Factors Affecting Requirements Elicitation for Heterogeneous Users of Information Systems

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Abstract: **Modern organizations keep up with the fast changing technology through successful information systems development and integration to automate their business operations. Among others, this can be achieved through effective requirements elicitation which a sub-phase of requirements engineering. It is recognized as one of the most critical, knowledge-intensive phase therefore determining the overall success or failure of the information system. In a setup whereby users are heterogeneous by nature, requirements elicitation becomes quite challenging. To improve the effectiveness of the requirements elicitation process from this type of users, the analysts should determine the factors that affect this process which are unique to this type of users. To address this issue, we have conducted research in two Kenyan public universities whereby information systems users are heterogeneous in nature. The objective of the study was to determine the factors that affect requirements elicitation process among heterogeneous user groups of information systems. Nine factors were identified by using multiple regression analysis namely, users' availability, users' and analysts' diverse cultural background, users' geographical distribution, communication issues, users' awareness and training on the process, technique used, institutional politics and bureaucracy, requirements elicitation policy and user's cooperation & motivation. These factors form a practical guide that can help analysts to consider before carrying out requirements elicitation from heterogeneous users**.

Keywords: **Requirements elicitation, requirements elicitation models, requirements engineering, software development, heterogeneous users**

I. INTRODUCTION

Requirements engineering (RE) is the first and an important stage in software development life cycle. Many researchers agree that most of the hurdles encountered during software development are majorly attributed to requirements engineering. Getting right from the beginning what to develop has been a major challenge to software developers. RE is concerned with establishing what the system should do, it's desired and essential emergent properties, and the constraints on the system operation and the software development processes [1].

Studies show that 60% of project failures fall into the RE phase and mostly aren't discovered until late during the project or when the system is already operational [2]. One of the greater challenges in procuring or developing any information system is capturing the user requirements since requirements decisions are affected by incomplete and uncertain information [3].

In software engineering, RE activities are requirements elicitation, analysis, specification, validation and management [1]. This research focused on the first activity of RE, which is requirements elicitation. Capturing user requirements is done through requirements elicitation process which is both the hardest and most critical part of

software development [4]. Additionally, errors at the beginning stage propagate through the development process and are the hardest to repair later resulting in ambiguous, informal, incomplete and inconsistent requirements [4]. As a result of such requirements the final product will have low user acceptance.

In a setup whereby users are heterogeneous by nature, requirements elicitation becomes quite challenging. To improve the effectiveness of the requirements elicitation process from this type of users, analysts should determine the factors that affect this process which are unique to this type of users.

The purpose of this paper is to provide a practical guide on factors that affect requirements elicitation from heterogeneous users. This guide helps analysts on what to consider before conducting the process. The factors outlined were determined as a result of the study carried out among the information systems users, who were the main respondents of the study. This study aimed to answer the following research question:

What are the factors that affect requirements elicitation process among heterogeneous user groups of information systems?

To address this issue, we have conducted research in two Kenyan public universities whereby information systems users are heterogeneous in nature. The objective of the study was to determine the factors that affect requirements elicitation process among heterogeneous user groups of information systems. A multiple regression test was run to predict factors that affect requirements elicitation as indicated by the respondents. Factors whose p-value was less than 0.05 (i.e $p < 0.05$) were considered as significant predictors.

The rest of this paper is organized as follows. Section 2 presents related work, section 3 presents the methodology, section 4 presents the results, and section 5 presents the conclusions.

II. RELATED WORK

Requirements elicitation is one of the important stages in software engineering. Many researchers agree that incorrect, incomplete and unclear requirements have a major impact on the quality, cost and delivery time of information systems [1, 2, 3, 4]. Due to these concerns, a complete, systematic process for requirements elicitation is required at the same time an understanding of the factors that affect this process is paramount. Requirements

elicitation phase mainly focuses on examining and gathering desired requirements and objectives for the system from different viewpoints e.g., customer, users, constraints, and system's operating environment [5]. It is in this view that this section examines the factors that affect this process.

First, communication is considered to be the major factor that affects requirements elicitation process. This is because it involves a rich communication activity that requires users to have the ability to interact and communicate their needs while on the other hand analysts should have the domain knowledge to be able to understand. Communication conflict is inevitable during this process since preference, priorities, backgrounds, objectives and goals vary from one person to another [6]. Due to this fact, users and analysts need to have appropriate communication skills to reduce these conflicts.

Another important factor is that the analysts may not be equipped with sufficient expertise/experience to perform effective requirements elicitation [7]. Apart from the experts there are the stakeholders who do not actually know what they want, can be adverse to the change a new system may introduce and can have varying levels of cooperation.

Consumers of any product, software included have different characteristics and it should be considered by software analysts before requirements elicitation is carried out. User characteristics based on human factors analysis are demographic characteristics which includes gender, age and physical characteristics like disability, experience characteristics that include training, prior and current job experience, academic experience, and computer literacy, work habits, preferences and language skills [8].

In a university setup, software users are quite heterogeneous in nature because University software users and the software experts come from vastly contrasting backgrounds and are divided by language, culture and needs. Eliciting and integrating requirements from large groups of diverse users remains a major challenge for the software engineering community [9]. This is majorly because end-users and IT specialists have different backgrounds, thus many misunderstandings occur often without realizing it until later in the project thus leading to financial and timely drawbacks. Exchange of information can also be improved when there are common cultural, educational and social backgrounds and experiences between the communication partners.

Target groups of the evaluation by the software analysts in a university are different stakeholders, including learners themselves who might include the disabled, as well as various professionals [10]. This heterogeneity of users in universities complicates the user requirements elicitation process resulting in problems during software development and in acceptance of the final product.

III. METHODOLOGY

In this paper we adopt a multiple case study research design. Use of Multiple cases yields more robustness to the conclusions from the study than a single case study [11].

The target population for this research was university IS users which comprised mainly of staff and students who interact with these systems. Staff who interact with the IS are of two types, expert and non-expert users. Expert users refer to the personnel who are responsible for the acquisition or development, implementation, utilization and management of IS in the university, therefore they are both managers and users of the IS. Non-expert users on the other hand are just users of the IS and they have no expertise on its acquisition, development or management, typically students and staff who do not fall on the expert category. The data collected from these groups provided a good representation of the sample.

The population was stratified into two strata namely staff and students. If a population from which a sample is to be drawn does not constitute a homogeneous group, stratified sampling technique is generally applied in order to obtain a representative [12]. After putting the groups into stratas, purposive sampling was applied in each stratum to target respondents who were believed to be reliable enough for the study. Respondents who are particularly informed well enough to respond to the research questions were selected to enable effective attainment of research objectives [11]. For the students' strata, we purposefully selected fourth year undergraduate students and second year postgraduate students from the selected universities. We considered the fact that the selected students have experience of information systems use and they were more informed about the university systems and procedures than the rest of the student population. For the university staff stratum, we selected the staff experts randomly while non-experts users were chosen purposefully, specifically targeting academic, administrative assistants and secretaries. This choice was supported by the fact that the selected users interacted with the software more often than the rest of the staff population.

Questionnaires were used to collect data from the respondents in each of the identified groups of university software users. Three sets of questionnaires were administered to the university information system users' who are non-expert staff, students and expert staff. We adopted close-ended questions on the questionnaire which was represented on a five point Likert scale with the following weights; 1- Strongly Agree, 2-Agree, 3-Not Sure, 4-Disagree, 5-Strongly Disagree. Respondents were required to choose the appropriate answers by rating the extent to which they agreed to the statements indicated.

In this research paper, the content validity of the data collection instrument was established through the experts who guided on items to include on the instrument with regard to compliance with the test specification which was drawn up through a thorough examination of the subject domain. To measure reliability of the instrument, Cronbach's alpha coefficient of the measurement scale was used due to its strength in determining the internal consistency of items. The measurement of the variables was found to be highly reliable with a Cronbach's alpha coefficient of 0.70 [13]

The collected data was summarized and organized in a manner that answered our research question. The data was analyzed using multiple regression analysis which is defined as a statistical technique used to analyze

quantitative data to estimate model parameters and make forecasts [14]. It is a statistical tool for the investigation of relationships between variables whereby the investigator seeks to ascertain the causal effect of one variable upon another. This technique was adopted for this study because there was need to see the relationship between the various variables in the study. In addition, we sought to determine which variables are important indicators, which ones carry only a little information and which seem to be redundant with other variables and are not significant to the analysis. The factors that were found to be statistically significant as predictors of requirements elicitation effectiveness were adopted.

IV. RESULTS

From the multiple regression analysis done as displayed in Table 1, factors that affect requirements elicitation process determined were statistically significant with a p-value of less than 0.05 (i.e. $p<0.05$). These factors include availability of the users was significant with a value of 0.03, diverse cultural background of both users and analysts was significant with a value of 0.05. Another factor was geographical distribution of the users was significant with a value of 0.03 and communication issues between the users and analysts was significant with a value of 0.03. Other factors included awareness and training on the requirements capture process which was significant with a value of 0.02, technique/method used to capture requirements which was significant with a value of 0.01, institutional politics and bureaucracy which was significant with a value of 0.04, requirements elicitation policy which was significant with a value of 0.02 and user's cooperation and motivation which was significant with a value of 0.01.

On the other hand insignificant factors with p-values that were equal or greater than 0.05 (i.e. $p>=0.05$) included gender and age of users, computer literacy level, experts experience and technical know-how, availability of resources, experience of the users, varied preferences of the users, time and place of the requirements capture process and management support & decision making. These factors were not adopted for the study.

A summary of the significant factors that were adopted as predictors of the elicitation effectiveness were used to construct an elicitation model. This model is presented in Figure 1.

TABLE 1
SUMMARY OF FACTORS THAT AFFECT REQUIREMENTS ELICITATION PROCESS

| Model	Significance			Mean sig.
	Students	Expert staff	Non-expert staff	
(Constant)	0.005	0.051	0.002	0.02
Age and Gender	0.325	0.699	0.94	0.65
Computer literacy level	0.156	0.47	0.47	0.37
Experience	0.255	0.12	0.26	0.21
Availability	0.02	0.037	0.027	0.03
Analysts and User's cultural diversity	0.041	0.064	0.044	0.05
Geographical distribution	0.049	0.002	0.052	0.03
Communication issues	0.029	0.026	0.026	0.03
Varied preferences	0.497	0.011	0.013	0.17
Req. capture process awareness & training	0.015	0.013	0.017	0.02
Time and place of the req. capture process	0.028	0.53	0.53	0.36
Technique used to capture requirements	0.012	0.029	0.003	0.01
Management support and decision making	0.091	0.698	0.698	0.50
Institutional politics and bureaucracy	0.046	0.03	0.03	0.04
Requirements elicitation policy	0.014	0.033	0.014	0.02
User's cooperation and motivation	0.002	0.012	0.002	0.01
Experts experience & technical know-how	0.627	0.04	0.04	0.24
Availability of resources	0.64	0.019	0.74	0.47
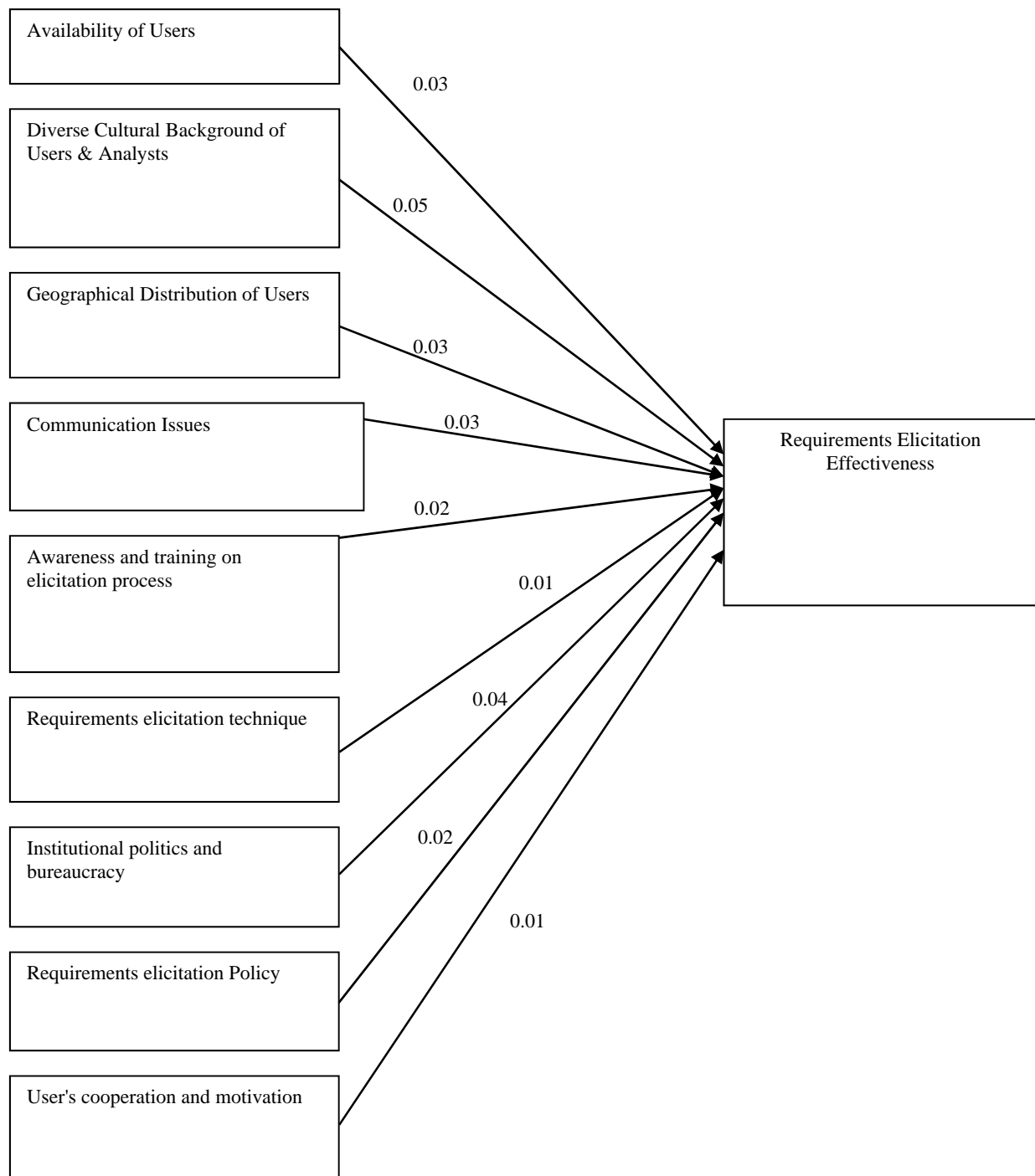
Figure 1: Factors Affecting Requirements Elicitation Process in Kenyan Public Universities

V. CONCLUSIONS

Understanding user requirements is an integral part of information systems design and is critical to the success of interactive systems. It is now widely understood that successful systems and products begin with an understanding of the needs and requirements of the users. An effective user requirements elicitation approach should ensure that the needs of the users are reflected in the design of the software application and hence prevent a situation where the developer's goals are achieved while the user's needs are not. This study sought to determine the factors that affect requirements elicitation process in Kenyan public universities. Multiple regression results indicate that majority of the respondents agreed that there are factors that affect requirements elicitation process. From the results of the study, the factors determined included; availability of the users, diverse cultural background of both users and analysts, geographical distribution of the users, communication issues between the users and analysts, awareness and training on the requirements capture process, technique/method used to capture requirements, institutional politics and bureaucracy, requirements elicitation policy and user's cooperation and motivation.

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