

# Strengthening the HCI Approaches in the Software Development Process

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**Abstract**—User-Centered Design (UCD), Usability Engineering (UE) and Participatory Design (PD) are the common Human-Computer Interaction (HCI) approaches that are practiced in the software development process, focusing towards issues and matters concerning user involvement. It overlooks the organizational perspective of HCI integration within the software development organization. The Management Information Systems (MIS) perspective of HCI takes a managerial and organizational context to view the effectiveness of integrating HCI in the software development process. The Human-Centered Design (HCD) which encompasses all of the human aspects including aesthetic and ergonomic, is claimed as to provide a better approach in strengthening the HCI approaches to strengthen the software development process. In determining the effectiveness of HCD in the software development process, this paper presents the findings of a content analysis of HCI approaches by viewing those approaches as a technology which integrates user requirements, ranging from the top management to other stake holder in the software development process. The findings obtained show that HCD approach is a technology that emphasizes on human, tools and knowledge in strengthening the HCI approaches to strengthen the software development process in the quest to produce a sustainable, usable and useful software product.

**Keywords**—Human-Centered Design (HCD), Management Information Systems (MIS), Participatory Design (PD), User-Centered Design (UCD), Usability Engineering (UE)

## I. INTRODUCTION

THE interest on human centeredness within the Management Information Systems (MIS) discipline is seen through the growing number of MIS researches that integrate human factors, usability and Human-Computer Interaction (HCI) approaches into the systems development life cycle [1], [2], [3]. The HCI discipline is associated with the design and engineering of IT artifacts and interactions, with the purpose of improving the utility, safety and effectiveness of the system. Besides emphasizing on the user perspective, recent work on HCI also viewed the technology in the design process [4], the functionality, and the usability of the software design [5], [6]. Currently, usability does not only focus on the IT product itself but also takes into account all aspects of the interaction between user and the system in use. As defined by ISO/IS 9241-11 [7], usability means the system utility, efficiency and satisfaction. As the fundamental concept in HCI, usability puts user as a central focus in the development process whereby a product is designed to serve the user. The design process involves the user and such, the system development is to satisfy the user.

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Previous literatures have discussed on the integration of usability or other HCI concepts in the software development process as seen in the User-Centered Design (UCD), Usability Engineering (UE) and Participatory Design (PD) [8], [9], [10], [11]. All of these approaches have been successfully applied in the software development [8], [9], [10], [11]. Usability does not only concern with the user interface design, but it also requires an effective process which can produce usable and sustainable product. Due to this reason, the system development requires a method that can emphasize usability based on the current view of usability. This method may need to consider various HCI approaches that involve users or stakeholders in all of the system development phases, ranging from end-users to top management who are involved in decision making. [12] stressed on the need to integrate various HCI methods in all stages of development work. Within this integration, various levels of stakeholders need to be involved: the end-users who will be interacting with the system directly; business managers who will define the work process in the organization; and senior managers who will decide on investments so that owners or investors of the organization reap the most benefits from their investment. The main objective of the development of any Information System (IS) is to make human effort becomes easier and safer [13]. However, the absence of a method to strengthen usability in the software development may cause user frustration on the software product [14]. For this reason, there is a need to have an approach which emphasizes on user involvement and usability in software development process. The introduction of Human-Centered Design (HCD) by Zhang [2] which encompasses all aspects of human, including aesthetic and ergonomic, is predicted to provide a better solution in the software development industry. Therefore, the aim of this study is to investigate the potential of HCD applied in the software development process in order to produce usable and sustainable products. The investigation views the HCI approaches or methods from a technological perspective, using the framework of technology triangle by Pieterse (2005).

## II. LITERATURE REVIEW

Researches and practices in HCI have two main domains of applications. The first domain looks into the understanding and designing for the human experience of interfaces for consumer use [16] as seen in the range of Apple products and the products of their competitors. The work involves the development of culturally appropriate technologies for the home and incorporation of human emotion into the interface. The second domain of application looks into the enterprise effective work [17].

The second domain of application looks into the enterprise applications that support the production of an efficient and the two domains of applications address two different users'

needs. The first domain addresses the appeal, while the second domain addresses the support for functionality. A HCI method is to strengthen the usability factor in its processes. It will therefore, need to cater for the different sector of users to be involved. UCD, UE and PD are HCI methods that focus on user involvement in the software development process. In the literature, the terminologies used for UCD, UE and PD may vary from one author to another. Some authors referred to UCD, UE, PD and HCD as an approach, method, technique, process and concept [18], [19], [20], [21]. To define the term for UE, UCD and PD is a part of technology criteria. Technology is the most persistent power in influencing people's live. It always plays a major role and becomes a key factor in a competitive advantage. Technology is use at all level of an organization and it is recognized as a backbone for the organization [15]. The technology triangle by Pieterse (2005) shown in Figure 1 can be a useful framework to evaluate various HCI approaches with the aim of seeking an integrative HCI method that emphasized the usability factor in the software development.

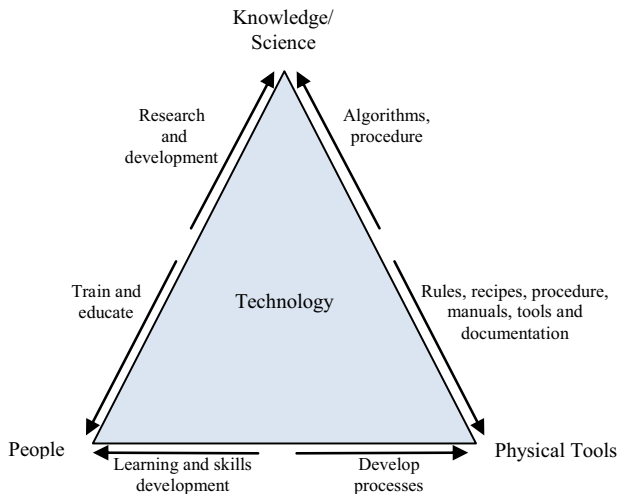


Fig. 1 The Technology Triangle (adapted from Pieterse, 2005)

The technology triangle described technology as the “integration of people, knowledge, tools and system with the objective to improve people’s lives” which is aligned to other definition of technology that relates to HCI [22], [23], [24], [3]. These literatures agreed with the view of two technology philosophers, Heidegger and Marcuse who concluded that technology does not only focus on technical but it also concerns with the way of doing something, the way of thinking and style of practice to create artifact or product [25]. This view seems to point towards the argument that if HCI is considered as a technology, then a strong HCI approaches should consider not only the technical aspect of development but also the necessary thinking style underlying the development process.

Software Development Life Cycle (SDLC) refers to Zhang and Eseryel’s work [2] consists of four stages, namely project selection and planning, analysis, design, and implementation stage. Each of these stages consists of activities to be performed in the software development process. In other

words, the scope of SDLC is referred to both the SDLC stages, as well as the activities in each SDLC stage. Activities in project selection and planning stage involved project selection and project planning. While at the analysis stage, the activities consist of requirement analysis, process analysis, data analysis and logic analysis. Meanwhile, the activities in the design stage include database design, user interface design and program design. On the other hand, the activities in implementation stage entail coding, testing, installation, documenting and support.

### III. METHOD

For this study, content analysis was chosen as the method to analyze HCI approaches within the HCI literature using the technology triangle as a guiding framework of evaluation. UCD, UE, PD and HCD are the approaches used in HCI which focus on user involvement in the software development process. The purpose of these approaches is to promote usability of software product. Therefore, the analysis of content is focused on texts written on UCD, UE, PD and HCD found in journals and conference proceedings articles.

### IV. HCI APPROACHES

This section gives an overview of four HCI approaches and their involvement with the users. The aim of this section is to compare all of the HCI approaches to obtain the similarities and differences among them. The following elaborates each of the HCI approaches.

#### A. User-Centered Design (UCD)

UCD is a term frequently used in the literature which emphasizes on user as a centre to all activities [12] starting from the software development process to the utilization of the software by the user [26]. UCD focuses on the system design as to serve the user, and the interface becomes the key component to control the rest of the system. Seneler [27] defined UCD as “an iterative design process that concentrates on users’ needs, wants, and limitations in each stage until the project’s usability objectives have been attained”. Meanwhile, Gould and Lewis [28] and Nielsen [29] defined UCD as an approach which “places the user, user tasks and user goals as the main concerns for the design and implementation of the product”. Based on the definitions above, UCD focuses on the end user- who will make use of the system to perform their work and also the one who will interact with the system.

#### B. Usability Engineering (UE)

The use of UE method in evaluating the usability of software product is an important aspect in the software development. As defined by Faulkner [30], UE is “an approach to the development of software and systems which involves user from the outset and guarantees the efficacy of the product through the use of a usability specification and metrics”. There are three types of usability evaluation based on the purpose of the evaluation itself. Exploratory evaluation is made before the development of the interface. While formative evaluation is made during the development of the interface. And, summative evaluation is made when the interface development is over. Nielson [32] supported that UE is a “set of activities

that ideally take place throughout the lifecycle of the product, with significant activities happening at the early stages before the user interface has been designed". This is aligned with the definition made by Seffah and Metzker [33] - UE approach as a software development methodology focused on maximizing the usability of the system to be developed.

### C. Participatory Design (PD)

PD uses a variety of methods and approaches to get user participates in the design process. PD stresses on user participations in the development process rather than developing the software for the user. PD involves user and system developer participations in providing information and feedback during development process to improve the efficiency of software product. PD emphasizes on "democratic values" [34] where users' have the right to participate in the software development developed for them. Furthermore, PD is a collaboration process between user and software developer to obtain and simplify new information in order to create democracy space at the workplace. Muller [35] agreed to this by stating that PD is a "practices that take place neither in the workers' domain, nor in the software professionals' domain, but in an "in-between" region that shares attributes of both the workers' space and the software professionals' space". However, PD rarely isolates the participation of "other organization entities" in development process which is very important in business strategy planning [36].

### D. Human-Centered Design (HCD)

In order to sustain the usability of software produced, practitioners need a method that encompasses all aspects of human life. Since user is the person who will later use the software, practitioners are responsible to provide a software that is usable, learnable, efficient, effective and satisfying to the user. For this same reason, Zhang and Eseryel [2] have proposed a model to integrate HCD and SDLC which emphasized on all categories of user at all stages in the software development process. HCD is an approach that puts the users at the heart of the process. This was supported by Walters [37] in his study which mentioned that HCD is an approach which explores "human need, knowledge and experience which aims to extend human capabilities and improve quality of life". Human-centered designer uses knowledge of human capabilities and limitations across a variety of methods to produce solution which is safe, efficient and satisfying to user. This method highlights the issues "concerning human, task and the working environment by using information of context of use, user and organizational requirements for making and evaluating design solutions" [21]. Furthermore, as being mentioned earlier, HCD method encompasses all aspects of human life, also esthetic and ergonomic which will provide better solution in the software development industry. In the next section, firstly, the study will discuss the comparison of each HCI approaches against user involvement in SDLC stages, and followed by the discussion on the mapping of HCI approaches and technology.

## V. DISCUSSION

### A. Comparison of HCI Approaches against User Involvement in SDLC Stages

This section refers to Zhang and Eseryel's SDLC which consists of project selection and planning, analysis, design and implementation stage [2]. The comparison of HCI approaches against user involvement in this SDLC stages is shown in Table1. User involvement is analyzed based on first, user involvement in each SDLC stage and secondly, user involvement in activities performed in each SDLC stages. From the Table, it shows that UCD involved user at the analysis, design and implementation stages as UCD focuses on the user who will later use the software. Since user involvement is important in providing feedback to improve the efficiency of software product, PD involves the user at each stages of SDLC. On the other hand, UE involve user at analysis, design and implementation stage as UE focuses on the evaluation on the usability of the software product. In contrast, HCD involved users in all activities performed at the project selection and planning, analysis, design and implementation stage. From the Table, it shows that HCD ensures the users are involved in all activities performed in each of the SDLC stages. All of the HCI approaches except for HCD do not stress on user involvement. HCD main concern is on user involvement activities from the organization perspectives. In HCD, user is not the only end-user. It also involves all stakeholders. Thus, it can be concluded that HCD is more human-centered as compared to other HCI approaches as it involves users ranging from end-users to the top management. The comprehensiveness of user involvement in the software development process has a better potential to produce software that is sustainable, usable and useful.

### B. Mapping HCI Approach and Technology Triangle Framework

'Technology Triangle Framework' as shown in Section II emphasizes on people, tools and knowledge. This framework argues that technology does not only concern with technical but also the way of doing something to create product or artifact with the goal to improve people's life. To investigate as to whether HCI is considered a technology or not, a mapping between HCI approaches and technology triangle is done. People component refers to stakeholders of the organization which can be further categorized as end-user, practitioner, business manager and senior manager. As shown in Table 2, UCD involves end-user to obtain information as to create software that is easy for the users to use later. While, UE involves end-user in evaluating the usability of software product during testing phase in the software development process. On the other hand, PD involves end-user and practitioner in the software development process but it overlooks the importance of the involvement of other user groups. However, HCD covers a bigger scope of user involvement. In HCD approaches, user includes end-user, practitioner, business manager and senior manager. These user groups will work together in strengthening the software development process to produce a software product that is usable and useful for users.

TABLE I  
MATRIX OF USERS INVOLVEMENT IN SDLC AND HCI APPROACHES

SDLC stages	Project Selection and Planning (project selection, project planning)	Analysis (requirement, process analysis, data analysis, logic analysis)	Design (database design, user interface design, program design)	Implementation (Coding, testing, installation, documenting, support)
UCD	-	Requirement	User interface design	Testing
PD	Project planning	Requirement	User interface design	Testing
UE	-	Requirement	User interface design	Testing
HCD	Project selection, project planning	Requirement, process analysis, data analysis, logic analysis	Database design, user interface design, program design	Coding, testing, installation, documenting, support

In 'Technology Triangle Framework', technology is described as a tool to create a product [22]. In HCI approaches, tools are used in the communication between computer and the users with the aim to examine the functionality of the software. On the other hand, 'Technology Triangle Framework' illustrates knowledge as human skill and experience [15] in creating something. From the organizational perspectives of HCI, knowledge is the skill and experience in using and developing the software, managing the resources, and strategizing the future of the software. Other HCI approaches do not stress on the knowledge except for HCD. HCD ensures that the users who will also later use the software are involved in every stage in the design process, again with the aim to produce a sustainable, usable and useful software product.

## VI. CONCLUSION

UCD, UE and PD are the HCI approaches that involve user in the software development process. However, they overlook the organizational perspectives of HCI. Among all of the HCI approaches, HCD approach involves user in all of the activities performed at each of the SDLC stages. Furthermore, HCD approach covers a bigger scope of user involvement which encompasses all aspects of human life, including aesthetic and ergonomic, in the software development process.

The mapping of HCI approaches and Technology Triangle Framework in Table II shows that HCD and technology address the same concerns specifically on human, tools and knowledge in creating something. From the findings, it shows that the HCD approach is a technology for integrating user requirement ranging from the top management to other stakeholders in the software development process. The results confirm that HCD approach is a technology that emphasizes on human, tools and knowledge in strengthening the HCI approaches to strengthen up the software development process

as to produce a sustainable, usable and useful software product.

TABLE II  
THE MAPPING OF HCI APPROACHES AND TECHNOLOGY

		UCD	PD	UE	HCD
P E O P L E	End-user	Involved	Involved	Involved	Involved
	Practitioner	-	Involved	-	Involved
	Business Manager	-	-	-	Involved
	Senior manager	-	-	-	Involved
TOOLS		Prototype	Sketch, mock-up, Prototype	Guideline scoring, action analysis	Interface specification, metaphor, dialogue, media, presentation design
KNOWLEDGE		-	Technical	-	Technical, business management

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