AN EXPLORATORY QUALITATIVE STUDY TO IDENTIFY FACTORS AFFECTING REQUIREMENTS ELICITATION AND FACT FINDING WHILE DEVELOPING HEALTH CARE KNOWLEDGE MANAGEMENT SYSTEMS IN PAKISTAN

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ABSTRACT: *Requirements elicitation or Requirements gathering is the most important part of any project irrespective of the system development methodology being used. A number of fact- finding techniques have been introduced in this respect. Many Healthcare Knowledge Management System (HKMS) projects start with an incomplete or incorrect list of requirements which ultimately result in halting, delaying or failure of those projects. Requirements elicitation is the most important step of the requirements discovery process which focuses on fact-finding and data acquisition by using different techniques. The purpose of this study is to identify and determine those factors which affect the requirements gathering and discovery process and cause hindrance individually or collectively during fact-finding process. This ultimately results in misguiding the direction of the project. Dealing with such factors will help in developing proper and appropriate system requirements specifications. Furthermore, this study will also pave the way to find out solutions to cater and mitigate the occurrence and existence of such factors.*

Keywords: Fact Finding, Healthcare Knowledge Management System, Requirements Discovery, Requirements Elicitation, System Requirements Specifications

1. INTRODUCTION

Healthcare Knowledge Management Systems (HKMS) are important and sensitive systems which require special and professional care with respect to requirements discovery and requirements specification. Requirements prove to be the basis for such as well as every project and they tend to define and describe in detail about the needs of a business and what a system must do in order to satisfy those needs. By definition, "A requirement is a need, expectation, constraint or interface of any stakeholder that must be fulfilled by the proposed software product during its development" [1]. To achieve these objectives, a scientific methodology is used in form of a controlled process, called "Requirements Discovery Process" [2]. Now if a System Analyst or a Project Manager is unable to collect proper, correct or complete requirements due to any of underlying reasons or factors, one can imagine that how much it is going to affect the success rate of the HKMS software project. This exploratory qualitative study highlights and determines all those factors which play their role as a hurdle in the requirements gathering process individually or collectively.

PERSPECTIVES ON REQUIREMENTS DISCOVERY PROCESS

It is important to view the requirements gathering activity as a process. Before one could understand requirements elicitation, it is important to comprehend the meanings of requirements itself and requirements gathering process.

"The possession of a certain capability that a product must attain for satisfaction of user needs to fulfill his objectives is described as a requirement". "The step by step collection of needs and requirements of users related to a particular system by using a professional scientific technique for solving certain problems and issues to achieve specific business objectives is rendered to as requirements gathering process".

A complete and correct set of data obtained by the help of a formal requirements gathering process aids and facilitates to formulate realistic time estimates, cost estimates, better planning and improved customer satisfaction.

The requirements gathering process attains one of the most important positions among the phases of Information System Development Life Cycle as every subsequent phase is affected by its outcome. The collection of basic needs and requirements for a system are believed to be the basis of any healthcare information systems project irrespective of the fact of excellence and quality in the design of the system. The customer or user needs may not be fulfilled by collection of unclear and incomplete business requirements in an information systems project [2]. Hence, inadequate, unclear and defective requirements tend to be the biggest failure factor for HKMS projects alone due to which they have a higher tendency of failure as compared to other technological projects.

This is where the main responsibility of business analyst comes into view. It is the liability of the business analyst for aligning the business needs with business objectives along with appropriate and well managed communication of the needs to the project team and all the important stakeholders [3]. That is why; they are required to ensure that the requirements are written in an easy to understand language for both factions. At this point it is difficult sometimes to deal with complex, conflicting and ambiguous views and opinions of stakeholders and to obtain a clear picture of those.

BASIC REQUIREMENTS DISCOVERY PROCESS

A basic requirements discovery process is a six stage process [3] which comprises of the following stages:

a) Requirements Planning
Requirements' planning is a roadmap or scientific management practice which is performed to define all the resources and activities that are related to planning and management of requirements gathering and fact finding activities throughout the requirements gathering process.

b) Requirements Elicitation

Requirements elicitation is practically performing the act of collection of all the information that is related to needs and requirements for an HKMS. The information regarding requirements is collected from individual resources which include all the major stakeholders of the system, existing documents, organizational processes and procedures which do not exclude information regarding organizational culture. Different techniques and methods are used to elicit requirements including questionnaires, interviews, observation, structured walkthroughs, documents reviews etc.

c) Requirements Analysis & Documentation

The information collected through the requirements elicitation stage is analyzed and documented in a formal and professional way keeping in view the consistency and feasibility of the needs of all the users. The requirements collected are defined and prioritized according to their importance and impact to attain the business objectives.

d) Requirements Verification & Review

It is not possible to finalize the requirements until they are verified and reviewed. Healthcare Knowledge Management Systems tend to be important and critical systems which are directly related to store and process information regarding public health that may be highly personal and classified in some cases. So, in these types of situations, the requirements collected by different means and resources must be cross verified and reviewed.

e) Requirements Validation & Acceptance

Ensuring the validity of requirements and their acceptance is another important activity in the requirements discovery process. The business analyst must ensure that the requirements and needs which have been collected are valid, legal and acceptable. A formal acceptance is also required from the top management of the organization.

f) Requirements Change Management

No matter, how accurate and valid they are, many of the requirements are always subject to change, increase or decrease. This happens due to a number of reasons that people change their mind. It is advisable to always be ready for such changes provided that business analyst keeps a record.

The most important and crucial is the Requirements Elicitation Stage in which the actual fact-finding and requirements gathering is done [4,5]. This study is related to the same phase identifying the factors which cause hindrance in the collection of requirements or finding facts while developing HKMS.

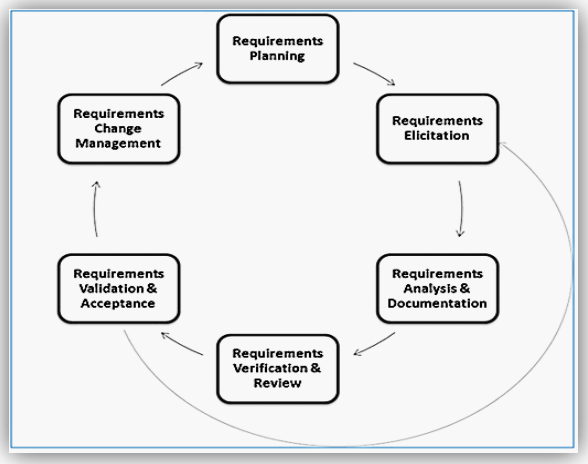

Figure 1: Adapted Basic Requirements Discovery Process (Pressman & Maxim, 2014)

2. PROBLEM STATEMENT

a) Gathering incorrect and incomplete requirements are the initial and primary problems that hinder successful implementation of healthcare software projects.

b) They tend to be a basic reason for the issues in scope identification and scope definition resulting into scope creep.

c) At the end, they result in incomplete, ineffective and incorrect design issues, further advancing towards time creep and budget creep.

3. PROPOSED SOLUTION

a) This research focuses on exploring, identifying, investigating and unfolding all those underlying factors that are the base of all the problems, hindrances, and constraints in the way of effective requirement elicitation or fact-finding process while analyzing healthcare knowledge management systems.

b) The study determines and describes in detail all such factors and highlights their importance along with their possible impact.

c) As a result, it will be possible to find out a solution to mitigate them.

4. RESEARCH METHODOLOGY

To gain an in-depth understanding of underlying reasons and factors that affect the requirements gathering and fact finding process, an exploratory qualitative research methodology is adopted. This research is additionally supported by the personal expertise of domain experts, literature review, and bibliographic research methodology. The domain experts are chosen directly from the healthcare industrial units and organizations that have more than 10 years of experience in dealing with system conversions and changeovers.

The authors themselves have more than 10 years of experience in the field of requirements engineering and software development. Other than these, individual interviews have been conducted with the domain experts to collect information from their real-time professional experience in this respect. To support the findings of individual interviews, a series of group discussions have also been conducted to solidify the ideas and investigations.

5. FACTORS IDENTIFIED

Following is the detailed elaboration of all the major factors explored and identified during this study that affect the requirements elicitation during requirements discovery process.

A. Sense of Job Insecurity among End Users

End Users are those individuals or the stakeholders which are ultimate users of an Information System at the transaction level. They have the highest level of probability with respect to the number of direct interactions with the system [6]. They also have the most reliable and correct information about the working and flow of a system.

Such individuals interact with the system at the operational level and are one of the most important resources for collecting facts and discovering requirements on ground realities [7]. The first thing that comes to the minds of the End Users is the sense of job insecurity resulting from a thought and fear of not being enough competent or being a misfit for the newly proposed system ultimately resulting in the non-cooperative behavior by them during requirements discovery and fact-finding process for the newly proposed system.

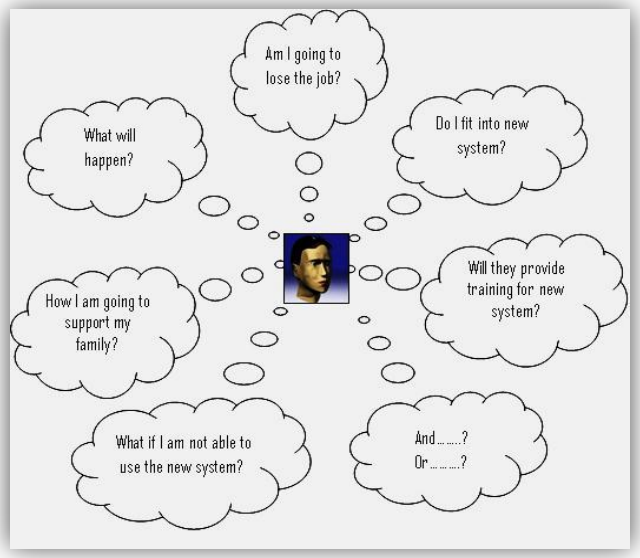

Figure 2: A typical end user mind-set regarding fear factor

End users interact with the system directly while using it during transaction entry and posting data. They also know the actual flow of processes of the HKMS. Hence, they are the individuals who can provide detailed information and help in gathering correct, complete and reliable requirements at the lowest level of the system [8].

On the other side, end users can also misguide the System / Business Analyst providing false and fake data by any means to hinder in the requirements gathering process, hence changing the direction of fact findings. This is the stage where the end user is feared and afraid of the proposed new system. Now when the end users come to know that an entirely new system is going to replace the existing system in near future, a sense of job insecurity cover-up their minds [8,9].

B. End User's Lack of Trust on System / Business Analyst

This is one of those factors which have its impact in the earlier stages of the requirements elicitation phase. The trust deficit is the main cause of this. The source employees or end users consider a lot of facts and information as secret and confidential business information and try to hide it from the system analyst which in reality is also to be incorporated into the new system [10]. They may be afraid of security or privacy breach as they do not trust a new person gathering that information. Well, they are right in their thoughts and concern. Anyway, this still serves to hinder the requirements gathering process.

C. End User's Level of Computer Literacy

Nevertheless, it's a fact that end users are comfortable and familiar with the old systems whether they are computer based information systems or manual information systems. The usage of the systems over the years makes them master and perfect users. But most of the time they do not have formal computer education due to which they are resistant and feel uncomfortable to fit into the new system [11]. They think that they are not capable and even sometimes they do not have enough confidence to learn the new system. This feeling results in a non-cooperative behavior with the system analyst or the project manager for requirements gathering further resulting into wrong or incomplete information discovery. They try to avoid project teams, remain absent from the meetings or even remain silent on many questions acting as they don't know anything.

D. Lack of Top Management Involvement and Commitment

Many researchers and studies over the past few decades have revealed that this one factor has the maximum negative impact on projects. The impact strength of this factor is on one side and all the rest of the factors collectively on the other side [1][3][4]. Figure 3 clearly explains the rationales of the importance of this factor.

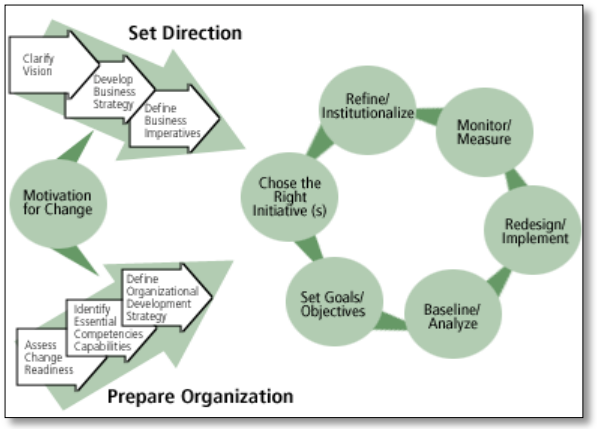

Figure 3: Why top management commitment is important? Adopted from Management Solutions

Usually in big organizations, the top management and the administrative sections are very busy entities. It is very difficult to get an appointment from managers, administrators, and directors to obtain or verify important and crucial information. The situation gets worst if they are not available when they are seriously required. Many of the top management personals are even not aware of the importance of the project.

This lack of interest from the top management also tends to encourage the lower level employees not to cooperate with the requirements gathering team, hence causing hindrance in proper requirements gathering.

E. Non-Availability of End Users

Usually, in big organizations, most of the staff members are jam-packed with official work and assignments in a 9 to 5 hectic schedule. Some of them even have to do overtime or late sitting to finish their work. In this situation, one can imagine, how much time these key resource employees can manage to spare for the project team to answer their questions [12].

Even if some of them are available also, they are not in a position to attend long meetings and interview sessions. This situation results to hinder the process of requirement gathering without any fruitful or useful details. The system analyst has to wait sometimes for the whole day for a five minutes appointment from the key staff member. Sometimes they are not available to give time for many days. Even sometimes some of them intentionally avoid giving time for meeting and interview sessions acting like they are very busy. What else?

F. Lack of User Experience in the Field

As a matter of fact, many organizations hire inexperienced and fresh staff members in key positions to avoid giving big salaries and many times it happens that senior and experienced staff members switch to better jobs for being offered attractive salaries there. Ultimately, such type of frequent turnover of employees and staff not only affects the company itself but also has considerable impact directly or indirectly on the requirements discovery process [13].

Fresh employees do not have enough experience or knowledge to provide useful information about the business processes. Many of them even don't know what to answer to a particular question. A few of them are not even sure about whether to provide specific information or not. Even they are sure, they don't have enough experience to express that information. Sometimes their answers are ambiguous and confusing.

Companies also tend to keep on transferring certain employees from one department to another or from one center to another making them "Jack of all and master of none". This particular practice never allows them to focus on one area or field of expertise which also results as a big hurdle in requirements gathering / discovery process.

G. Methods Used for Gathering Requirements

The requirements gathering or elicitation phase has a step by step progressive elaboration and can be done by using various techniques and methods [3,13].

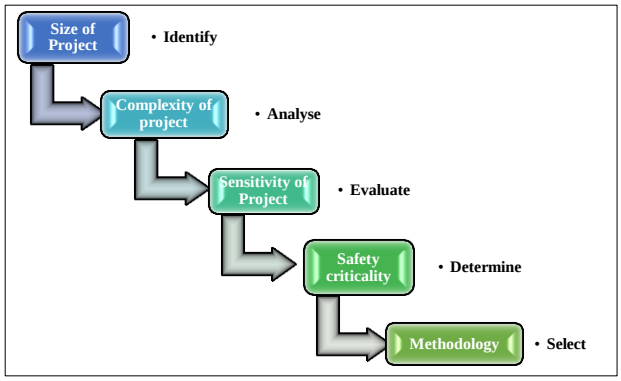

Figure 4: Project Parameters to Consider before finalizing Requirements gathering methodology

Which method to use for a particular project, depends on certain parameters or key elements of the project as depicted in figure 4.

The system analyst tries to collect information and facts by using different methodologies. Some of them collect information in a professional way using varied techniques based upon the type of project [14]. Unfortunately, some of them fail to figure out how clever and deceiving an end user is? Irrespective of the fact that the system analyst is using a professional methodology for gathering requirements, they still are unable to discover correct, complete or sometimes reliable information. This hinders the process of requirements discovery.

H. Employees Union Political Behavior

Many organizations have a culture of developing employee unions for the welfare of staff and employees. Many of these unions become a symbol of politics and tend to blackmail the top management for their own benefits [6][8]. This extortion sometimes also creates hurdles during requirements elicitation phase while developing healthcare information system projects.

The top office bearers of the employee union try to interfere in every step of a project to prove their importance and to show the top management of the organization as well as the project team that nothing could be done successfully without their cooperation. They even try to peril those who are helpful or offer their services to cooperate with the requirements gathering team.

I. Competency and Skill Level of System/Business Analyst

Many software projects tend to be different from each other. Some are small, some are medium and some are very large scale projects. On the other hand, there may be complex as well as safety critical projects [1][3].

On the contrary side, there are incompetent, competent or experienced system analysts. One could imagine if everything else is fine, but a system analyst is an incompetent person for requirements discovery task, then what could happen. As a result, this appears to be one of the biggest and major factors which affect the requirements elicitation for any type of the project [1][2][3]. Figure 5 emphasizes the basic qualities a system/business analyst must possess to be an effective and efficient entity in requirements discovery process.

Figure 5: Essential skills of a business analyst. Adopted from (BA) Business Analysis, "http://www.businessanalysis.in/"

Many organizations hire inexperienced or incompetent IT professionals without measuring the complexity of the project and later on suffer due to the collection of incomplete and inappropriate requirements. Fact-finding or requirements discovery is not a piece of cake in every project. A system/business analyst must know how to: a) bring business and technology together, b) research new technology, c) test systems to ensure efficiency and d) devise ways to meet the needs of the business.

J. Time Constraint: Shortage of Time

Well, we don't know how to fit the famous saying, "Time is Money", into the requirements discovery process. You may save a lot of money by compromising time during requirements discovery process, ultimately compromising over the success of the project. Certain case studies over the years show that the requirements discovery process consumes almost 50% of the total time taken by a project to complete, if done properly and rigorously [4]. It's not about just asking questions and preparing reports, it's a complete process comprising of different important and crucial steps [15].

Unfortunately, organizations give very little time for requirements elicitation activity. The stakeholders are in a bit of hurry to see the prototype of what they want. This sounds to be fast and furious.

K. Illegal or Unacceptable Requirements

Last but not the least, many times it happens that the end users or other staff members do attempt to put forward those requirements which may appear to be illegal or unacceptable [16]. Sometimes there is a long wish list of substandard requirements also. This causes to slow down the requirements gathering process and puts the system analyst in a confusing situation. He may require more time to decide upon what is acceptable or what is not acceptable or may need to arrange more meetings with the top management to validate, verify or rectify such issues.

6. RESULTS AND DISCUSSION

Ranking Factors In Terms Of Severity of Impact and Likeliness to Occur

A total of 15 professionals including 3 information technology project managers, 4 business analysts, 4 healthcare information systems professionals and 4 healthcare top management officials were interviewed to perform this exploratory study to determine the factors that affect the requirements elicitation process while developing HKMS. During interviews, the participants were also asked to rate the identified factors (from 1 to 10) in terms of most likely to occur and rank them (from 1 to 10) in terms of most severe impact to the requirements elicitation process.

Table 1: Rank of Factors in Terms Of Severity of Impact

Factors	Rank (1 = Least Impact → 10 = Most Severe Impact)										Part.	Avg.
	1	2	3	4	5	6	7	8	9	10		
A	0	0	0	0	0	3	5	1	4	2	15	7.80
	0%	0%	0%	0%	0%	20%	33%	7%	27%	13%		
B	0	0	0	0	0	1	2	6	3	3	15	8.33
	0%	0%	0%	0%	0%	7%	13%	40%	20%	20%		
C	1	1	4	3	5	1	0	0	0	0	15	3.87
	7%	7%	27%	20%	33%	7%	0%	0%	0%	0%		
D	0	0	0	0	0	0	0	0	4	11	15	9.73
	0%	0%	0%	0%	0%	0%	0%	0%	27%	73%		
E	0	0	0	0	0	0	4	3	5	3	15	8.47
	0%	0%	0%	0%	0%	0%	27%	20%	33%	20%		
F	0	4	3	3	2	1	2	0	0	0	15	3.93
	0%	27%	20%	20%	13%	7%	13%	0%	0%	0%		
G	3	2	4	4	1	1	0	0	0	0	15	3.07
	20%	13%	27%	27%	7%	7%	0%	0%	0%	0%		
H	1	1	3	3	2	4	1	0	0	0	15	4.33
	7%	7%	20%	20%	13%	27%	7%	0%	0%	0%		
I	0	0	0	0	0	0	3	4	5	3	15	8.53
	0%	0%	0%	0%	0%	0%	20%	27%	33%	20%		
J	0	0	0	0	0	0	2	2	4	7	15	9.07
	0%	0%	0%	0%	0%	0%	13%	13%	27%	46%		
K	0	0	4	1	3	6	1	0	0	0	15	4.93
	0%	0%	27%	7%	20%	40%	7%	0%	0%	0%		

The data analysis in Table 1 shows that lack of top management commitment, time constraint, competency and skill level of the business / system analyst and non availability of end users respectively are the most vulnerable factors that influence the requirements elicitation and fact finding activity in a most negative way.

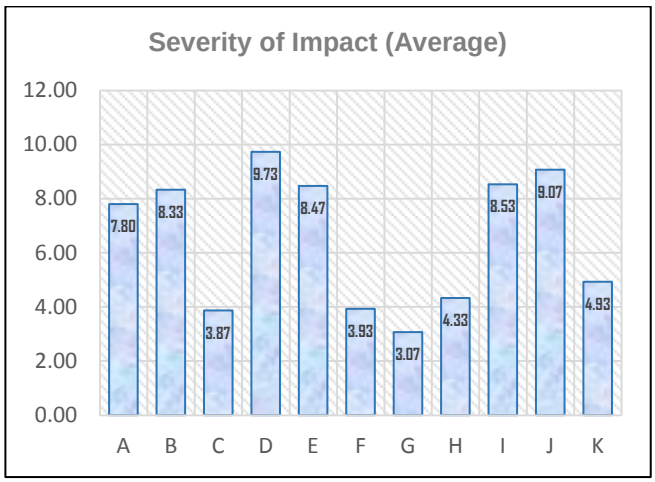

Figure 6: Graphical Representation of Severity of Impact

Figure 6 above provides a graphical comparative analysis of all the factors discussed before. It is very clear that factors like lack of top management commitment, time constraint, competency and skill level of business / system analyst and non availability of end users are some of them whose severity of impact is most and need to be catered accordingly.

Table 2: Rank of Factors in Terms Of Likeliness to Occur

Factors	Rank (1 = Least Likely → 10 = Most Likely)										Part.	Avg.
	1	2	3	4	5	6	7	8	9	10		
A	0	0	1	2	1	1	4	2	2	2	15	6.93
	0%	0%	7%	13%	7%	7%	27%	13%	13%	13%		
B	1	1	1	5	2	3	2	0	0	0	15	4.53
	7%	7%	7%	33%	13%	20%	13%	0%	0%	0%		
C	0	1	1	0	4	3	5	1	0	0	15	5.73
	0%	7%	7%	0%	27%	20%	33%	7%	0%	0%		
D	0	0	0	1	2	4	3	1	2	2	15	7.00
	0%	0%	0%	7%	13%	27%	20%	7%	13%	13%		
E	2	1	5	2	2	3	0	0	0	0	15	3.67
	13%	7%	33%	13%	13%	20%	0%	0%	0%	0%		
F	1	1	1	6	5	1	0	0	0	0	15	4.07
	7%	7%	7%	40%	33%	7%	0%	0%	0%	0%		
G	1	1	2	1	3	4	1	1	1	0	15	5.07
	7%	7%	13%	7%	20%	27%	7%	7%	7%	0%		
H	0	1	1	3	7	2	1	0	0	0	15	4.73
	0%	7%	7%	20%	46%	13%	7%	0%	0%	0%		
I	1	1	2	2	3	5	1	0	0	0	15	4.60
	7%	7%	13%	13%	20%	33%	7%	0%	0%	0%		
J	0	0	0	0	1	1	2	2	3	6	15	8.53
	0%	0%	0%	0%	7%	7%	13%	13%	20%	40%		
K	0	1	2	2	1	2	2	1	2	2	15	6.20
	0%	7%	13%	13%	7%	13%	13%	7%	13%	13%		

Table 2 analyses the factors in terms of likeliness to occur. That means to categorize those factors that have high tendency to occur as compared to occur. This helps to focus more on those factors so that they are dealt with extreme care and concern. From the data presented, it is obvious that the shortage of time, lack of top management commitment and sense of job insecurity among end users are the factors that are most likely to hinder the requirements collection process.

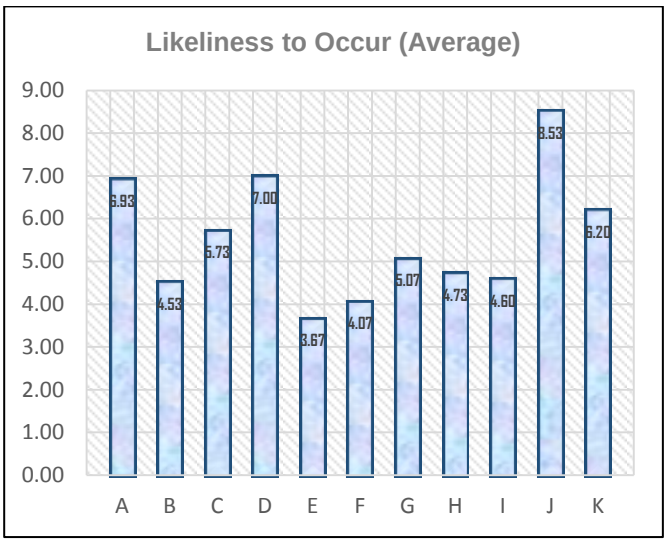

Figure 7: Graphical Representation of Likeliness to Occur

Figure 7 provides a graphical illustration and comparative analysis of all the factors in terms of likeliness to occur.

7. CONCLUSION

Healthcare Knowledge Management Systems are complex and sensitive systems that deal with public health data and are service oriented systems. They need special care in terms of understanding the requirements and specifications. The "Requirements Discovery Process" itself provides a deep insight of the importance and elaboration on the criticality of all the tasks and steps that are performed for gathering the correct, complete and useful information regarding requirements and facts while implementing HKMS. Here, it is emphasized that the most important phase is "Requirements Elicitation" phase, where the business or system analyst has to work very hard to dig out what is called as a legal requirement [5]. Now here is the point where one has to face the maximum hurdles placed in the way by different types of factors. It is not necessary that all the factors which are identified in this research, work altogether at the same time. Some factors are involved individually while others effect in a group. Anyway, the main point is that a System / Business Analyst should identify and overcome these factors as early as possible and try to implement solutions if he could to avoid failure in discovering the reliable, complete and correct information regarding requirements for the healthcare information systems project.

This study is important and unique in this respect that it has a wide range of implications and propositions in the healthcare domain. The factors identified were also analyzed in terms of their severity of impact and likeliness to occur that will further help to extend the study by finding out the solutions and preventive measures to mitigate the impact of these factors.

This exploratory and investigative study is not a conclusive research but later on it may help to extend this research and pave the way to a conclusive quantitative research by generating solid ideas and hypothesis. Further on, this study may also be extended to explore and identify solutions to mitigate the effects of the factors identified in the current study.

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