study, the evaluation should address, but not limited to the following areas of enquiry:

1. To what extent the patient centric health services and quality of care was met and what remained unmet?

2. Did the user benefit out of the e-hospital implementation? (A before and after usage comparison of the e-hospital software is to be done. Efficacy and effectiveness is to be analysed)

3. Ease of generating the hospital reports and complying with accurate and valid data?

4. The overall implementation helping to develop and maintain continuity of care; streamlining of referral services? (Case based study could be undertaken and documented.

5. Did the e-hospital software bring about any change in the usage of tele radiology and telemedicine functioning?

6. Is there any change in the turnaround time at various service points after implementing the e-hospital scheme?

7. To what extent the data generated got consolidated with other existing monitoring tools like HMIS, RBSK, Nikshay, IDSP, NCD, e-Ausadhi and Civil registration system and how far it could be aggregated with State level data?

8. The objectives conceptualized pertaining to adopting e-hospital scheme addressing the need holistically?

9. How far the scheme has helped to improve the delivery of the scheme?

10. Lessons from the usage of the e-hospital software from neighbouring states (eg. Tamil Nadu)

11. To what extent the expected outcomes are sustainable?

12. Scalability and further scope of improvement?

6. Sampling and Evaluation methodology

A purposive sampling is to be adopted for this study.

The prospective bidder shall propose a detailed work plan and methodology for the evaluation plan.

It would entail understanding of the TOR and determining of SMART indicators and their measurement methodology, identifying data sources, prescribing data collection and analysis methods, fixing sample size for respective components of study, sampling design, survey instruments, fixing threshold values for drawing inferences, putting in place procedures for verifying the findings etc.

A mixed method of qualitative and quantitative approaches is to be adopted while designing the methodology appropriate to bring out the nuances of study areas.

The evaluation would entail hospital evaluation, beneficiary interview and users' interview. Sample size determination is given below as Table 1.

Table1: Sample size determination for the evaluation:

Particulars	Sampling Determination
Hospital evaluation	The three hospitals where it got piloted namely, KC General Hospital, Jayanagar General Hospital and Sanjay Gandhi Institute of Trauma & Orthopaedic Centre
Beneficiary Interview	5% of average monthly patient flow (OPD and IPD respectively) An exit interview to be conducted. The response should be able to bringout the experience undergone during the various service points while availing the service (eg. appointment scheduling, turnaround time, report despatch etc.)

Users' experience	For users' experience, details to be collected from each of the module implementers. Atleast 25% of the staffs from every department (end users) to be interviewed for the evaluation.
	Respondents both from clinical and non clinical department should be chosen. Doctors using CPOE to be included in the sampling frame
	Departments to be covered:
	1. OPD Patient Registration personnel 2. Emergency Registration personnel 3. Admission and Discharge 4. Billing and Accounts personnel 5. Laboratory technician 6. Radiology technician 7. OT nurse 8. OT technician 9. Pharmacy personnel 10. Blood bank personnel 11. Medical Records personnel 12. Stores and Inventory personnel 13. Laundry personnel 14. Dietary personnel 15. Telemedicine technician 16. Ward nurse 17. Doctors using CPOE (suggested a mix of OPD and IPD as applicable)

This section would be considered as one of the prime component for crediting for short listing.

7. Deliverables and time schedules

The evaluation study should be completed within 5 months. However the proposal would be subject to competitive bidding with the mixed criteria of work plan, judicious time utilization and optimum costing.

The task and deliverables should comply with the proposed work plan and respective micro activities and indicate the major milestones/phases.

Prospective bidders should submit their deliverables as below indicated:

Deliverable 1: Inception report/evaluation workplan

Deliverable 2: An initial draft evaluation report for review

Deliverable 3: A final evaluation report

Time schedule should be from the date of signing of the work order/MOU

The evaluation work plan should be prepared by the prospective bidder before going into the full fledged data collection exercise, presented to a joint team of Officers of the sponsoring department

and the KEA Technical Committee and get approved within four weeks from the date of release of first instalment of money. This ensures that the sponsors and the external evaluator stay on same page and ensures compliance with minimal standards. The evaluator would then proceed to collect the data.

The consultant should submit the draft evaluation report within four weeks of completing the field work. It would again be reviewed by the joint team of officers of the sponsoring department and KEA Technical Committee. Within two weeks of receiving comments on draft report, the consultant should submit a final evaluation report incorporating the suggestions on the draft.

The consultant shall submit both soft copy and hard copy of the deliverables. 4 soft copies in CDs and 4 set of hard copies should be submitted for each of the deliverables.

In addition to the deliverable submission, the sponsoring agency may seek translated version of the final report (2 soft copes and 2 hard copies), policy briefs, write up for bulletins/newsletters, power point presentation and other knowledge products for dissemination.

For developing the report, following font details can be used:

Font style : Calibri body; Font size: 11; Line spacing: Multiple at 1.15; Spacing before- 0 point Spacing after -10 point

8. Qualities Expected from the Report

The following are the points, only inclusive and not exhaustive, which need to be mandatorily followed in the preparation of evaluation report:

By the very look of the evaluation report it should be evident that the study is that of Department of Social Welfare of the Government of Karnataka, and Karnataka Evaluation Authority (KEA) which has been done by the Consultant. It should not intend to convey that the study was the initiative and work of the Consultant, merely financed by the Karnataka Evaluation Authority (KEA).

Evaluation is a serious professional task and its presentation should exhibit it accordingly. Please refrain from using glossy, super smooth paper for the entire volume overloaded with photographs, graphics and data in multi-color fancy fonts and styles.

The Terms of Reference (ToR) of the study should form the first Appendix of the report.

The results should correspond to the ToR. In the results chapter, each question of the ToR should be answered. It is only after all questions framed in the ToR that is answered, that results over and above these be detailed.

With regard to recommendations, the number of recommendations is no measure of the quality of evaluation. Evaluation has to be done with a purpose to be practicable to implement the recommendations. The practicable recommendations should not be lost in the population maze of general recommendations.

The report should be complete and logically organized in a clear but simple language. Evaluation report should conform to standard report writing style and structure.

Ensuring quality

The evaluation report and its findings must demonstrate highest professional standard on par with National and International studies.

Providing Oversight

Karnataka evaluation authority will provide the funding; all technical aspects of the study will be monitored by E-*hospital - Health and Family Welfare department*

9. Administrative arrangements for the study

Conducting the survey would be solely undertaken by the consultant/organization awarded the assignment. However few of the arrangements like the permission/approval letter in the hospitals would be issues by KEA. Also a prior intimation would be given to the respective hospitals and departments to extend timely cooperation to the consultants.

However, the bidder should also specify in the proposal the further support(s) required from the administration and/or the study stakeholders. Necessary arrangements would be made by the sponsoring agency. Ethical clearance/consent should be followed as applicable

The prospective bidder should detail the team structure and team movement plan that would be involved for the study with appropriate justification for contribution in the assignment.

While building the team, the bidder should refer the details as mentioned for the Principal Investigator, and two core team members who would take up the study:

Table 2:

Sl. No	Subject Experts Requirements	Educational Qualification	Experience in the relevant field
1.	Principal Investigator	MBBS/BDS/AYUSH with healthcare IT (HIT) background	At least 5 years of experience in HIT implementation
2.	1st Core Team Member	MHA/MBA in hospital administration	At least 5 years of work experience in hospital system process managing and strengthening
3.	2nd Core Team Member	BE - IT/ B.Tech - IT/ MCA	At least 5 years of work experience in software QA testing

10. Cost and Schedule of Budget release:

Output based budget release will be as follows-

1. The **first instalment** of Consultation fee amounting to 30% of the total fee shall be payable as advance to the Consultant after the approval of the inception report,

but only on execution of a bank guarantee of a scheduled nationalized bank, valid for a period of at least 12 months from the date of issuance of advance.

2. The **second instalment** of Consultation fee amounting to 50% of the total fee shall be payable to the Consultant after the approval of the Draft report.

3. The **third and final instalment** of Consultation fee amounting to 20% of the total fee shall be payable to the Consultant after the receipt of the hard and soft copies of the final report in such format and number as prescribed in the agreement, along with all original documents containing primary and secondary data, processed data outputs, study report and soft copies of all literature used in the final report.

Taxes will be deducted from each payment, as per rates in force. In addition, the evaluating agency/consultant is expected to pay service tax at their end.

11. Selection of Consultant Agency for Evaluation:

The selection of evaluation agency should be finalized as per provisions of KTPP Act and rules without compromising on the quality.

12. Contact person to get further details about the study

At Health department approach to Mission Director National Health Mission Karnataka and subsequently after Office Order the evaluation team should coordinate with Deputy Director, e-hospital programme (mail Id: eh.karhfw@gmail.com) Government of Karnataka; phone: 9449843439.

ANNEXURE - I

The desired delivery time duration at various service points, post adoption of the e-hospital scheme:

Sl. No	Services/Facilities	Using e-hospital @NIC
1.	Patient Registration	35 seconds per New patient
2.	Follow-Up Re-Registration with UHID)	15 seconds per patient
3.	Billing & Cash Collection	30 seconds
4.	Laboratory Investigation report for OPD patient	Same day in most cases
5.	Radiology Investigation Report for OPD Patient	Same day in most cases
6.	Emergency Services such as Ambulance, Blood Bank, OT etc	Managed and available at all care points
7.	Dietary Service	Managed diet distribution among patient as per diet scale & linked with inventory system of raw materials
8.	Inventory Service	Reduced waste - no stockpiling or expired products
9.	Blood Bank	Increase in blood utilization, specially on the high cost products - wastage avoided *Donor's information shared and disseminated helping Donor deferral process and avoiding repeat of expensive tests. *Centralize Blood inventory information -saves time, cost and makes blood banking productive.
10.	Care Planning by Physicians	EMR of a patient helps physician in better care planning and monitoring

11/10/17

Chief Evaluation Officer
Karnataka Evaluation Authority

(Chaya Degamkar)
(Con.(EVI)

Annexure 2: Questionnaire adopted for assessment:

Part A:

1. Name: …………………………………………………..…

   Gender: Male / Female/ Others

2. Name of Health Care Facility: ……………………………………………………

3. Designation: …………………………………………………………

4. No. of years employed in the current facility: …………………………………………

5. Type of HCF:-

6. Educational details:

Please respond to the following to the best of your knowledge:

ITEMS	YES	NO
1. Using e-health solutions in my job could improve the care I give to my patients.		
2. Using e-health solutions in my job would increase my efficiency as a physician, nurse, or technician.		
3. Using e-health solutions in my job will make it easier to do my job.		
4. Using e-health solutions in my job would be an improvement in the area of my job.		
5. Using e-health solutions in my job increases my productivity.		
6. Learning to operate computer to use e-health solutions would be easy for me.		
7. Learning to operate e-health solutions would be easy for me.		
8. I consider e-health solutions system to be easy to use.		
9. My interaction with e-health solutions system is clear and understandable.		
10. People who influence my behavior think I should use e-health solutions.		
11. People who are important to me think that I should use e-health solutions.		
12. Doctors have been supportive in use of e-health solutions.		
13. In general the doctor has supported the use of e-health solutions.		
14. I have physical and mental ability necessary to use e-health solutions.		
15. I have the knowledge necessary to use e-health solutions.		

16. Support and assistance is available if I have difficulties.		
17. I am not in favor of e-health solutions as it lacks the face-to-face interaction between patients and doctors.		
18. I am not in favor of e-health solutions as it is complex for users and providers.		
19. I am in favor of e-health solutions since it is beneficial to my patient care and management.		
20. I am in favor of e-health solutions as it is fully integrated in providing patient care.		
21. I feel nervous about using e-health solutions equipment.		
22. I worry that if I hit wrong button my information may be lost.		
23. I hesitate to use equipment for fear of making mistakes.		
24. The equipment is somewhat intimidating to me.		
25. I could complete most tasks without assistance.		
26. I could complete most tasks if I could call someone for help.		
27. I could complete most tasks with just the instructions provided.		
28. I will use e-health solutions if my hospital implement this technology.		
29. I will increase my use of e-health solutions technology in future.		
30. I will recommend others to use e-health solutions technology.		
31. I will use e-health solutions because the significance and prevalence of the problems to be addressed, and the information needed are available on a timely basis.		
32. I will use e-health solutions because e-health solutions in my hospital is fully integrated in providing patient care.		

SECTION B: Technology User

1. Do you consider yourself computer literate?

2. If yes do you use this or know how to use these following?

Serial no		Yes	No
1.	Word Processer		
2.	Spreadsheets or excel		
3.	Databases		

4.	Statistics package		
5.	Presentation software		
6.	Copy and transferring files		
7.	Scanning and creating PDF		
8.	Use Email		
9.	E-health solutions applications		

3. Do you use Digital Camera to take Picture?

4. Do you use Smart (Mobile) Phone?

5. Do you own Laptop?

6. Do you have Personal computer?

7. Have you attended training on e-health solutions?   Yes   No

Part C:

Perceived ease of Use as a Factor Influencing the Adoption of E-health solutions

1.	I believe that e-health solutions is likely to breach patient confidentiality.	YES	NO
2.	The diagnosis process is distorted by the lack of physical presence.		
3.	I believe I am in control when I am using e-health solutions technology.		
4.	Entering of online patient notes diverts attention from the patient.		
5.	To use e-health solutions, I don't have to change anything I do currently		
6.	To use e-health solutions is a new experience for me.		
7.	I would be at ease using e-health solutions if convinced that the applications are in line with the laws that govern medicine.		
8.	I would be at ease using e-health solutions if convinced that the applications are in line with the laws that govern medicine		

9.	I am more likely to want to use e-health solutions because of being part of a pilot test.		
10.	I like the idea of trying out e-health solutions technology on trial basis before deciding whether they like it or not.		
11.	E-health solutions implementations would be adopted more easily if we were allowed to use the system without formal commitment.		
12.	I would adopt e-health solutions more easily if I was exposed to demos from different suppliers and involved in the selection process.		
13.	I would adopt E-health solutions more easily if the implementers acted on the feedback that I share with them.		
14.	Learning how to use e-health solutions applications is difficult.		
15.	I think that finding information in e-health solutions applications is tedious.		
16.	I must acquire technical assistance to learn how to use e-health solutions systems.		
17.	I prefer person-to-person over written manuals and online technical assistance when using.		
18.	Interacting with the e-health solutions is frustrating		

Perceived usefulness

Sl no	Question	Yes	No
1.	I believe that an e-health solution has the potential to improve the clinician's diagnostic endeavours.		
2.	E-health solutions make the prescribing process easier.		
3.	E-health solutions makes information dissemination more efficient.		
4.	E-health solutions presents more advantages than disadvantages over the manually written notes.		
5.	Providing patient care without having to travel makes healthcare service provision effective.		
6.	E-health solutions technology makes it more difficult to adhere to hospital policies such as patient care documentation.		
7.	E-health solutions equipment would work better if it was installed on mobile device.		

		yes	No
8.	E-health solutions reduces my diagnosis accuracy		
9.	I would adopt e-health solutions more easily if one of the members of the implementation team was my colleague		
10.	I prefer not to use and e-health solutions because my colleagues are highlighting its weaknesses.		
11.	E-health solutions has made my colleagues work more efficient and effective.		
12.	I would be easier to adopt e-health solutions if I had that doctors from other hospitals are using similar applications		

Attitude

Sl no	Questions	yes	No
1.	E-health solutions will enable me provide care to more patients.		
2.	E-health solutions will degrade the quality of care due to reduced patient doctor contact		
3.	When clinicians use e-health solutions to provide healthcare it will make referrals easier as the patient records are online.		
4.	I will strongly support the use of e-health solutions technology at my work place.		
5.	E-health solutions vendors exaggerate on the advantages of e-health solutions.		
6.	E-health solutions could lead to loss of jobs in the future.		
7.	When clinicians use e-health solutions to provide healthcare there is an increased workload.		
8.	E-health solutions vendors should educate users on the disadvantage also		
9.	Use of e-health solutions will increase my efficiency		
10.	Patient record management is enhanced when clinicians use e-health solutions to provide patient care.		
11.	I will strongly support the use of e-health solutions technology at my work place.		
12.	Learning to use e-health solutions will be an exciting learning experience		

13.	I look forward to discovering the extent to which e-health solutions will enhance the patient experience		
14.	I believe that I will learn the shortcuts to make use of e-health solutions faster than my peers		
15.	I am worried that e-health solutions will lead to loss of jobs		
16.	I will be happy to learn how to use e-health solutions in order to contribute to organizational goals		
17.	Learning e-health solutions will be very stressful for me		

C. Guiding questions for conducting key respondent interviews with stakeholders:

- What was the reason for introducing e-hospital software system?

- When and how was it initiated?

- What were the initial problems during implementation?

- Was the training and handholding provided adequate to start using the system as intended?

- What is the attitude of the people using the system?

- Has the system helped in improving efficiency of services in the hospital?

- What are the major advantages of the system in the hospital at _____location?

- What are the major disadvantages of the system in the hospital at _____location?

- How can the system be improved further to enhance utilization and benefits to all stakeholders?

Beneficiary Interviews

Questionnaire-based on the above definition and context:

Circular flow diagram with nodes: ನೋಂದಣಿ, Patient ರೋಗಿಯ ವಿಭಾಗ, ಪ್ರಯೋಗಾಲಯ, ರೋಗ ನಿರ್ಣಯ, ಒಳರೋಗಿ, ವಿಧಾನ/ ಶಸ್ತ್ರಚಿಕಿತ್ಸೆ, ವಿಸರ್ಜನೆ, ವಿಮರ್ಶೆ/ಅನುಸರಿಸು

.
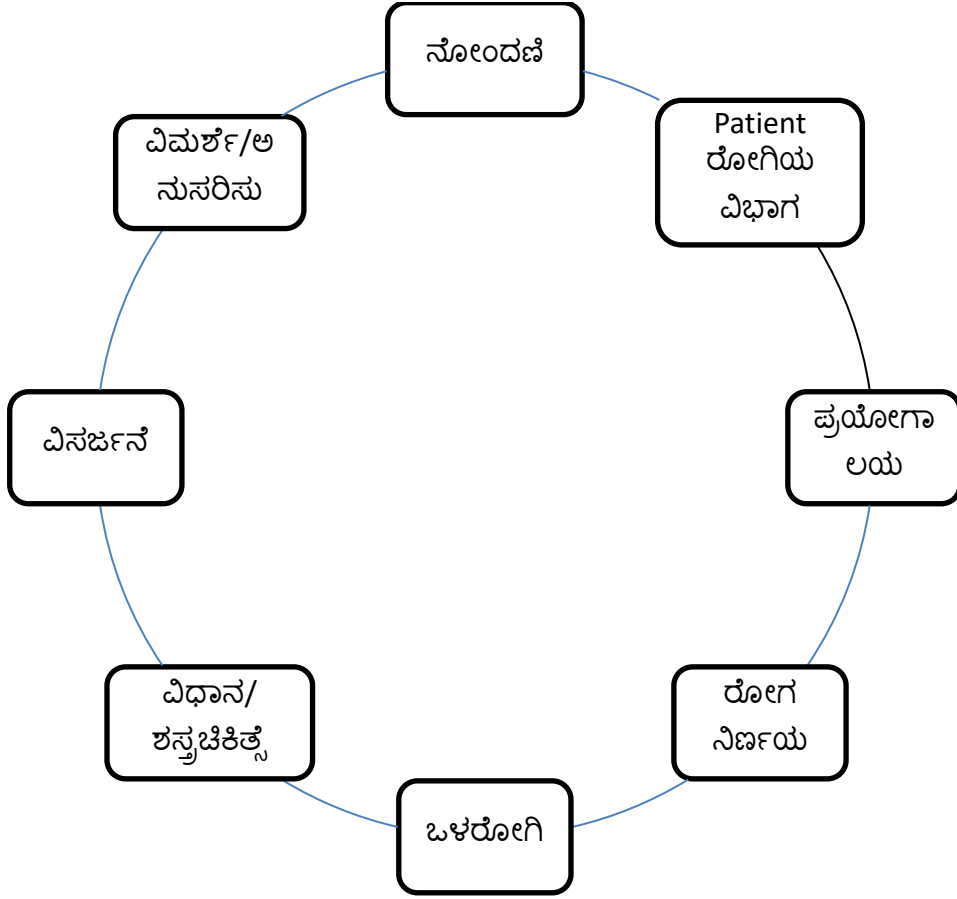
Sl No.	Patient Details	Responses
1	Name and Address:	
1.1	Care taker Name: Relation to Patient: Age Sex:	 ____yrs. 1. Male 2. Female
12	Age:	____yrs.
1.3	Sex:	1. Male 2. Female
1.4	Mobile No:	
1.5	From Setting:	1. Urban 2. Rural
1.6	Income Group:	1. APL 2. BPL
1.7	Education (highest completed Level):	

1.8	UH ID No	
2	Name of the Hospital	
3	Name of the disease	
4.	Location:	1. Out Patient 2. In Patient
4.1	What is the place you are in the hospital? 1. Registration 2. OPD Consultation 3. Lab Sample Collection 4. Lab Report 5 Definitive Treatment 6. OP to IP admission 7. In-Patient 8. Discharge	
5	Is the computer used when you're getting register?	
5.1	If Yes, what information is taken?	1. Aadhar card No 2. Phone No. 3. Name and address 4. others
5.2	Was the process of registration Quick and easy?	1. Yes 2. No
5.3	How long does it take to be registered?	1. Yes 2. No
5.4	Are you happy with the time taken at the registration counter?	1. Yes 2. No
6	Does the doctor enter your information in the computer after the check-up?	1. Yes 2. No
6.1	Was the process of doctor consultation made convenient with an e-hospital solution?	1. Yes 2. No
7	Was the process of discharge made quick and efficient with an e-hospital solution?	1. Yes 2. No
8	According to you, the time taken at the registration counter was:	1. Acceptable 2. Unacceptable 3. No comments
9	According to you whether the technology use will help you in accessing a better quality of services.	1. Agree 2. Disagree 3. No comments
10	How did your E-hospital visit compare to a traditional in-person medical visit?	1. Better than a traditional visit 2. Just as good as a traditional visit 3. Worse than a traditional visit 4. Not sure
11	According to you, there is higher transparency	1. Yes 2. No

	and efficiency compared to previous paper system in care process at the hospital			
12	Using the scale below, please rate your satisfaction with each of the following:	3 = Satisfied 2 = Neither satisfied nor dissatisfied 1 = Dissatisfied		
13	How likely are you to use E-hospital again?	1. Definitely will 2. Definitely will not 3. Not sure		
14	How likely would you be to recommend E-hospital to someone else?	1. Definitely will 2. Definitely will not 3. Not sure		
15	**Are you willing to use a mobile phone for seeking hospital services in future?**			
16	What are the major difficulties you faced due to the e-hospital system?			
17	How can the system be improved to make your experience more comfortable?			

18	**Activity**	**Start time**	**End Time**	**Total Time is taken**
18.1	Registration			
18.2	OPD Consultation			
18.3	Lab Sample Collection			
18.4	Lab Report			
18.5	Definitive Treatment			
18.6	OP to IP admission			
18.7	IP stay			
18.8	Advise to Discharge to leaving out of hospital			

Annexure3: Average Patient Flow and Hardware details of the Sample Hospitals

Average Patient Flow

Sl. No	Days	KC General Hospital		General Hospital, Jayanagar	Sanjay Gandhi Institution of Ortho and Trauma	
		Out Patients	In Patients	Out Patients	Out Patients	In Patients
1	Monday	1120	78	1360	383	25
2	Tuesday	940	62	1195	300	22
3	Wednesday	984	63	1077	285	25
4	Thursday	945	59	1092	272	15
5	Friday	890	57	892	190	08
6	Saturday	746	44	1001	120	07
7	Sunday	396	38	348	35	03

Source: Secondary Data

Hard ware details

KC General Hospital

Sl. No	Name of the hardware	No's	Presently using (Nos)	Not in use (Nos)
1	Computers	47	47	
2	UPS	44		
3	Barcode Reader	6	3	
4	Barcode printer	1	0	1 (Not Working)
5	Printers	13	10	3 (Not Working)

Source: Secondary Data

Sanjay Gandhi Institution of Ortho and Trauma Hard ware details

Sl. No	Name of the hardware	No's	Presently using (Nos)	Not in use (Nos)
01	Computers	10	07	03
02	Printers	05	04	01
03	UPS	10	07	03
04	Barcode Scanner	05	02	03

Source: Secondary Data

	JAYANAGAR GENERAL HOSPITAL, BANGALORE						
	HARDWARE ITEMS LIST						
Sl.No	Purchase Order Number	Name Of The Items	Qty	Purchase Order Date	Warranty Till	Vendor Name	Warranty
1	N1350652	EX2200-C-12T-2G Switch and other items	3	5/30/2014	5/30/2019	Inspira Enterprises	5 Years
2	N1350652	EX2200-24-4G Switch and other items	9	5/30/2014	5/30/2019	Inspira Enterprises	5 Years
3	337	Cisco Security Bubdle, Data License and AC Power Cord etc.	1	5/29/2014	5/29/2017	Wipro	3 Years
4	N154044	Optical Cable and 38 Line Items		3/10/2014	3/10/2015	SN Electric & Electricals	1 Years
5	238	Server	4	5/15/2014	5/15/2019	Wipro	5 Years
6	1259-3	UPS	14 (5 KVA - 2, 2 KVA- 1, 1 KVA- 11)	12/21/2014	21-12-17 ----UPS 21-12-2016 ---- Battery(AMC Required for UPS and Battery)	Keptron Electronics	UPS 3 years, Battery 2 Years
7	138	UPS	31 (700 VA)	2/25/2014	25-02-2017---UPS 25-02-2015--- Battery(AMC Required for UPS and Battery)	Sanwalli RES Systems PVT LTD	UPS 3 years, Battery 1 Year
8	219198	Desktop(ACER)	31	2/25/2014	2/25/2019	ACER	5 Years
9	68956	Laser Printer	11	5/7/2014	07-05-2015(AMC Required)	Intergraph Systems	1 Year
10	68275	Scanner	1	2/3/2015	03-02-2016(AMC Required)	Intergraph Systems	1 Year
11	1503-2	Barcode Reader	6	1/22/2015	1/22/2018	Intergraph Systems	3 Years
12	1705-2	Barcode Printer	2	2/25/2015		Skanm Interlabels Industries	3 Years
13	1238-3	Desktop (DELL)	11	12/16/2015		HCL Info systems Ltd	3 Years

Annexure 4: List of individuals of groups interviewed/consulted and visited

- o   Medical Superintendent of Sample Hospitals

- o   Programmers of Sample Hospitals

- o   Doctors and Staffs of Sample Hospitals

- o   Beneficiaries/Stakeholders.

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Annexure 5: Dissenting views by evaluation team member or client in any

None expressed or recorded. We do not believe there is any dissenting view among the members of the research team

Annexure 6: Short biographies of the Principle investigator

Dr B S Nanda Kumar

MD, DNB, PGDHHM, MAMS
Head- Research & IPR, Division of Research and Patents,
Associate Professor,Dept of Community Medicine, M S Ramaiah Medical College, Bangalore-560054
Mobile: + 91-9916799937,E -mail: bsnandakumar@msrmc.ac.in

Educational qualifications:

- M.B.B.S., 2001 (**Gold Medallion in Medicine**)- **First Rank** at Dr. B R Ambedkar Medical College, Bangalore University. *PFIZER* Award in medicine for highest score in General Medicine.

- M.D. Community Medicine from M S Ramaiah Medical College (**State Second Rank**, Rajiv Gandhi University of Health Sciences, Karnataka). (2006)

- Post Graduate Diploma in Health and Hospital Management- IGNOU (2006)

- DNB (Community Medicine- Exam @ **PGI Chandigarh**) National Board of Examinations (2008)

- MAMS- Awarded-Member of Academy of Medical Sciences of National Academy of Medical Sciences. (2013).

Summary of professional skills and experience

- After MBBS, I worked as technical analyst for medical evidence at Health Informatics Group (HIG), subsidiary unit of London School of Hygiene and Tropical Medicine at St John's Medical College till 2002. Presently, working as Head- Research & Intellectual Property Rights, Division of Research and Patents along with the position of Associate professor in the Department of Community Medicine (Public Health) of M S Ramaiah Medical College, Bangalore.

- As an entrepreneur ventured in the domain of health data analytics - *ANVESHANA* (partnership firm) specializing in clinical research data analysis, data visualization, epidemiological consultancy, publication support, training and capacity building of professionals for research activities.

- Technical consultant to government (State and Central) and private sector in the domain of health, primary health care, health care informatics, data analytics.

Major consultancies:

o **Hospitals / Health Care Institutions:** Narayana Hrudayalaya, JSS Hospital

o **Pharmaceutical :** Novo Nordisk, Abbot, Micro Labs

o **Clinical research:** Clintec, Infinitus, Freelancers

o **Medical Devices:** S N informatics, Tele-medicine, FORUS Health Care, ITS Mysore

o **Medical Education:** Entrance Book, COMED-K

Tasks as Head, Research Division and Associate professor- Community Medicine:

- UG Teaching- 4th Term Theory, Practical, 1st term classes, Block Postings, COP activities

- PG- Seminar, Journal Club, Guide for post graduates Dr. Hamsa & Dr. Shwetha- RGUHS

- PG curriculum committee member

- School Health team member

- BPT Classes- Theory, MHA classes – MSRUAS, PGDHHM- Classes- IGNOU, HCWM classes and training (EMPRI, PWD etc.)

- Part of the core team for UNIDO-GOI-GEF (M) project on training of health personnel for bio-medical waste management- ICT infrastructure and short documentary, State implementation support for Maharashtra, Orissa, Gujarat, Karnataka, and Punjab

- Recognized PG teacher from RGUHS- Guiding 2 PG students for MD (Community Medicine)

- Recognized UG examiner for RGUHS

❖ Co-PI for Childhood Injuries Project (ICMR)- Approved by ICMR- Pending release of funds

❖ Co PI- Oto Acoustic Screening project (ICMR) - Ongoing and 2 phases completed. Release of funds complete.

❖ PI- Submitted proposal for Indo-Sweden, ICMR-FORTE grant call in tele-geriatrics along with researchers from Umea University, Sweden

❖ Co-PI- Submitted proposal to DST for Development of Big data Tele Healthcare Infrastructure for Resource Constrained Population with Wearable Physiological Monitoring Systems

Division of Research and Patents

- Support UG,PG, Faculty research activities across the campus

- Development of guidelines for academic, sponsored research in the campus

- SOPs for authorship guidelines

- Issue of Unique IDs and maintenance of records of ongoing research in the campus

- Coordinator for DSIR certification

- Support external MOUs and collaboration for research agreements (intra and extra mural research)

- Data analysis and reporting support for publications and proposals

- Development of grant proposals- support

- Plan and train- UG, PG, Faculty in research, bio-statistics and epidemiology, data analysis, publications, grant proposals

- Interact with MSRIT research committee / Director research for developing joint proposals and research training activities

Core committee member of GEMS – Student life cycle management systems

- Identify and discuss the institutional requirements for successful implementation of GEMS

- Coordinate with the development team for customization of deliverables

- Organize and implement training of end users

- Coordinate with technology vendors for optimizing the use of GEMS in the campus

Core Committee Member- Technology Development Fund of GEF (M)

- Support development of SOPs

- Development of templates for submission of proposals and scoring

- Review of proposals submitted for screening and fitness for presentation

- Support the core committee in deciding the funding of proposals

- Support the office of TDF in preparing the background documents and minutes of the meeting

NAAC- research and consultation, extension activities- Core group member

- Consolidation of publications

- Consolidation of CME, Workshops and other activities

- ❖ Editorial team of Gokula Gnana Vahini- Monthly Newsletter of GEF (M)

- ❖ Member – MSRMC Museum development committee

- ❖ Member- Cultural and College day (Introspection) committee

Evaluation study on Usage of the e-hospital software developed by NlC, Karnataka

❖ Member- Spandana- school for special children (KAIWARA)

❖ IRO- Support the **international relations office** for coordinating external visitors (foreign exchange students and faculty). Support the generation of various reports as required by collaborative partners or regulatory authorities.

❖ Member- Centre of excellence in maternal and child health (Initial activities with Dr. Vidyasagar- Chicago, coordinated by Dr. S Pruthvish)

❖ Interactions and support to the vision / retreat activities of Dr. Arakalgud Ramprasad. Undertook scoping study of ICT status at GEF (M)

❖ Member- training of GEF(M) staff for team building and inter-institutional rapport by Chief HR

❖ Support the EMR implementation in the MSR hospitals- generic coding of diseases and other SW related inputs

❖ Support PhD of Dr. Sarala- Hospital infections and its cost economics model under MSRUAS (Dr. Narendranth – Guide); PhD core committee member- Dr. Arjunan Isaac, Dr. Pushpanjali- RGUHS

❖ Winter school (2015)- coordinated development of promotional materials and dissemination

Clinical experience:
- **2001-2003 –** Post MBBS, worked as a general practitioner in Life Line Health Care and diagnostics, Bangalore- Private medical clinic.
- **2003-2006 –** During MD- community medicine, worked as a PG-Tutor in the Department of Community Medicine rendering clinical services at the urban and rural outreach centers in Bangalore slums and Kaiwara area. Supported rendering of care to patients during the Chickenguniya outbreak and other camp related activities.
  o Provided clinical / screening services to school health and geriatrics programs in urban and rural areas
  o As a part of the MD dissertation, worked with the respiratory evaluation of workers in concrete industry.
- **2006 till date**: Participating in outreach clinical services of the Community Medicine Department of M S Ramaiah Medical College and Hospitals.

- o Planning and organizing health camps for non-communicable diseases
- o Delivery of school health program
- o Planning and rendering of services for geriatric care
- o MCH and immunization programs
- Supported BV Raman Somanahalli Trust, a rural based organization providing health care to rural population of Somanahalli and surrounding villages, Ramanagara Taluk.

Provided technical support for following initiatives:

- Health Care Waste Management Cell, WHO Training Center for SEARO- India
- Food hygiene Cell, M S Ramaiah Medical College, Bangalore
- Compiled the final report of the core group of implementing information communication technology for rural health care. Operational Guidelines for telemedicine in primary health care, under the aegis of **Media Lab Asia and Dept. of Space (ISRO), Govt. of India. (2006).** Development of a proposal for operationalizing **Telemedicine for Primary Health Care with support from Media Lab Asia, Ministry of Information Technology, Govt. of India.**
- Facilitated and coordinated the Workshops for Problem Solving for better Health (PSBH) for Health Action by People, Dreyfus Foundation, Trivandrum
- WHO Regional meet SEARO, for bio-medical waste management, GOI-WHO-MSRMC, Dec-2007
- A short film on Health Care Waste Management **for WHO** (2005-06)
- An IEC capsule in response to Chikunguniya outbreak in KAIWARA (2006)
- Team member- **WHO workshop** on 'Integrating oral health into general health' at Government Dental College, June 2009 (Participated in developing guidelines to improvise medical –dental referral networks and mechanisms)
- Provided support for compiling manual on first aid for undergraduate medical students 2005
- Provided support for compiling and editing Manual for implementation of **Community Orientation Programme** for Under Graduate Medical MBBS students of Rajiv Gandhi University of Health Sciences, 2005
- Provided technical expertise to amend the Bio Medical Waste Management Rules- 2001, commissioned by the Ministry of Environment and Forests, Government of India. 2011.

Evaluation study on Usage of the e-hospital software developed by NlC, Karnataka

- Provide inputs for "Integrating oral health into general health" workshop held at GDC, Bangalore under the aegis of WHO-SEARO, India
- Establishment of hospital based stroke registry under the aegis of WHO, SEARO
- Core Committee member- 2011, Oral health survey- Bangalore District under the aegis of IDA, Bangalore Chapter and Government Dental College
- Ontological analysis of health programs and policies in India- Presented the paper in **IIM-Bangalore**- August 2015.
- Determinants of Non-use of Contraceptives: An Ontological Analysis- Paper presentation in **IIM-Ahmedabad**- Conference on health policies- 2016

Other Projects and activities:

- Worked on "Use of Geographical Information Systems for mapping Vector borne diseases outbreak- emphasis on Chikungunya outbreak at Kaiwara" (2008-09)
- Completed a project titled "Technology Adaptation Model (TAM) study on implementation of telemedicine in at Tertiary care hospital" as partial requirement for Post graduate **Diploma in Health and Hospital Management** course (PGDHHM) for IGNOU
- Co-research member, for the Bangalore Healthy Urbanization Project, North Zone in association with WHO Kobe Center, looking at the Social Determinants of Health in Urban areas. 2007-08 (Completed)
- **Evaluation of Rajiv Gandhi Arogya Yojana, Amethi**, Uttar Pradesh. Co-ordination and management of rural health clinics with ICT implementation at primary health level for rural health care. (2008). Need assessment survey for identifying the feasibility of establishing a micro-insurance scheme through PPP model
- Supported **Global Innovation Fellowship program of Medtronics, Global**
- Developed proposal for emergency and Medical response using ICT, Mysore project with leading software companies
- Developed proposal for establishment of M S Ramaiah Telehealth network catering to the health care needs of rural populations (2009-10)
- External observer for COMEDK exams
- Validation of COMEDK PG entrance test for various measure of test reliability

- Technology evaluation of air-disinfectant devices for sanitizing air in critical health care settings for ITS Mysore, (2010)

Research, Publications, Conferences:

- Supported editing of the following Journals:
  - Karnataka Journal of Community Medicine (2004-05 ~ Special Conference Edition)
  - Indian Journal of Hospital Waste Management ~ 2005-2010
- Key speaker and invited speaker at several national and international conferences / workshops on research methodology, epidemiology, biostatistics, telemedicine, occupational health, maternal and child health, IT and health care, infectious diseases.

Sl no	Citation
International Publications in Indexed Journals	
1	Nandagudi Srinivasa Murthy, S Shalini, **B S Nandakumar** , G.Suman, Sreekantaiah Pruthvish and Aleyamma Mathew, Increase in incidence of cancer of corpus uteri: Estimation of time trends– Indian scenario, EJCR, 2010, 0959-8278, DOI: 10.1097
2	Murthy NS, **Nandakumar BS**, Pruthvish S , George PS, and Mathew . Disability Adjusted Life Years for Cancer Patients in India. Asian Pacific Journal of Cancer Prevention, 11, 2010, 309-316.
3	Santosh M. Avvannavar, **Nanda B. S. Kumar**, Shrihari Surathal, Raghunath Babu, "Socio-environmental impact of idol immersion: Dimensions and directions" Environmental Engineering and Management Journal, 2009, Vol.8, No.1, 123-128
4	Santosh M. Avvannavar, **Nanda B. S. Kumar**, Shrihari Surathal, Raghunath Babu, "Mobile phones: an anthropological review of its Evolutionary impact", The Journal of International Social Research Volume 1/5 Fall 2008
5	Santosh M. Avvannavar, Monto Mani, **B. S. Nanda Kumar**, "An integrated assessment of the suitability of domestic Solar still as a viable safe water technology for India", Environmental Engineering and Management Journal , November/December 2008, Vol.7, No.6, 667-685
Publications in National Indexed Journals	
6.	Murthy NS, **Nandakumar BS**, Shivarj NS , Pruthvish S , Shalini C N, Chaudhry K, and Mathew A; Cancer registration: Its relevance for health care planning in India", Ind.Jour Prev. Soc. Med, 41, 1-2, 2010

7.	N.S. Murthy, Usha Agarwal, **B.S. Nandakumar**, S. Prutvish, K. Chaudhary, Obesity and Colorectal Cancer, ICMR Bulletin, 2009, Vol.39, No.7-9, 33-38
8.	NS Murthy, **BS Nandakumar,** C. N.Shalini, S.Shivraj, MS Gautham and S.Pruthvish**,** Need for cancer screening program- Pitfalls and solutions: The Symposium on Empowering Medical and dental Institutions in Cancer Care, Rajiv Gandhi University of Health Sciences, Karnataka**,** Continuing Medical Education Series, No. 4, pp 3-14, 2010
9.	Ashwini Nayak, **Nandakumar B.S**, Asha Swarup O.V, Vijayashree Muthukumar, and Vivaan Dutt. 2015. Study of Etiological Factors of Infertility in a Tertiary Care Centre. International Journal of Health Sciences and Research (IJHSR), 2015, 5 (12), 94-98.
10.	Savita S Patil, Dinesh R Rajaram, **Nandakumar BS**, Jayasree S Seeri, Correlation of Waist Hip Ratio and BMI with Hypertension and Diabetes Mellitus in an Urban Area of Bangalore City, National Journal of Community Medicine, 2015, Vol 6 (1), p 82-85
11.	Ravi Kumar R, Jyothi E. K, **Nanda Kumar B. S**, Madhava Murthy M. R., Efficacy of Air Disinfection Devices in Controlling Atmospheric Microflora in Enclosed Health Care Settings. Journal of Evolution of Medical and Dental Sciences/Volume1/Issue5/November-2012 Page-715
12.	Jyothi GS, Umadevi K, **Nandakumar BS**, Sujani BK, Study of Changing Trend in Maternal Mortality, Perinatology, Vol. 13 • No. 1, Apr–Jun 2012, p 17-23
13.	Vani H. C., S. P. Suryanarayana, **B.S. Nandakumar**, N. S. Murthy. A cross sectional study of pattern of injuries and its socio- economic impact in an urban area. International Journal of Community Medicine and Public Health. 2016; 3(2): 419-425
14.	Chalageri H Vani, Suryanarayana P Suradenapura, **Bidare S Nandakumar**, Nandagudi S Murthy, Pattern Of Child Injuries And Its Economic Impact In Bangalore: A Cross-Sectional Study, National Journal of Community Medicine; Volume 7; Issue 7; July 2016, 618-623
15.	CH Vani1 , **B. S. Nandakumar** , N. S. Murthy , S. P. Suryanarayana, A cross sectional study to assess the socio-economic impact of falls in an urban community in South India, Public Health Review: International Journal of Public health Research, July - August, 2016/ Vol 3/ Issue 4, 146-153
16.	Sastry Nanda Kumar B, Madhumitha M, Ramaprasad A, Syn T. National healthcare programs and policies in India:an ontological analysis. Int J Community Med Public Health. 2017 Jan 25;4(2):307–13.

17.	**V Narendranath , B S Nandakumar , KS Sarala,** Epidemiology of Hospital-Acquired Infections in a tertiary care teaching hospital in India: A cross-sectional study of 79401 inpatients, Int J Community Med Public Health. 2017 Feb;4(2):335-339
Publications in Text Books, National Guidelines, State Level Journals	
18.	**Nanda Kumar B S**, Gopinath D, "Operationalising Telemedicine for Primary Health Care-A Background Paper" , Guidelines for Practice of Telemedicine in India, Government of India, Dept of Space, ISRO Publication, 2005,p 103:107
19.	**Nanda Kumar B S**, 2006, "Fundamentals of Research Methodology" , "Screening for Diseases" and "Evidence based dentistry", Chapter for the textbook on Community Dentistry, Edited by Dr Hiremath, Principal Government Dental College, Bangalore, Elsevier Publications
20.	Murthy NS**, Nanda Kumar BS**, Shivaraj NS,.Gautham MS, and Pruthvish S, Lecture notes on epidemiology & biostatistics- A Primer for Post Graduate students
21.	**Nanda Kumar B S**, "Select Internet resources for Public Health and Community Medicine" Karnataka Journal of Community Health, 2006, Issue: 17, p 25:26
22.	**Nanda Kumar B S**, " Internet Resources for Health Care Waste Management: An overview", Journal of Indian Society of Hospital Waste Management, 2005, Issue: 6, p 23-28
23.	**Nanda Kumar B S**, Chandil G, "Health Information and Management systems in Primary health care" 2007, KJCH, Vol 5, P 53-58
24.	**Nanda Kumar B S** and Madhav Murthy, 'ICT for primary health care: Dimensions and Directions" KJCH, 2007, Vol 5, P 33-39
25.	**Nanda Kumar BS,** Murthy NS, Kumar S, 'Thesis to publications- a logical pathway', Archives of Oral Sciences & Research, AOSR **2012;2 (2):108-112.**
Manuscript sent for publications in Indexed Journals as per MCI requirements-	
26.	Sreekar Augumbe Pai, **Nanda Kumar Bidare Sastry**, Monisha Madhumitha, Ramprasad Arkalgud, Thant Syn, Surgical Procedures for Optimizing Resources in Low Resource Setting: An Ontological Analysis, International Journal of Surgery and Medicine

EVALUATION STUDY ON USAGE OF THE E-HOSPITAL SOFTWARE DEVELOPED BY NIC, KARNATAKA