Survey Based Analysis of Internet of Things Based Architectural Framework for Hospital Management System

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Abstract—Healthcare is very important factor in every body's life and Information technology is playing an important role in providing better health with number of advances. Internet of things (IoT) is an emerging technology. Due to its popularity in technology and internet world, IoT is rising in every field of life and so in health sector. Health is something in which its focus is more concentrated due to its hypnotic features. But it's still not implemented for the broad scope of Hospitals, and especially in Pakistan it's not being used for any purpose in health sector. So we need to define and provide IoT based hospital management information system (HMIS). In this paper we have presented IoT based architectural framework with context awareness for hospital management systems. We have used Context awareness as middleware above network layer to overcome the problem of data management. Moreover we did survey to investigate the decision to adopt the IoT based system in Pakistani Hospitals. Survey was questionnaire based. The accumulated results indicate that participants want to adopt this system and most of the population agreed that IoT based HMIS would provide better monitoring, communication and early diagnosis.

Keywords— smart hospital, hospital management system (hms), Survay, Internet of things (IoT)

I. INTRODUCTION

Healthcare consistently has been an important thoughtful concern the all-time for humankind. In the last decade, with the fast development in web and internet technologies, smart hospitals have developed manifest in our lives. Advancement in the technology has changed the world along with thinking of the world due to the development of smart phones and other handheld gadgets. Good health is the basic necessity of good life. Several technologies and gadgets in last few years have been developed and have promoted to monitor the healthcare and other hospital's critical assets.

However in Pakistan no such infrastructure exists due to lack of resources, budget etc. There are some hospitals in which hospital management information system (HMIS) has implemented. But most of these systems are just maintaining database of patients. Few of the hospitals have telehealth or ehealth system, but these systems have just implemented telemedicine via the technologies of telecommunication, teleconferencing and videoconferencing etc. Literature has shown that these systems lack quality and are expensive and we need a better communication and monitoring system. If we talk about HMIS from all around the world, there are some countries, which have better mobile patient care systems. But still we lack at monitoring, communication and tracking of assets and patients. And there is no common framework to manage the patients and others assets at one platform. Hence, so far all the development in field of health we lack a common communication environment or structural platform, therefore we are proposing an architectural framework that describes the components of hospital based IoT and their communication at one common platform in an organized way for the better quality of HMIS. We have targeted large scale and medium scale hospitals because only these hospitals have the capabilities to implement this system.

IoT is an emerging technology, which we can find in every field of life. IoT is the fourth generation of technology revolution of information realm moreover to execute smart recognition, locating, tracking, following, checking and administration, by methods of GPS, infrared sensors, laser scanners, radio frequency identification (RFID) and some other data sensor devices, as indicated by traditional practice [2]. IoT can be defined as; a technology which allows connection of anything and anyone, anywhere, at any time possibly using any path, network or service [1]. Figure 1 [3], shows the new dimension of communication and information technology i.e. IoT. From the initiation of IoT in Auto-ID Center at MIT toward the start of 2000

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numerous innovative developments have been fulfilled by technical scholars. As per Gartner [2] about 26 billion gadgets will be linked with Internet in 2020 [2]. Because of the improvement of sensor innovations in all fields of life for instance industrial, bio, chemical and so on, microcontroller based systems and networking protocols improvement for embedded frameworks have been tranquil.

The smart hospitals is new sort hospital, incorporated with the functionalities of decision making, management, treatment, administration and diagnosis based on IoT. The peculiarities from internet of things, for example, thorough recognition, solid transmission, smart processing et cetera gives strategy support framework for the development and execution of smart hospital [4].
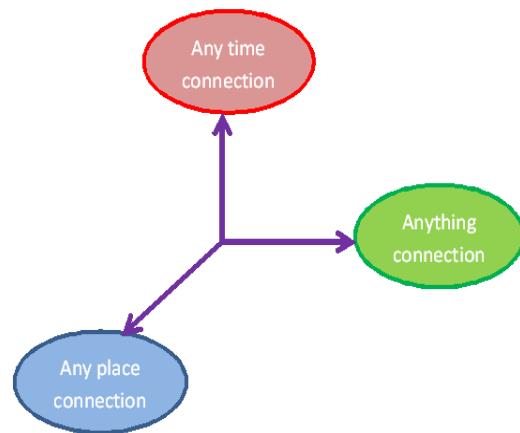

Fig. 1. IoT as a new dimension

In the propelling procedure of hospital management system, the implementation and the deployment of partial HMS (hospital management system) have made the hospitals to accomplish certain level of digital information. However still HMS has some insufficiencies, for example, manual info record, settled networking data point, particular single propose, comparatively autonomous systems between every division [1] etcetera, which totally confine the development of hospital information system. Hence the rapidly growing new technology IoT, has given the new idea to overwhelm the problems mentioned above.

Consequently, in this paper, the essence of smart hospital is studied founded on the presentation of healthcare IoT and other associated ideas anticipated by numerous researchers. In the following sections we have discussed the abstract view of smart hospital, its application that how it works and then we have presented the survey results.

II.   SMART HOSPITAL

When we talk about IoT technology in medical field, we see, many scholars have put their work based on IoT in medical, healthcare based IoT, IoT based patient care and other associated ideas, which have the same pith, just distinctive in perspective and scope of depiction. But in Pakistan none of this is implemented. So we are proposing a smart hospital framework based on IoT. Smart hospital, with the perspective of the IoT technology and built with the course of different program service structures, is the determined impression of internet of things applied in the particular spots of hospital and it is another sort of hospital. This has the functionalities of identification of abnormal condition or determination of diseases, treatment, administration and decision making. Furthermore, coordinating the ideas of intelligent hospital [5], digital doctor's facility, informative hospital and computerized doctor's facility [6], it is the more particular, complete, dynamic, effective depiction regarding hospitals. By the deployment and usage of smart hospital based IoT, it can execute digital application system through which individuals can access related, significant, fast and accurate service information, consequently it can figure it out analysis, diagnosis, administration regularization, , and decision making. Concept of smart hospital is illustrated in figure 2.

III.   PARTICIPANTS AND METHODOLOGY

The ultimate goal of proposed architectural framework is to provide better communication, monitoring of patients, tracking, early diagnosis and treatment, interoperability of data and so on. These features are directly related to better patient health care and easy and efficient management of overall hospital.

The primary participants here are the doctors, nurses and management administrator and hospital servants who will use system. They are capable to ensure that survey is valid from their perspective, and also that it is performed in accordance with the standards considered. IT related personals are also considered, who implements and deploys system such systems.

Major respondents were from large hospitals of Islamabad and Rawalpindi including combined military hospital (CMH) and Pakistan institute of medical sciences (PIMS) hospital. Survey was conducted during the months of May 2015 and June 2015.
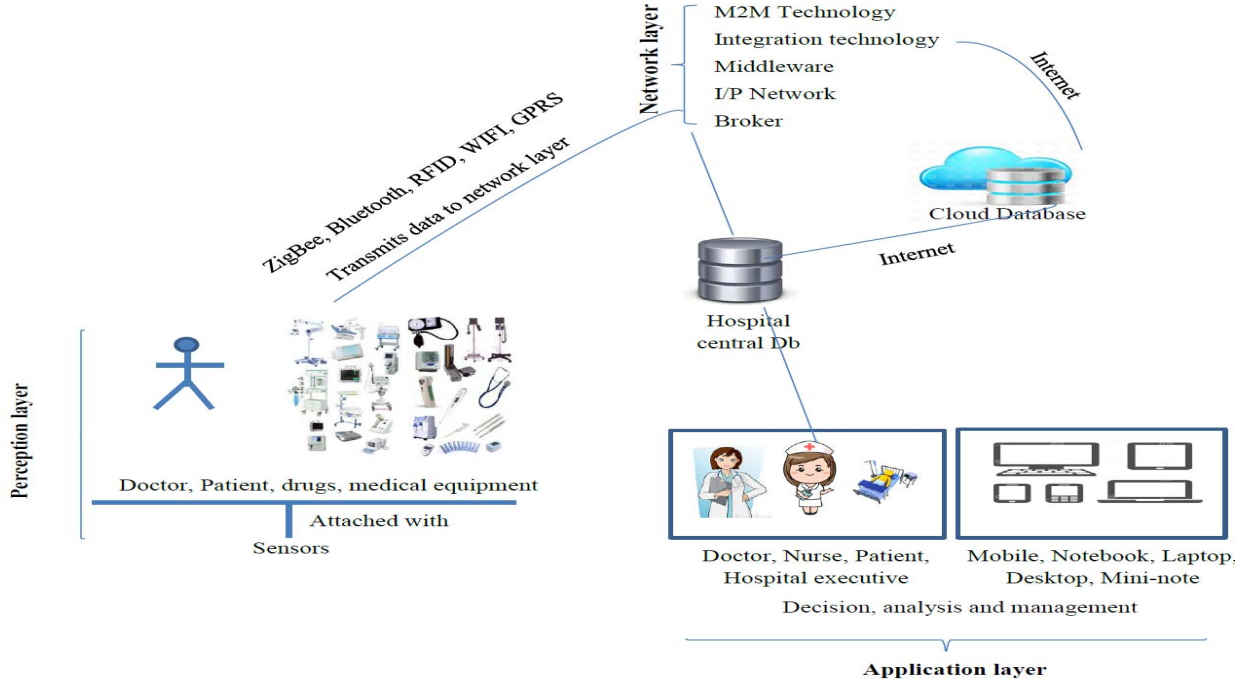
Fig. 2.   Conceptual smart hospital

IV.   CONDUCTING THE SURVEY

The survey was taken out through questionnaire. Potential members were given hard copy of questionnaire and requested to fill up the questionnaire. Before asking them to fill-up the questionnaire we gave them a good understanding about currently used HMIS, our proposed architectural framework that how it works, how the implementation is carried out of such system and some well-known features and characteristics which have significant importance in patient care and HMIS via presentation and video. The survey is done to ensure frameworks feasibility, its implementation and after effects and their tradeoffs, while using HMIS based IoT.

Survey participants are required to answer around 45 questions. Six sections are mentioned to classify questions. In first 2 sections we have asked about the basic computer knowledge of individuals and availability of computers at their workplaces. In next two sections we have asked about the current HMIS and satisfaction with it if they are using any. Then there are questions about role of HMIS for different outcomes and then there is a section containing questions related to our proposed architectural framework i.e. HMIS based on IoT. For this section we have prepared 22 questions, to analyze how doctors are supporting this system, what they think about usage of system. All survey participants were needed to fill up the form according to their skills and experience.

V.   SURVEY RESULTS

Twenty participants from public and private hospitals took part in the survey. The given answers from professionals are then represented in table and charts. Tables are prepared for each section with respect to questionnaire. It is revealed while conducting survey that some questions asked in survey might not be interpreted as the author intended; otherwise results could have been more accurate. It is likely because the participants are lack of experience with computer systems. In this section we have presented results only related to the section containing IoT related questions.

Most of the respondents were happy to adopt IoT based HMIS and agreed that most of the functionalities are beneficial for them as well for patients, especially for the time saving, monitoring and communication purposes.

From Table 1 and Figure 3 is evident that Survey results have about 88 % of respondents are agreed to adopt use the IoT based HMIS while 6% are uncertain and 6 % disagreed to accept the system. For the mean values of all the features most of the individuals participated in the survey have shown their maximum positive interest in the "Strongly Agreed" and "Agreed".

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Table 1: Survey accumulated Results (%) for IoT based HMIS

|		strongly agree	agree	uncertain/ not applicable	Disagree	strongly disagree
1.	Will the system be accepted and used?	11.76	76.47	5.88	5.88	0.0
2.	Patient care is more reliable and perceptive than to the existing system?	11.76	58.82	23.53	5.88	0.0
3.	This system would help me to see more patients per day and also save time (or go home earlier) than you could with the existing system.	23.53	64.71	5.88	5.88	0.0
4.	Do you believe that IoT will bring a disruptive change?	0.0	5.88	52.94	41.18	0.0
5.	This system would be more effective for the situation to monitor and instruct far from patient	23.53	64.71	5.88	5.88	0.0
6.	This system wouldn't just enable us to manage the assets and data of hospital but it would actually help to provide better patient care	11.76	76.47	5.88	5.88	0.0
7.	Would it be beneficial?	17.65	64.71	11.76	5.88	0.0
8.	The e-health and telemedicine is easy, fast and error free with the IoT.	5.88	52.94	41.18	0.0	0.0
9.	The way, in which architecture is proposed is suited to the task you want to perform with the software	11.76	47.06	35.29	5.88	0.0
10.	There are some features of this systems, that are not related to actual work	0.0	35.29	52.94	11.76	0.0
11.	Will system implementation have an impact on control in the organization	17.65	47.06	35.29	0.0	0.0
12.	You would be able to track the stuff (including equipment and patient data) easily and efficiently with IoT based hospital	23.53	76.47	0.0	0.0	0.0
13.	Intra-office communication and tasking would be fast, easy, and effective with IoT based hospital	29.41	41.18	5.88	5.88	0.0
14.	The data, you would be able to handle easily (thorough IoT) with the new HMIS that you could not do before?	23.53	76.47	0.0	0.0	0.0
15.	This would provide useful tools for disease management (for instance, diagnosis-specific prompts, alerts, and patient education materials).	17.67	58.82	17.67	5.88	0.0
16	Is the system cost-effective?	5.88	29.41	35.29	29.41	0.0
17	IoT based HMIS promotes patient safety?	5.88	47.06	29.41	17.67	0.0
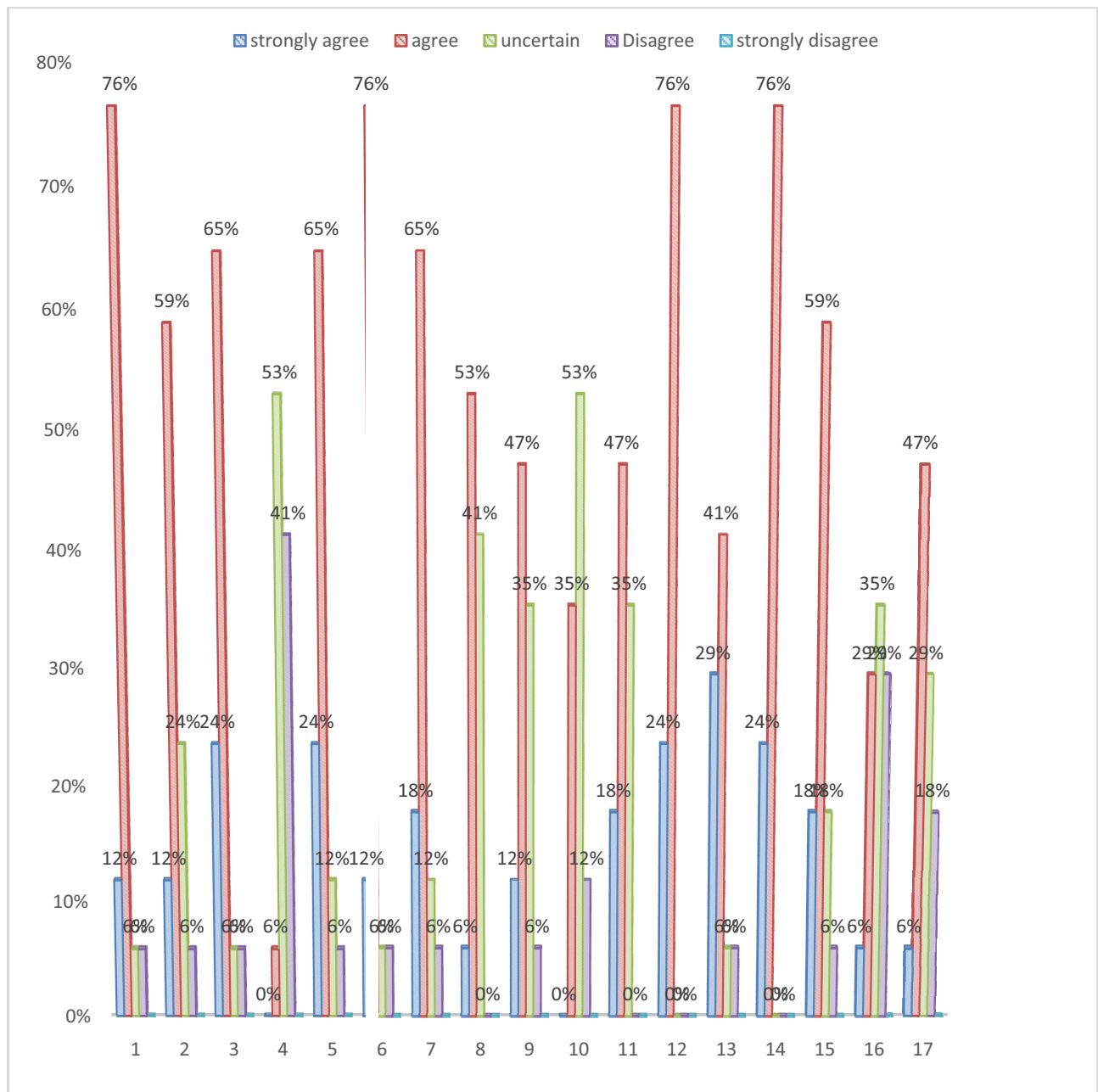
Figure 3. Graphical view of results for analysis of IoT based HMIS

VI. DISCUSSION

We surveyed and asked the respondents about "which department need this IoT based HMIS now"? Individuals selected options from given list, some of the respondents selected more than one option. The accumulated results are shown in figure 4. As we can see most of the respondents wanted it in OPD and then in ICU.

Despite the widespread use of information technology, hospitals in Pakistan still lack in IT advancement. Currently used many large hospitals still don't use computer systems, but many are using simple HMIS systems, such as CMH. Some of hospitals also have implemented basic level of e-health and working on tele-health and making progress.

Our survey is showing that people are willing to accept and use HMIS with advanced technology as technology is always there to ease humans and give comfort in our daily life.
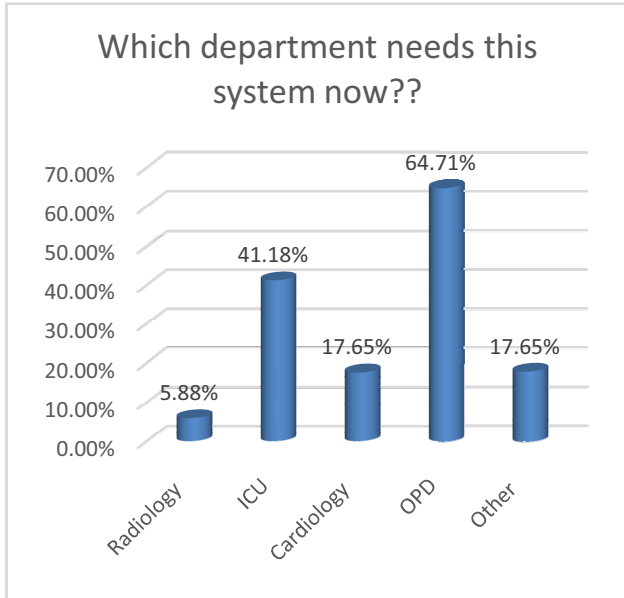

Figure 4: results for the priority of d^partment, in which we need this system now.

So does our proposed framework. And around 80% of respondent's agreed that IoT based system would provide better communication, better health care, reduce cost, better monitoring, and early diagnosis, better data management and so on.

Most of the questions in questionnaire were understood and correctly interpreted by most of the respondents. But for some questions respondents were confused and scored questionnaire with wrong interpretation. For example some of doctors were thinking that with on distance monitoring as we are already doing in ehealth and telemedicine, communication with patients would be less and difficult.

VII. Conclusion:

IoT (Internet of Things) has turned into a real life changer. In last decade this technology through its excellence of pertinence is emerging in every zone of life from logistics to environment observing and trades to farming. Healthcare is one of those fields which request a motivational provision which may only be fulfilled by IoT in conservative and helpful way. Implementation of IoT based HMIS framework would change the existing hospital architecture and will give satisfied result and this methodology is for sure fit to tackle the issues of hospital. We have discussed the basic connotation of smart hospital and have conducted a survey for analysis of IoT based HMIS. This study investigates the decision about adoption of IoT based hospital management system in Pakistan.

Result shows that 87% of participants were happy with the features of IoT and functionalities provided by IoT based smart hospital. For the question that which department needs it now, the high rated departments are ICU and OPD. To our knowledge this is first assessment for the process of Internet of things implementation in hospitals of Pakistan. In future we will discuss the security issues and data formats for all embodied and mobile systems for the versatile implementation in IoT based HMIS.

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