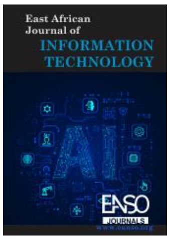


East African Journal of Information Technology
eajit.eanso.org
Volume 7, Issue 1, 2024
Print ISSN: 2707-5346 | Online ISSN: 2707-5354
Title DOI: https://doi.org/10.37284/2707-5354

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

*Original Article*

# A Framework for Guiding the Design of Interactive Systems for Communication through Activities in Higher Learning Institutions

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**Article DOI: https://doi.org/10.37284/eajit.7.1.1671**

**Date Published:**

*05 January 2024*

**Keywords**:

*Human-Computer Interaction, Design Science Research, Activity Theory, Users' Involvement, Users' Satisfaction, Higher Learning Institutions*

## ABSTRACT

Human-computer interaction is paramount in the process of designing interactive-computer systems with high capabilities of guaranteeing users' satisfaction. However, lack of suitable frameworks complicates their effective design. This study investigated suitable frameworks capable of guiding appropriate design of interactive systems for communication through activities (ISCA) in higher learning institutions in Tanzania. These systems are necessary for augmenting communication thereby overcoming persistent challenges related to their reliance on face-to-face, phone-based, and social networking websites communications. This study used a thorough user centred design approach where a framework for human activity design-centred (HADC) was employed. Authors qualitatively analysed data on communication and interaction issues from participants involved. Design science research was then combined with activity theory to develop a four-phased methodology which was used to design an intended human activity interactive communication (HAIC) framework. The findings confirmed that interactions design techniques based on human-activities undertaken are fundamental in designing communication frameworks capable of guiding suitable design of interactive systems in a particular setting. In the context of this study, and with ISCA need, the obtained HAIC framework was found to be appropriate. This study found out that the current user-centred design approach does not explain precisely how designers can employ activity-based interaction design techniques into the design process. Thus, the study contributes to the literature on users' involvement in interactive systems' design through the HADC framework provided.

**APA CITATION**

Mwombeki, A., Shidende, N. & Mselle, L. (2024). A Framework for Guiding the Design of Interactive Systems for Communication through Activities in Higher Learning Institutions. *East African Journal of Information Technology*, 7(1), 1-22. https://doi.org/10.37284/eajit.7.1.1671

**CHICAGO CITATION**

Mwombeki, Anthony, Nima Shidende and Leornard Mselle. 2024. "A Framework for Guiding the Design of Interactive Systems for Communication through Activities in Higher Learning Institutions". *East African Journal of Information Technology 7* (1), 1-22. https://doi.org/10.37284/eajit.7.1.1671.

Article DOI: https://doi.org/10.37284/eajit.7.1.1671

**HARVARD CITATION**
Mwombeki, A., Shidende, N. & Mselle, L. (2024) "A Framework for Guiding the Design of Interactive Systems for Communication through Activities in Higher Learning Institutions", *East African Journal of Information Technology*, 7(1), pp. 1-22. doi: 10.37284/eajit.7.1.1671.

**IEEE CITATION**
A. Mwombeki., N. Shidende & L. Mselle "A Framework for Guiding the Design of Interactive Systems for Communication through Activities in Higher Learning Institutions", *EAJIT*, vol. 7, no. 1, pp. 1-22, Jan. 2024.

**MLA CITATION**
Mwombeki, Anthony, Nima Shidende & Leornard Mselle "A Framework for Guiding the Design of Interactive Systems for Communication through Activities in Higher Learning Institutions". *East African Journal of Education Studies*, Vol. 7, no. 1, Jan. 2024, pp. 1-22, doi:10.37284/eajit.7.1.1671.

## INTRODUCTION

Human-computer interaction (HCI) is a multidisciplinary field that focuses on designing, evaluating, and implementing of Interactive-Computer Systems' (ICSs') to enable the interactions between humans (the users) and computers [1]. HCI answers challenging scientific questions on how ICSs' may be better designed. This to a large extent depends on how people in a particular setting do interact, which then necessitates the need for appropriate design of all necessary interactions [2]. Interaction Design (ID) is concerned with the design of interactive products and services in which the designer's focus goes beyond the item in development to include the way users will interact with it [2, 3]. Thus, ID aspects based on targeted users' activities cannot be ignored in the quest to find out how to better design ICSs' [4]. In essence, ID is vital in HCI, therefore ID techniques need to be incorporated in designing ICSs' [4, 5, 6]. On that account, combining HCI and ID techniques is paramount in providing effective means of communication in Higher Learning Institutions (HLIs'). These techniques can lead to suitably designed Interactive Systems for Communication through Activities (ISCA) [7]. It is through ISCA where an on-line means of communication in HLIs' can effectively and reliably take place.

HLIs' globally come across a number of challenges on how to ensure that major interacting and communicating parties in these institutions are brought together under a single communication environment capable of enabling key interactions and communications based on activities undertaken [7, 8, 9, 10, 11]. The use of phone based and face to face means of communicating in these institutions can rarely bring these major parties together. On the other hand, an on-line means of communication via suitably designed ISCA can effectively bring together these key parties. However, used interactive systems in these HLIs' for the most part help to make simpler some of the activities associated with academics such as teaching and learning while other activities like those related with academics, financial issues, career development issues, institutions development issues and others concerning major communicating parties and which require suitably designed ICSs' environments for their simplification being not taken into account [12]. Following this study; absence of interactive communication frameworks was found to be among major challenges complicating the design of ISCA capable of augmenting communication and interaction in HLIs'.

In Tanzanian HLIs', difficulties affecting online computer-based communication are among the challenges facing major communicating parties. These difficulties have resulted in other challenges that could have been overcome if appropriate ISCA had been suitably designed and implemented [7, 13, 14]. However, the design of ISCA through which an on-line means of communication can effectively take place is not much focused despite increase in demand for these ICSs'. Generally, Tanzanian HLIs' still rely on the use of phone and face to face communications in the administration and running of most of the activities while an on-line means of communication is less being used. This means of communication is largely used for social communications via social networks and email systems [7, 15, 16, 17, 18].

Article DOI: https://doi.org/10.37284/eajit.7.1.1671

Humans should be communicating effectively in accordance with effective communication principles [19, 20, 21]. This means researchers in HCI have to make sure that an on-line means of communication which normally occurs through ICSs' is effectively utilized and guarantees simplification of major activities taking place in various organizations. So, researching on effective involvement of users in the design process is necessary towards augmentation of an on-line means of communication particularly in institutions of higher learning. This has to begin from early design stages where communication frameworks capable of guiding further detailed design stages have to be designed under ID aspects based on activities performed through effective users' involvement [2, 4].

HCI aims to guarantee that intended needs of the users are satisfied by designed ICSs' in a particular setting. The user centred approach for guiding the design process help designers' in involving users into the design phase in order for designed ICSs' to effectively satisfy the needs of the users [4, 22, 23]. However, there are still challenges on techniques designers can employ to boost users' involvement in the design process [5, 24, 25, 26]. To a large extent, techniques offered by the present user centred design approach are based on designers understanding and experience while offering limited design-based techniques that are based on users understanding and experience for enhancing their involvement in ICSs' design. Most of the design techniques which are popularly employed as based on this approach are easily understandable to designers' while users are only involved during gathering of requirements and possibly wait to be later involved in the evaluation of system prototypes which have already been developed and/or be involved in evaluating fully functioning systems. This as a result causes difficulties in capturing necessary users' needs especially during this phase which might have been crucial for the phases of developing and implementing intended ICSs'.

This study revealed that the users cannot be easily involved in the conceptual schema designs since they are complicated. On the other hand, user interfaces are used in HCI in interactions creation, so, the focus of ICSs' designers should be on ID techniques based on undertaken activities since these designs can be easily understood by users and therefore could be an effective alternative strategy to involve them into the design phase. This will guarantee the possibilities of capturing most of the necessary needs of the users [6, 27, 28].

Two research questions guided this investigation;

- How can designers incorporate interaction design methods prior to conceptual schema designs considerations so as to involve users effectively in designing interactive systems for communication through activities?
- How can the user centred design approach facilitate user-involved design of interactive systems for communication through activities?

## LITERATURE REVIEW

### Interactive Communication Status in Tanzanian Higher Learning Institutions

The majority of computer systems used in Tanzania's HLIs' are primarily intended to enable tasks like keeping records of students, instructing and learning, providing the most recent news, and the like [29, 30], while neglecting to place enough emphasis on how to simplify different important activities which occur among members of these institutions and other important stakeholders through an on-line means of communication [23, 31, 32, 33]. The necessary ICSs' must be able to accomplish and make simple both corporate and individual goals [27, 34]. Essentially, this has to start by ensuring that the intended users' needs in a specific scenario are effectively captured.

Basically, when designing ICSs', designers must consider both the current HCI usability standards, which call for designing ICSs' that make it easier for targeted users to complete tasks in a specific

Article DOI: https://doi.org/10.37284/eajit.7.1.1671

environment, and meet international standards conformance schemes such as ISO 9241. Unfortunately, most of the ICSs' utilized in these institutions do not operate this way [23, 27, 29, 34,35]. As an illustration, it is still unclear how interaction via computer-based online communication methods can simplify the tasks carried out in these institutions. Since Tanzanian government scaled back to finance the administration of a number of tasks taking place in the country's institutions of higher learning, and in the light of global pandemic threats which limit communications and interactions among people like the previous COVID-19 and the like then ensuring satisfying communications is crucial for the betterment of these institutions in assuring proper activities administration and running through suitably built ISCA [19, 20, 36, 37].

**Designing Interactions in Interactive Systems**

Fundamentally, most HCI approaches used in designing ICSs' are challenging for being understandable by average users because they rely more on designers' knowledge and skills than actual users' knowledge and experience. Since ID is necessary for HCI, and ID includes design techniques such as those which are based on performed activities which are easily understandable to average users, so, it may be preferable to use these techniques first before moving to more complex techniques like conceptual schema designs which are more based on designers understanding and experience. Therefore, researching methods for merging HCI and ID methodologies into ICSs' design is necessary.

Following this study proper ICSs' design should start with ID aspects based on performed activities and then progress to the design of conceptual schema [3, 6, 42]. This is because it is challenging for users to participate in conceptual schema creation and assessment compared to the aspects of interactions design, which are the foundation of user-interfaces and are typically simple to be understood by users. In contrast to the aspects of interactions design which are the foundations from which user-interfaces do emerge, conceptual schema designs are typically complicated for users to understand. However, most ICSs' designers focus more on creating conceptual models than activity-based ID, which leads to ICSs' that ineffectively meet the demands of their intended users [4, 27].

In essence, users interact with ICSs' by means of user-interfaces at the higher-level while interactions reside in the lower-level which is essentially invisible to users but is where user-interfaces originate. Just as astronomy is not the study of telescopes, HCI is not the study of interfaces. The primary focus should be interactions design and evaluation rather than interface design. This is because HCI requires interfaces to establish interactions [3, 6, 28].

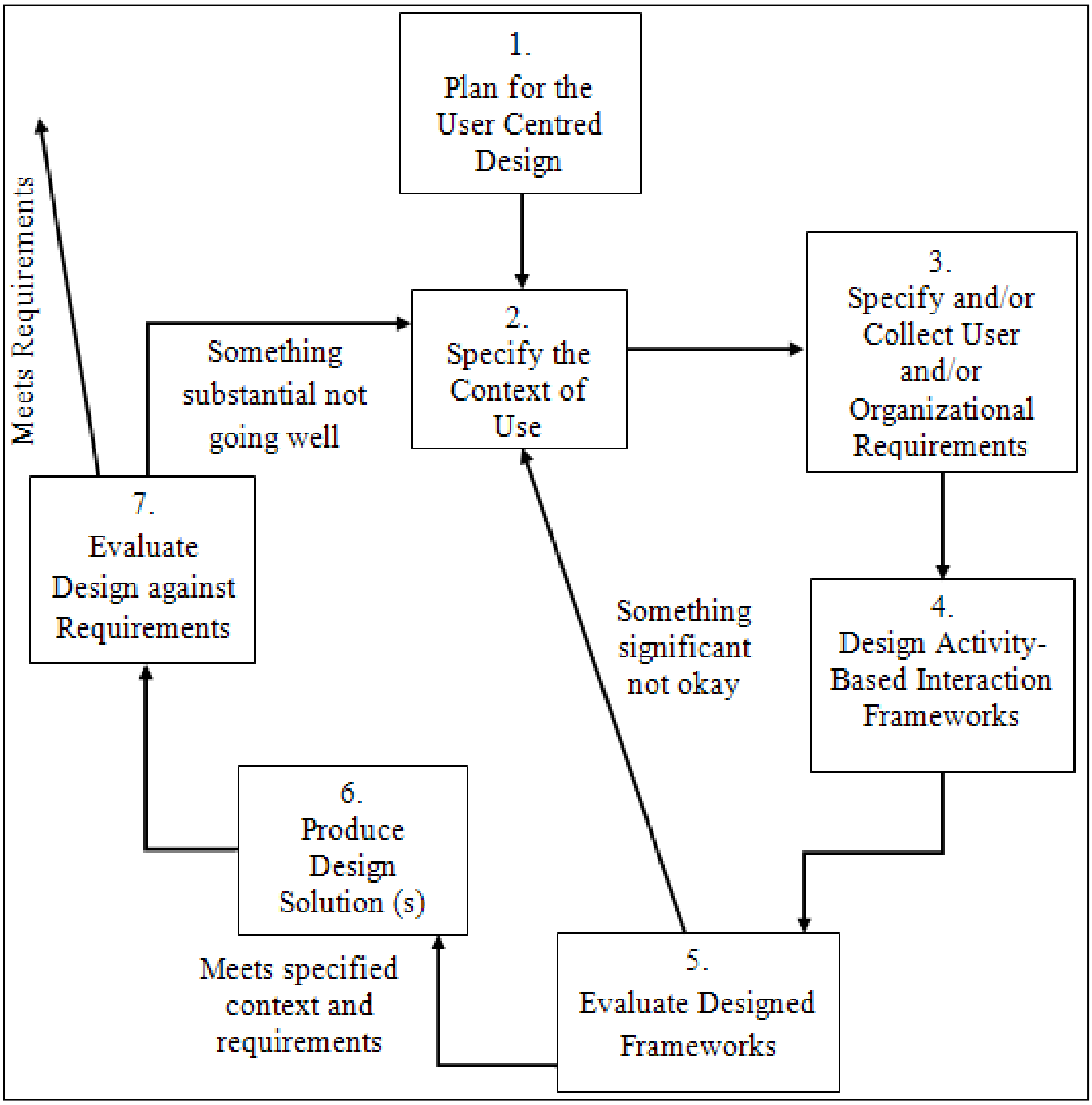
The design process should start soon after the users' needs have been identified. This is according to a number of researchers in HCI and ID [2, 4, 6, 23, 25]. However, there are still some challenges that have not been adequately addressed. Example, is it sufficient to proceed directly from identification of requirements to the design of conceptual schema? Or is anything lacking between the design phase and the outcomes from the field (the needs gathered)? Alternatively, what should be firstly designed; conceptual schema designs or another element such as activity-based ID?

**Human Activity Design-Centred Framework Employed**

The existing user centred design process requires enhancement for ensuring easy capture of the majority of the needs of intended users based on human-activities undertaken. With the need for enhancing the present user-centered design approach, the framework in figure 1, which is the Human Activity Design-Centred (HADC) framework, illustrates the two innovative steps introduced in current user-centered design process subsequent to this research. A full explanation is then offered on the HADC framework obtained.

Article DOI: https://doi.org/10.37284/eajit.7.1.1671

**Figure 1: Human Activity Design-Centred Framework (adapted from [7, 22, 23, 25]).**




The HADC framework above demonstrates important steps to be taken when designing interactive communication systems to guarantee that users are satisfied with the final developed ISCA. The framework was created following discussions held in the focus-groups under this investigation, with authors' experiences on the engineering and usability requirements of the current user-centered design process and other critical issues in HCI related to ICSs' design [4, 22, 23].

The added two stages in the current user centred approach are stage four (4) and stage (5) of the employed HADC framework. Following this investigation, it was revealed that most ID and HCI researchers could not adequately explain these two stages and when they may need to be employed. The attempts made by the majority of designers of ICSs' to identify efficient ways to capture the majority of the needs of users, especially in the phase of designing ICSs', have been complicated for a long time by this lacking explanation [4, 6, 22, 23, 27]. As a matter of fact, ICSs' are created for users'; therefore, they should be for users' [27].

Using activities the targeted users undertook; stage four (4): designing activity-based interaction frameworks was carried out. In this

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case, various questions needed to be thoroughly investigated, keeping in mind that the activities carried out and the requirements acquired are distinct. How do users accomplish their goals? How do users communicate? What are their relationships? What activities are being undertaken by users? Which interactive communication environments are suitable for the various activities they carry out? During this stage, the design was guided by these important questions. Intended users', and other significant stakeholders' who were discovered to be the expected users of the intended ISCA, were involved, as were ID and HCI researchers.

The expected framework was developed to be easily understandable by targeted users to enable them to add vital contributions for enhancing it. This was necessary based on stage-five requirements (5), which demands appropriate evaluation of frameworks designed. Targeted users, ID professionals, designers of ICSs', and skilled user interface designers (who were not necessarily programmers) were all involved in this stage. Both qualitative and quantitative evaluation methods were employed [38, 39, 40].

The conceptual schema designs carried out in stage 6, often handled by ICSs' designers, should be guided by well-designed and evaluated frameworks and/or approaches from stage 5 [42]. With these designed frameworks, ICSs' designers' here can provide more than just theoretical responses to the conceptual schema design requirements. ICSs' designers will then use the framework as a practical guide on human-interactions occurrence based on undertaken human-activities in a specified context.

This HADC framework clearly demonstrates how ID processes should be done during the design of ICSs', as well as who should be involved and when, which is a key distinction between it and the user-centred design approach. The user-centred design approach does not adequately explain these design processes [4, 6, 22]. These users' involved ID processes are essential for ensuring that enough attention is given to organizational and human factors. Based on this study, most ICSs' designers were perplexed by this lack of explanation regarding how to effectively incorporate users in the design process, which made it challenging to ensure that users would be highly satisfied with ICSs' that were previously designed [2, 27].

**Human Factors' Issues in the Designing Phase**

The scientific field of Human Factors (HFs') concentrates on the systems processes through which interactions occur among people and their settings. The setting is intricate and includes the social settings, which include other people and culture, the organizational settings which involve different ways through which human-activities are structured, planned, and managed, and physical settings which consist of the things that are there [41, 42].

Human factors may adopt a systems approach [41]. The study of HFs' focuses on purposely and goal-oriented systems created for people and their settings [41]. Design may also be viewed as influencing HFs' which target improving human performance and well-being via designed systems [41]. From planning to ongoing system improvement, HFs' can be taken into account at every stage [42, 43]. Thus, human factors professionals have to be active players during the designing process [51, 44].

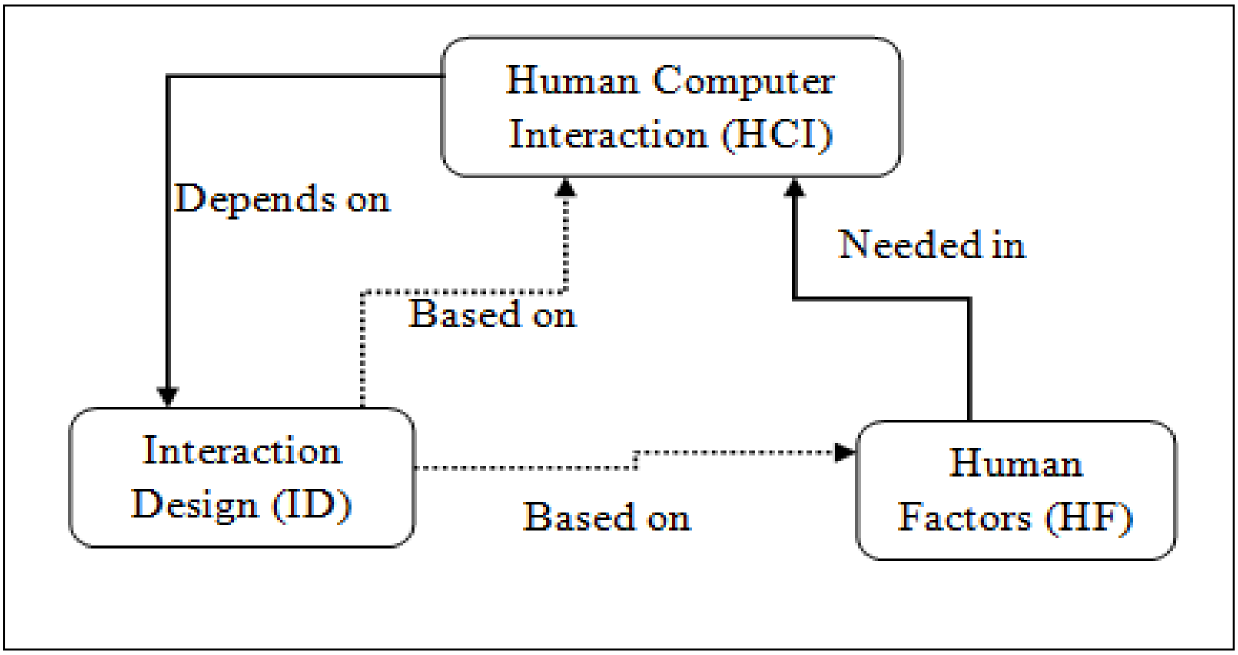
Human factors have impact on performance and well-being, and the two relate [41]. Accordingly, performance and well-being are two connected systems outcomes that can be accomplished by adapting the setting to human. To effectively meet the needs of intended users, HFs' have crucial roles in ICSs' design process.

After conducting this review, it was determined that appropriate methods must be developed to enable users' to be effectively involved in ICSs' design. These can be discovered by looking into how the fields of ID, HFs', and HCI research can be merged to produce methods which could improve users' participation in the design process. This is necessary in assuring that users needs are effectively captured thereby guaranteeing their satisfaction with designed ICSs' [23].

Article DOI: https://doi.org/10.37284/eajit.7.1.1671

A number of research on the user centred design approach have been undertaken [23, 25, 26], but there have been few studies done to investigate how HCI, ID, HFs' methods can be merged to produce vital techniques for suitable ICSs' design. In order to effectively capture the majority of users' demands, required techniques should essentially be those that are simple for targeted users to understand and, as a result, enable them to participate appropriately in the design process [3, 6, 42, 45]. In the light of this study, it is now possible to understand the interdependence between ID, HFs' and HCI.

**Figure 2: Design Science HCI-ID-HFs' Dependencies [46, 47, 48].**




**Existing Human-Computer Interaction and Interaction Design Frameworks**

Frameworks are the basic building blocks that designers can use to create their own systems. They can cover various aspects or stages of the design process and range from very detailed to general descriptions [2]. Basically, techniques are available for modelling users, systems, and job tasks in HCI. However, few techniques or concepts specifically address how users' needs may be captured through activities performed based on HCI and ID paradigms [22, 23, 27].

Most of the existing frameworks and techniques in HCI and ID do not provide enough explanation on how users needs' can be captured through their activities with respect to suited HCI and ID paradigms [6, 28, 46, 49, 50]. This as a result leaves ICSs' designers hanging on which technique is suitable to employ during ICSs' design process. This means; more frameworks capable of guiding ICSs' designers must be investigated particularly from HCI and ID research areas.

## MATERIALS AND METHODS

### Study Approach and Paradigm

Qualitative research techniques were used in this study [51]. Design Science Research (DSR) paradigm was chosen for this investigation since it demands designers to provide answers to questions applicable to human problems through construction of inventive artefacts [52]. This aims at adding fresh knowledge in the body of scientific evidence [53]. Since the main focus was on construction of design-based artefacts, then DSR paradigm was found to be appropriate for this study.

### Study Strategies

Design Science Research Methodology (DSRM) was combined with activity-theory since the main focus of this study was on coming up with the

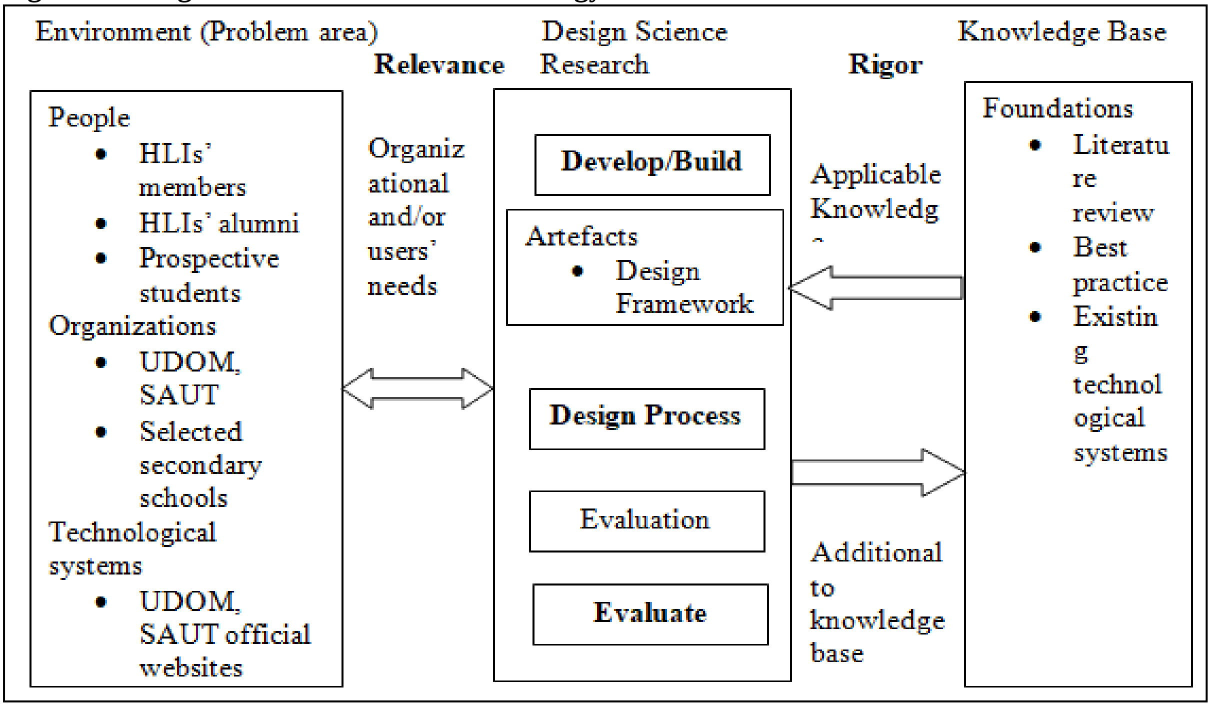
Article DOI: https://doi.org/10.37284/eajit.7.1.1671

framework capable of guiding ISCA design process based on key human-activities undertaken by major parties communicating and interacting in HLIs' [27, 50, 53]. DSRM guided the construction of the framework intended whereas activity theory complemented the DSRM by augmenting how human-activities can be incorporated into the framework designed.

**Design Science Research Methodology**

Aiming to design artefacts required for ISCA design, DSRM was appropriate for this investigation. This methodology was chosen among genre prototypes' of DSR [53]. DSRM depicted in figure 3 illustrates how it was employed under this study. Basically, three cycle model is being described by the DSRM which relies on iterative processes. These are the relevance, design, and rigor cycles.

**Figure 3: Design Science Research Methodology [52].**




**The Constituents of Activity-Theory Applied**

This investigation employed third-generation of activity theory as demonstrated in figure 4. This was chosen because it is an activity theory generation which has been used effectively in analysing case studies in fields such as professional communication, information systems, computer supported cooperative work and other related fields [50].

While the earlier third generation activity theory aimed at developing theoretical tools for understanding multiple perspectives, dialogues as well as interacting activity systems networks with activity theory experts being mostly involved, this study aims at ensuring that the third generation activity theory is being applied with HADC framework obtained following a rigorous user centred design approach undertaken to develop a practical interactive framework where by the community of users targeted are effectively involved.

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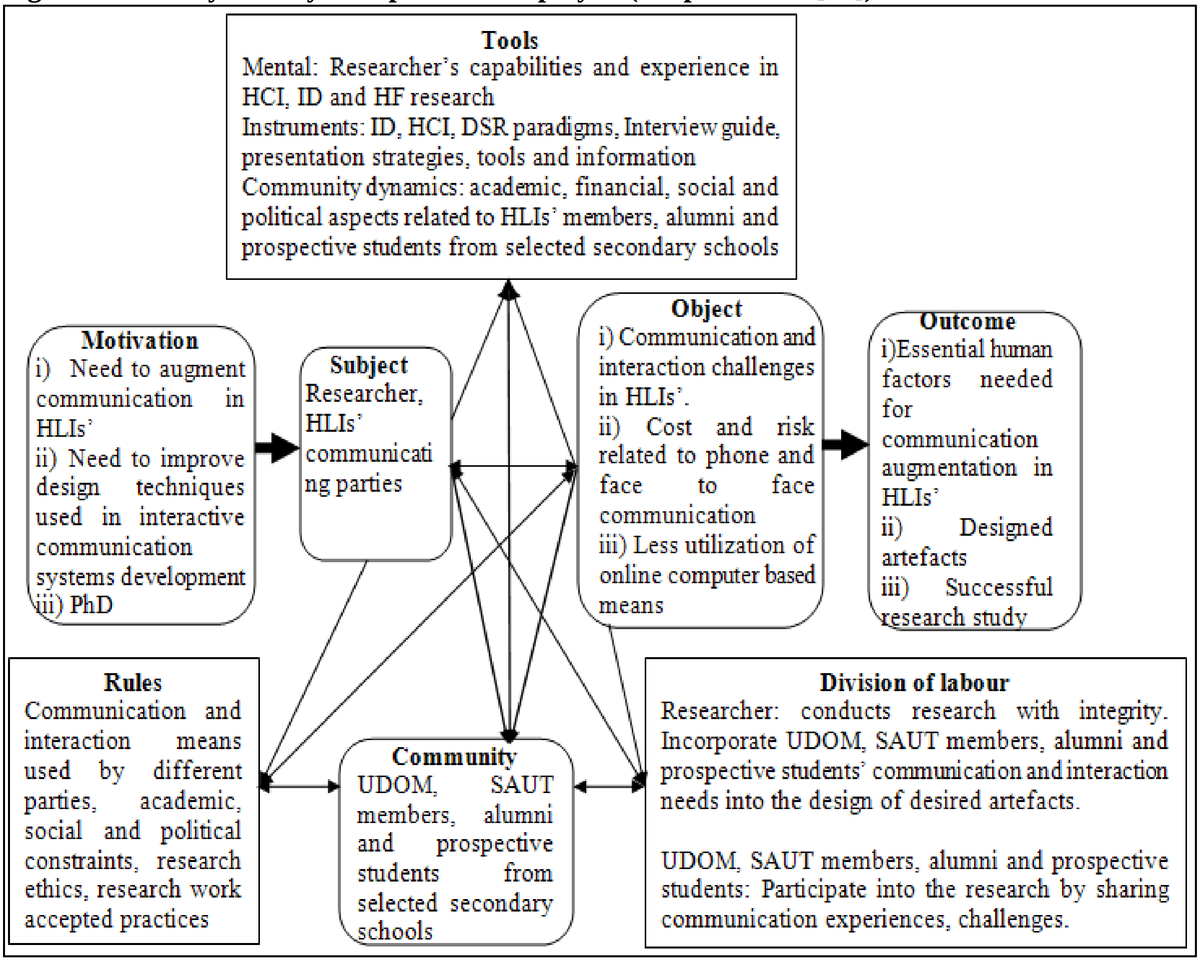
**Figure 4: Activity Theory Components Employed (adapted from [54]).**




### Cognitive Interviewing

During the visit in selected HLIs', authors employed a qualitative survey development strategy in designing questionnaires used in cognitive testing [55]. During this process, authors employed techniques such as verbal probes to gaining insights into respondents' capabilities to understand human communication challenges persisting in visited HLIs' as related with the use of major means through which interactions and communication occur in HLIs' in addition to essential HFs' aspects related with major human-activities undertaken [55, 56]. Data obtained during cognitive interviewing was then analysed based on the cognitive interview data analysis technique [55, 57].

### Focus Group Discussions

Authors conducted five focus group discussions with different categories of participants involved. These discussions were conducted according to the sampling strategies employed. The discussions aimed at obtaining participants HFs' related with communication and interaction in HLIs'. These discussions were conducted based on a thorough user-centered design process using the HADC framework.

### Framework Validation

The proposed framework was validated using expert opinions validation strategy alongside the theoretical models to validate methods used in designing information systems [58, 59, 60]. The validation process ensured acceptable qualities and capabilities of the framework developed to suitably guide ISCA designing process in HLIs'.

### Sampling and Data Analysis

The sample of the participants included HLIs' members, HLIs' alumni, prospective-students from one secondary school chosen in Dodoma city

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and in visited regions where SAUT campuses are located. Two SAUT campuses (Mwanza and Iringa), two UDOM colleges (Social Sciences and Informatics and Virtual Education) and one secondary school from secondary schools located in Dodoma (Dodoma secondary school) and those in visited regions where SAUT campuses are located (Nyegezi secondary school in Mwanza and Iringa Girls secondary school in Iringa) were sampled as strata to ensure greater precision. Involvement of secondary schools in this study was due to the fact that most of prospective students registered in HLIs' do come from secondary schools and furthermore there have been reported challenges recently at UDOM and SAUT during students' admission processes on how to communicate for various essential issues such as missing documents, multiple selections, knowledge on which programme to apply for and the like, thus considering secondary schools involvement in this study was necessary.

Using convenience sampling; thirty students (five first-year, five second-year, five third-year, five fourth-year and five postgraduate), twenty alumni (ten HLIs' alumni who are currently working as employees in visited HLIs' and ten alumni working in different organizations, companies, and institutions), twenty prospective students (advanced level students aged from eighteen years and above) and fifteen staff members (nine academic and six administrative) were selected from each stratum. This strategy enabled authors to obtain rich data concerning communication and interaction issues prevailing in HLIs'.

After data collection, data analysis and interpretation were done so as to be useful by contributing to the findings and conclusions. Methods such as analytical memos analysis, causes and effects strategy of analysis, and context analysis divided into physical, technical, organizational, and social and cultural contexts were used. Furthermore, HFs obtained were analysed under the design paradigms of HCI which were based on cognitive-revolution, situated-perspective as well as human-performance and wellbeing [46].

**Four Phase DSR Methodology**

During the design of the intended artefacts, the four-phase DSRM was employed. This methodology was necessary because the required framework was to be designed under a rigorous user centred design approach where different categories of users with different expertise levels in interactive systems design process had to be effectively involved and thus these four phased methodologies was found suitable for obtaining a framework capable of appropriately guiding ISCA design in this study's context.

This methodology positions activity theory in the design through demonstration of key activities by showing how the outputs need to be incorporated in the final artefacts to be designed. The development of this four-phase DSRM was based on the proposed HADC framework, DSR, activity theory which were then linked to the challenges persisting in this study area. This four-phase DSRM was then used to guide the design of the intended framework.

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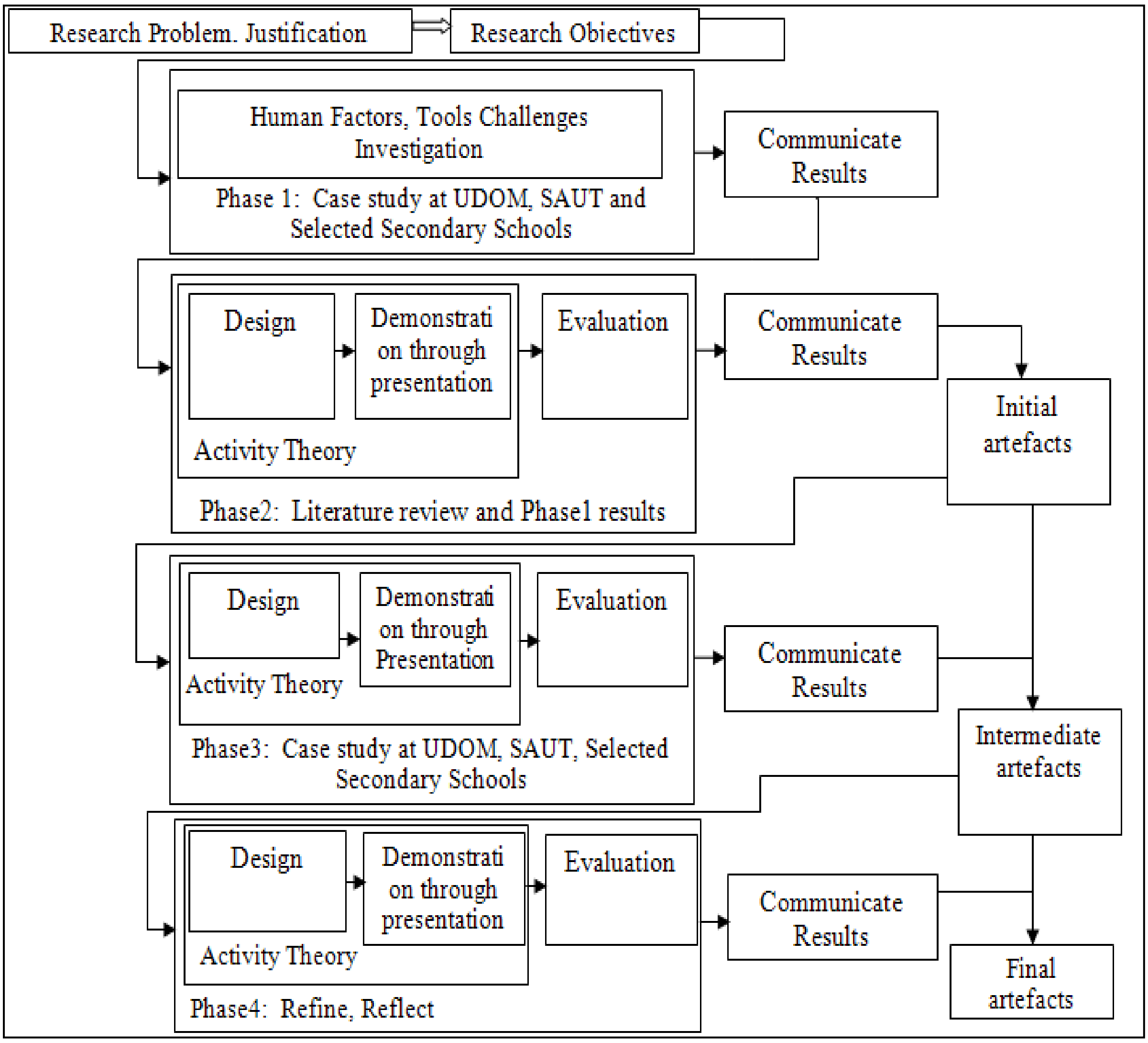
**Figure 5: Four-Phased DSRM for ISCA Designing in HLIs' (adapted from [52, 61]).**




***Phase 1***

Involved intended users (members of HLIs' members, alumni of HLIs', prospective-students), as well as HCI researchers. Here HFs' essential for ISCA design were analysed based on the challenges affecting existing communication means and activities performed. Finally, HFs' framework for guiding ISCA design was constructed based on analysed HFs'.

***Phase 2***

This phase involved: targeted users', ICSs' designers, HCI and ID experts. Human Activity-Interactive Communication (HAIC) framework design was done by based on:

- Key sets of human-activities undertaken by major interacting and communicating parties,
- Classification of key activities was done based on the paradigms of HCI design of cognitive-revolution, situated-perspective as well as human-performance and wellbeing related [23, 62, 63],
- Different interactive environments suited for communicating investigated major human-activities undertaken.

Human factors framework developed during phase 1 was employed as a guide tool under this phase.

HAIC framework designed was evaluated based on qualitative techniques of evaluation. This phase's results were used as input in phase 3.

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***Phase 3***

Targeted users, HCI and ID experts, designers, and developers of ICSs' were involved in this phase. The design and reconstruction of HAIC framework was done following the evaluation process undertaken in phase 2. Final modified framework under this phase was further evaluated under major dimensions for evaluating ID frameworks' [28] where qualitative evaluation strategies were employed.

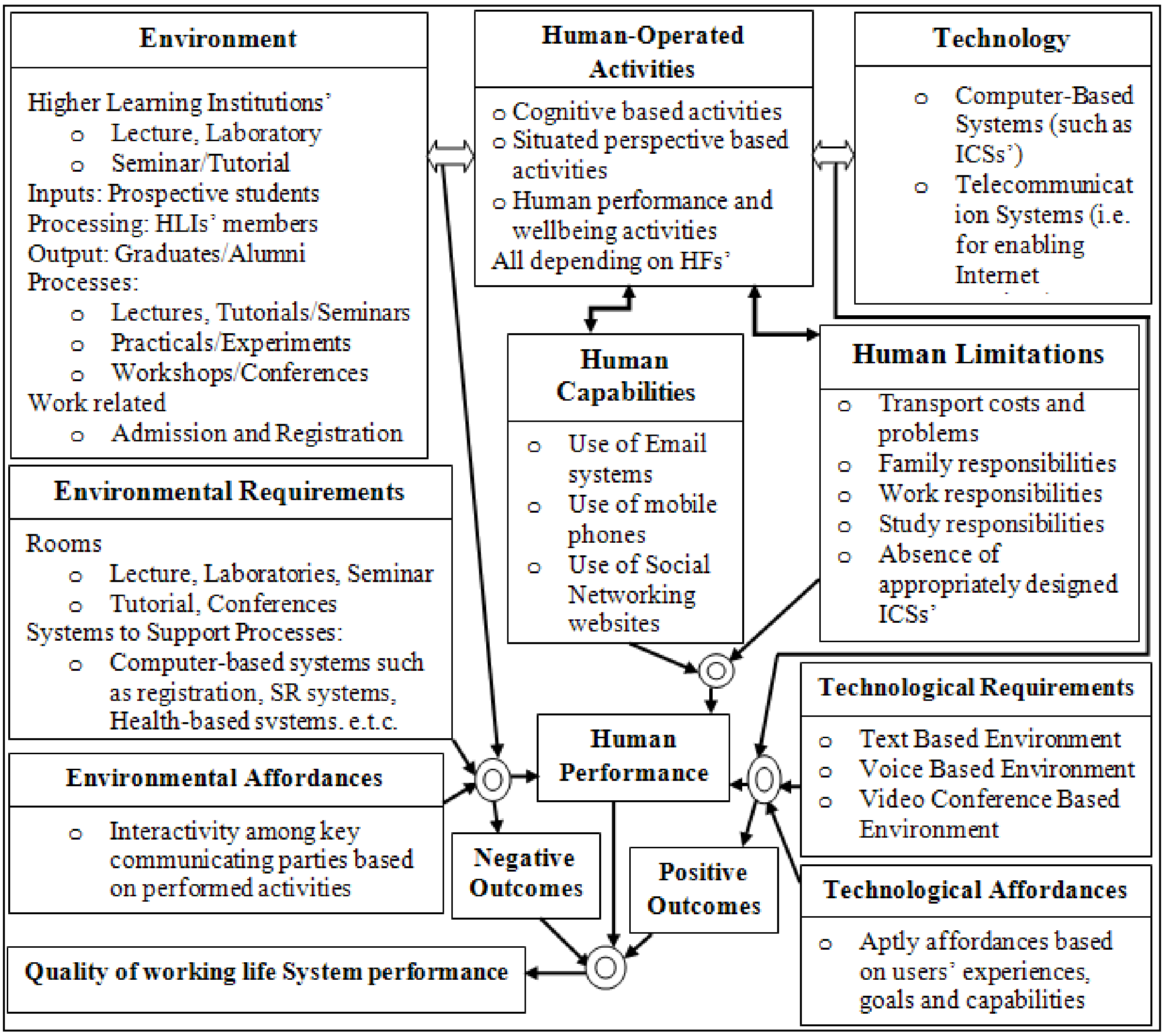
***Phase 4***

Here, full evaluation of the HAIC framework was done. Users targeted, experts in ID and HCI, designers and developers of ICSs' together with user-interface design professionals who were not essentially needed to possess programming expertise were involved in this phase. Major dimensions for evaluating ID frameworks were employed under a mixed evaluation approach of quantitative and qualitative techniques [28, 42, 64]. This mixed evaluation approach was necessary to guarantee the acceptable qualities and capabilities of the framework built to guide ISCA design.

**Human Factors Framework Employed**

This framework was used to ensure the capture and analysis of essential HFs necessary for guiding ISCA design in institutions of higher learning [7, 41, 52].

**Figure 6: The Framework for investigating HFs' for ISCA Design in HLIs' [7].**




The framework in figure 6 above was designed in the first phase of the employed four-phase DSRM.

Article DOI: https://doi.org/10.37284/eajit.7.1.1671

This framework was then used as a crucial input in the second and third phases the four-phase DSRM.

This framework necessitates the designing of ISCA in the contexts of HLIs' to be undertaken under the consideration of a number of issues. First, by considering major sets of human-activities undertaken and therefore communicated, second, through considering major communicating parties' capabilities in using ICSs' intended to be developed based on suitable interactive-communication environments', third, by considering suitable technologies and other requirements which support human-activities undertaken by major communicating parties, last, through guaranteeing that effective evaluation of ISCA in the settings of HLIs' is undertaken under design-evaluation aspects in HCI and under human-limitations so as to ensure suitable implementation of ISCA with needed capabilities for improving performances of targeted users based on human-activities carried out[7, 65]. This framework was employed to guide the analysis of essential HFs needed for guiding suitable ISCA design in institutions of higher learning.

## RESULTS

### Analysis of Communication and Interaction Problems

In determining problems related with interactions and communication persisting at SAUT, UDOM, and in secondary schools visited, the causes and effects analysis strategy was employed. *Table 1* and *Table 2*summarize the results obtained.

### Interactive Communication Framework Design

Following this study, the design of the framework for Human Activity Interactive Communication (HAIC) was performed. According to this study; a suited HAIC framework has the necessary qualities to guide the designing of ISCA with high capabilities of satisfying intended users' needs related to how interactions and communication via major activities taking place in a specified setting occur. On the other hand, an ISCA is an interactive system that enables communications among major communicating and interacting parties based on activities performed. These communications should be through suited interactive communication environments capable of suitably supporting simplification of different sets of key activities undertaken based on vital HCI paradigms.

The activities investigated were classified based on cognitive-revolution, situated-perspective, and human-performance and wellbeing activity sets. During the design process of the intended HAIC framework, cognitive revolution-based activity set included activities communicated based on intellectual and critical thinking before and during communication depending on specific communicating parties. These included academic, developmental, and planning related activities.

Situated perspective-based activity set included activities related with politics as well as social aspects prevailing in HLIs' depending on communicating parties specified while human performance and wellbeing-based activity set included activities which in one way or another do affect the performance and wellbeing of communicating parties in HLIs' like family and financial related activities as well as other challenges related with transport and family issues.

Major communicating parties whose communications were investigated included:

Student-to-student, student-to-academic staff, administrative staff-to-student, academic staff-to-prospective-student, administrative staff-to-prospective-student, academic staff-to-academic staff, administrative staff-to-administrative staff, student-to-alumni, alumni-to-alumni, alumni-to-academic staff, administrative staff-to-alumni, academic staff-to-administrative staff

*Figure 7* and *Figure 8* illustrate the designed HAIC framework following this study.

Article DOI: https://doi.org/10.37284/eajit.7.1.1671

**Table 1: Causes and Effects Analysis Technique Summary**

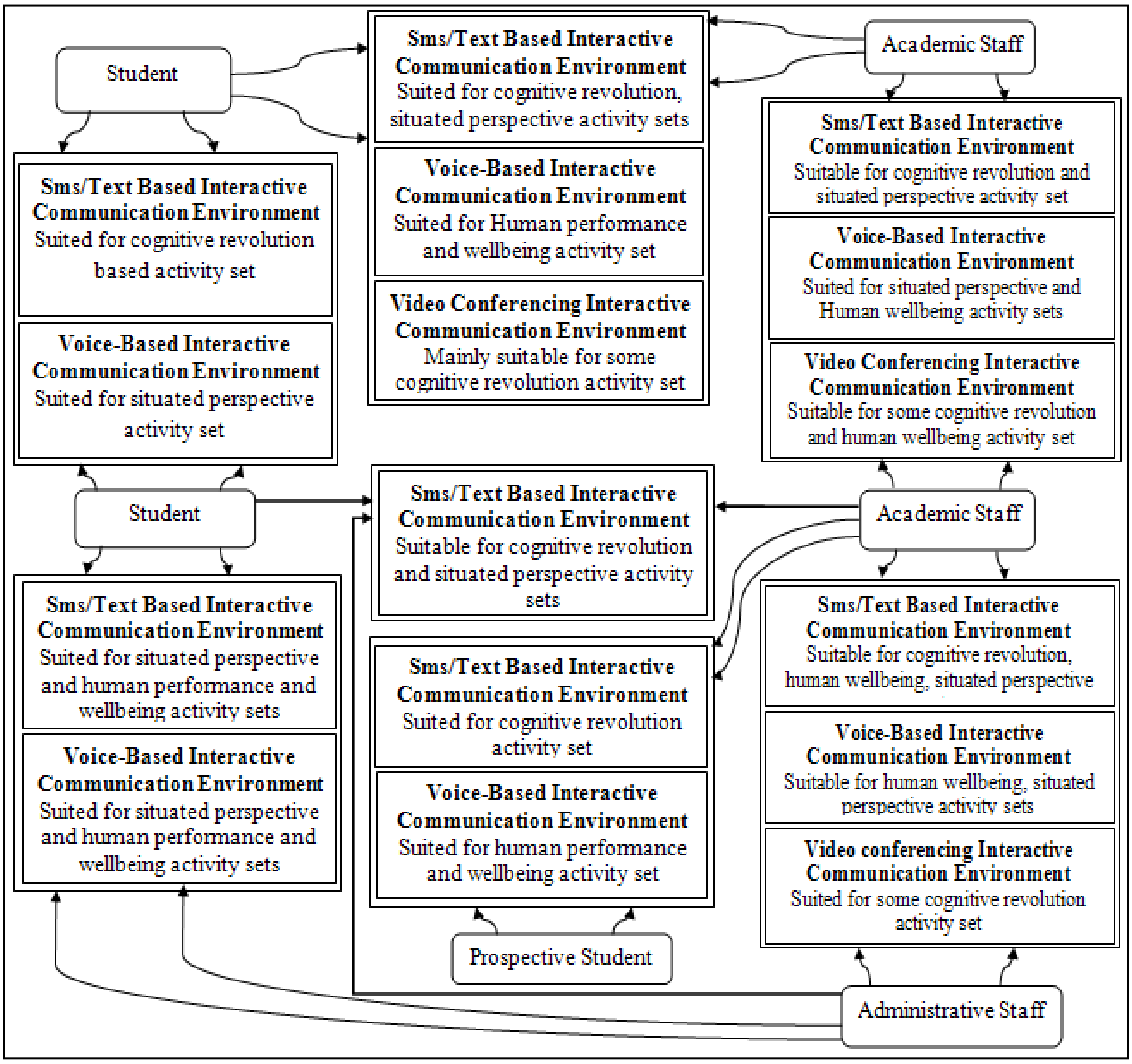
| Problem/challenge | Cause and effect | Objectives for the design process | Constraints for the design process |
|---|---|---|---|
| On-line computer-based communication is challenging due to a number of issues:<br>The desired interactivity is not offered by the currently implemented systems, and only some parties have access to them<br>Absence of ICSs' built with the aim of simplification of various activities undertaken by key communicating parties | • Absence of appropriately constructed interactive communication environments<br>• There is a paucity of experience among designers with integrating HCI into systems design<br>• Absence of thorough investigation prior to creating intended systems<br>• Systems designers lack the necessary expertise to focus effectively on ID before moving on to interface design<br>• Top management lack sufficient knowledge of the value of communicating through ISCA, thus they neglect to invest enough time in researching how to effectively deploy such systems<br>• Financial issues because not enough money is set aside for doing in-depth study prior to designing, developing, and implementing systems | • Design ISCA that offer the necessary interactivity while taking into consideration ID aspects<br>• Design ISCA that allow only HLIs' members, alumni and possibly prospective-students to access suitably built ICSs' environments<br>• Utilize suitable interactive-environments based on various activity sets carried out following HFs' analysis | • The design of necessary ICSs' should be based on thoroughly researched communication frameworks obtained after carefully considering HFs' approaches achieved after in-depth HFs' analysis |

**Table 2: Causes and Effects Analysis Technique Summary**

| Problem/challenge | Cause and effect | Communication means objectives | Communication means constraints |
|---|---|---|---|
| Face to face communication difficulties | • An exponential rise in the number of registered students in every year<br>• Expansion to colleges/schools of the institutions under investigation<br>• Expensiveness because of the difficulties with transportation, obligations to family and job<br>• The challenges posed by global pandemics such as the previous COVID-19 communication and interaction limitations | • Use ISCA built using appropriate HFs' frameworks or methodologies to move to online computer-based communication | • Make sure suitable interactive communication environments are available based on various activities undertaken |
| Phone-based communication difficulties | • High costs associated with utilizing phones for communication<br>• Fear of being bothered by several calls from strangers, which gives one anxiety<br>• The difficulties of keeping track of a lot of contact information for so many members in HLIs', alumni, and may be prospective students. | • Use ISCA built using appropriate HFs' frameworks or methodologies to move to online computer-based communication | • Make sure suitable interactive communication environments are available based on the various activities undertaken |

Article DOI: https://doi.org/10.37284/eajit.7.1.1671

**Figure 7: Suited HAIC framework for ISCA design in HLIs'**

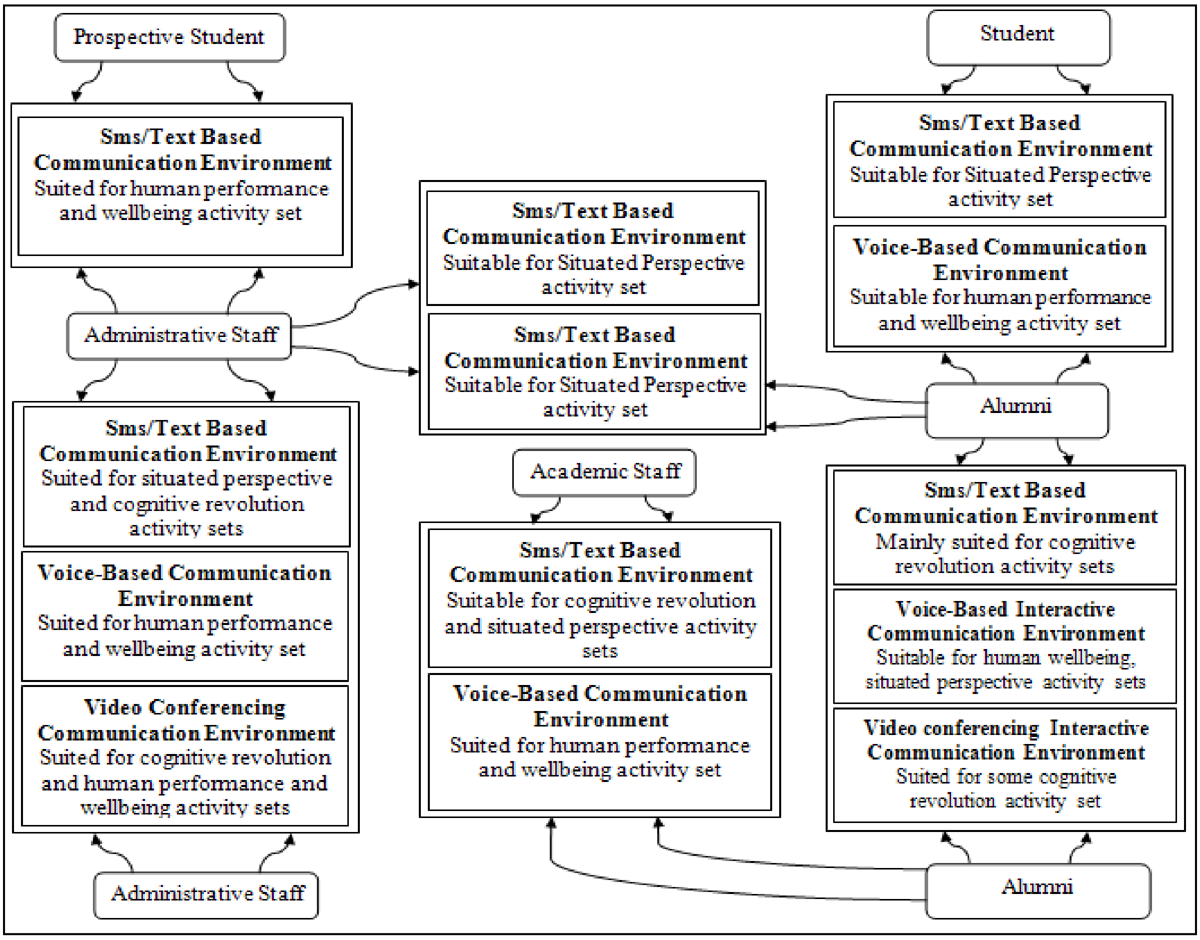



HAIC framework depicted in *Figures 7* and *8* has been designed to cope with communication and interaction needs among major communicating and interacting parties based on key activities performed. The framework has addressed several issues related to on-line communication means as explained below;

Firstly, it has identified most frequently communicating groups among major interacting and communicating parties based on HFs' framework employed following this study. Secondly, it has identified key interactive-environments through which essential HCI paradigms' set of human-activities can be communicated based on the framework for examining HFs' for designing ISCA in institutions of higher learning as it was employed following this study.

Thirdly, it has indicated the need for separate interactive communication environments among most frequently communicating groups so that users in those groups may have options to choose appropriate types of interactive environments suited for certain types of activities they may need to communicate at certain times. For example, some activities might be communicated much better via may be voice-based interactive environments on may be working days and may be during official working hours. This communication flexibility has advantages to top level management in HLIs specifically in the directorates for communication and interactions on how to well manage vital communications among key interacting and communicating and interacting parties. Lastly, HAIC framework has indicated that HCI paradigms are vital in determining appropriate interactive-environments suited for communicating corresponding sets of activities undertaken.

**Figure 8: Suited HAIC framework for ISCA design in HLIs'.**




## DISCUSSION

This section provides a discussion on the two research questions which guided this study based on the findings obtained.

*First, how can designers incorporate interaction design methods prior to conceptual schema designs considerations so as to involve users effectively in designing interactive systems for communication through activities?*

In most cases, designers have been employing conceptual schema design techniques for designing ICSs' for a long time. Despite these design techniques being employed, the challenge of how to make users satisfied with the use of the resulting systems has been persisting. This study revealed that ID methods; particularly activity-based ID, could be key in overcoming users' satisfaction challenges since such techniques for the design process are easily understandable to users. Therefore, this will help users be effectively involved in designing phase, thereby assuring effective capture of their needs. Following this study, suited activity-based ID frameworks have to be designed soon after the requirement gathering phase before the designing of conceptual schema commence. In this study, a HAIC framework has been designed under ID aspects.

According to the interviews conducted among involved participants, it was revealed that an

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effective activity-based interactive communication framework should have the ability of simplifying important activities undertaken by major parties involved. The findings of this study suggest that an effective interactive communication framework should be designed by putting vital HFs' and targeted users' communication and interaction values at the centre of the design. Based on this study, a HAIC framework was designed to bring together HLIs' community, HLIs' alumni and HLIs' prospective students under suitable interactive-communication environments through suited categories of human-activities undertaken. The framework is expected to guide ICSs' designers towards ISCA design in HLIs'.

*Second, how can the user centred design approach facilitate user-involved design of interactive systems for communication through activities?*

The user centred design approach assists designers to make users be involved in ICSs' designing [5, 23]. This is necessary for ensuring that designed systems are widely accepted and used effectively [23, 24]. This means designers need to be guaranteed with the possibilities of obtaining effectively the needs of intended users particularly from early design stages. This can to a large extent be possible if users can be provided with design techniques that are easily understandable to them, thereby ensuring their effective involvement into the designing phase instead of only relying on techniques that help designers capture users' needs. As it is well known that users in most cases do not know exactly what they need from ICSs' rather than only stating their requirements. According to this study, effective users' involvement in ICSs' design process assures designers of capturing most of their needs.

This study has found out that most of the techniques recommended by the existing user centred design approach rely mainly on requirement gathering as well as analysis processes with less focus on how to effectively capture users' needs based on activities undertaken through ID under essential HFs'. This signifies that the key focus of this approach as based on techniques it recommends is mainly on how to design interfaces through which users' do use to interact with ICSs' with limited focus on the aspects of interactions design which are the sources for the user-interfaces.

It was also revealed that a number of involved participants understood key sets of activities taking place in HLIs' with less understanding on complicated conceptual schema designs techniques, thus if suitable activity-based ID techniques are provided, can make them be well involved into this vital phase. This study revealed that combining HCI paradigms, ID paradigms and HFs' analysis could guarantee effective capture of users' needs during the designing phase.

Thus, two activity-based ID stages have been proposed to be added after stage number three in the current user centred design approach. These added stages were found to be vital in boosting effective capture of users' needs from participants involved during this study. The *Human activity design-centred framework employed* subsection of this paper provides a detailed discussion and illustrations on this.

## CONCLUSION

This study investigated suitable techniques necessary for ensuring effective users' involvement in the design process of ICSs' through focusing on interactions design based on undertaken human-activities. It was revealed that effective users' involvement into ICSs' design process is paramount in assuring that their needs are effectively captured particularly from the early design stages. The study also revealed the need to investigate more on design-based techniques that could be easily understandable to users regarding ICSs' design. It was evident that interactions design based on activities undertaken are much understandable and appropriate for users in contrast to designer-based aspects of conceptual schema designs which are much difficult for normal users to understand and be involved in.

 

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The study set out to investigate the necessary methods for appropriate ISCA design in HLIs', with a focus on Tanzania. The literature analysis related with this investigation is firstly presented followed by presenting the HCI-ID-HFs' interdependence framework. The user-centred design process was then analysed in light of the viewpoints offered by the body of prior research as well the perspectives and participation abilities of the intended users. Following this analysis, the human activity design-centred framework capable of enabling an inclusive design strategy involving designers and users was developed. The developed HADC framework, along with DSR and activity theory played a vital role in developing a four-phase DSRM which was then used to guide the design of the intended HAIC framework.

The study therefore, adds to the body of knowledge on HCI, HFs' and ID theories by providing a novel HAIC framework capable of guiding the design of ISCA in the context of institutions of higher learning. The developed HAIC framework plays a vital role in guiding designers of ICSs' to ensure that users' satisfaction with designed ICSs' is highly guaranteed.

From a practice standpoint, this paper provides valuable knowledge to HLIs' management, members of HLIs', their respective alumni, and prospective-students on the importance of communicating through an online computer-based means of communication while at the same time providing vital design-based artefacts to ISCA designers and developers. The paper, consequently suggests more study on techniques which can make users participate effectively in the design of ICSs'. Through these techniques, most of the users' needs may be effectively captured. This is necessary to ensure that users' satisfaction with designed ICSs' is highly guaranteed.

In light of this, this work offers a useful methodology for studying design-based approaches for interactive systems, which can direct further studies on user-involved design in information systems.

## CONFLICTING INTERESTS

All authors declare that they have no conflicting interests to report regarding the present study.

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