

# Triangle Model Theory for Enhance the Usability by User Centered Design Process in Human Computer Interaction

Ahamed. Mohammad Mithun, Zainab Binti Abu Bakar<sup>2</sup>

<sup>1</sup> Faculty of Computer and Information Technology, Al-Madinah International University, Malaysia, [mithun\\_lonedies@yahoo.com](mailto:mithun_lonedies@yahoo.com)

<sup>2</sup> Faculty of Computer and Information Technology, Al-Madinah International University, Malaysia, [zainab.abubakar@mediu.edu.my](mailto:zainab.abubakar@mediu.edu.my)

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## Abstract

User Centered Design process or approach is one of the applicable methods that is using in Human Computer Interaction. This method is based on the relation of user requirement and satisfaction. Several methods are used for the development of user interface and interaction for a system. Human computer interaction tells us what should be the certain interaction and user interface that human can operate easily and efficiently. Any defective user interfaces or interaction methods are not acceptable and also harmful for human life. For developing Interaction methods or user interface are follows by some specific methods and processes. This research is based on the user centered design methods which is vastly uses in human computer interaction. The user centered design method has been developed in this research to overcome the limitations of the methodologies and the complexity of development process. A Triangle Theory Model has presented of the developed version of conventional user centered design methods. A briefly previous research works have been discussed in the field of user centered design methods.

**Keywords:** User Centered Design, Human Computer Interaction, Interaction Design, Interaction Methodologies, Triangle Model Theory

## 1. Introduction

interaction methodologies and user interfaces. From several years it has been studied for enhancing the usability between human and computer system or a machine. To interact with a machine the interaction or the user interface has to perfect and efficient on a system. The term Human Computer Interaction (HCI) is first used by Stuart, et al. in 1980 [1]. Diverse fields are studies in HCI including computer science, behavioral science, media studies, cognitive science, psychology, ergonomics and many more. According to the study of HCI it demonstrates the human psychology and relation between human and machine behaviors. Human interaction and the necessity of good user interface were popular and important research area when the computer development era has begun in 1980's. After in 1985 when the Windows and Macintosh operating system released their software to the personal computer system the technological revolution has started. In modern life all the technology products and devices we are using have created concerned on the computer technology. Though computer technology was the main tool for our modern life, therefore it has speared many fields into different research category. All the technical products and the graphical user interfaces interest are go to the usability, good user interface and the perfect interaction methodology. The Researchers and designers are main concern area into evaluation between human and machine behavior. A systems architecture can be vary that depends on the system functionality and the necessity of the system or the product requirements. The ACM (Association of Computer Machinery) expressed what should be the

computer system and interface architecture that Machines have specialized components for interacting with humans. The components are:

- Input and Output Devices.
- Dialogue Techniques.
- Dialogue Genre.
- Computer Graphics.
- Dialogue Architecture.

Some of these components are basically transducers for moving information physically between human and machine. Human Computer Interaction as “a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them”. There other viewpoints that takes places in HCI which is necessary for computer science. ACM also have drawn the four development processes of HCI: Design Approaches, Implementation Techniques and tools, Evaluation Techniques and Example Systems and Case Studies [2]. Regarding the background of this research Interaction is one of the most important points. The author Alan, et al. explained in their book as the interface sits between the User and the System, there are four interactive cycle, each corresponding to a translation from one component to another. The four components are: the System, the User, the input and the Output. For required user interfaces in Human Computer Interaction must have two materials mentioned by the author, they are: Understand Computers-

limitations, capabilities, tools, platforms and Understand People- psychological, social aspects, human error [3].

For enhancing the usability of a machine by human user has to be rigorous on the interaction and user interface. In this paper our main concern is to develop the usability between human and machine behavior by extending the User-Centered Design process. We will try to discuss the previous works of interaction methods or processes and user interfaces regarding the obligation of this research into the following sections. An extended UCD model will be proposed as 'Triangle Model Theory (TMT)' for improving the interaction methods and user interfaces on a system.

## 2. Related Studies

In human computer interaction (HCI) 'interaction' term is the basis for design or developing user interface and interaction between human and machines. Since those terms were studied several researches have been done in the field. The author Elizabeth, et al. defined their article that how to extends HCI research methods and theories. They stated, studying practice, especially professional practice is not a straightforward endeavor; its complexity suits a range of approaches and methods. The methods we discuss are not entirely new to HCI – indeed, some are quite familiar. Our aim is to argue that these methods should be applied not just to study user experiences of technology but also interaction designers' experience of their own work. We are convinced that experiential approaches to user experience could and should be applied to the study of design practice. Three approaches expanded by them: Reported Approaches, Anecdotal Descriptions and First-Person Research. Also refers the Theorizing Interaction Design Practices [4]. A case study has done by Anna. Kantosalo, et al. for evaluating the interaction of Human Computer Co-creativity. They discussed the interaction design and evaluation in computational creativity contexts says, the field of Interaction Design studies how to best design interactive products to facilitate human interaction and communication. As such, it seems ideal for designing human computer co-creative tools. Interaction Design covers a multitude of design fields and approaches, such as user-centered design. Demonstrated some areas of HCI as determine the evaluation goals, exploring the questions, methods, ethics and identifying issues [5].

The author Hans, et al. has proposed a Blended Interaction is based on blends between concepts from the users' familiar reality, including already well-established digital concepts, and the expressive power of digital computation. In particular, Blended Interaction draws strength from considerate blends of what cognitive science and HCI have identified as basic-level experiences and building blocks of human thought. There are four domains in the research: Individual interaction, Social interaction and communication, in practice, last but not least. It is important to understand that Blended Interaction in its

current stage is an explanatory and not a prescriptive conceptual framework [6].

In this research our main concern is to extend the User Centered Design methods for enhance the usability of human and machine behavior by good user interface and interaction design perspective. The author Israt. Begum, has done an research work and proposed an extended UCD approach in 2014. In that article discussed the advancement of User Interface, Necessity of good user interface design, Reasons of poor interface design and proposed an extended UCD process that has added 'Understand' phase on the methods. The conventional UCD stages are: Study, Design, Build, and Evaluate. The researcher extended as: Understand, Study, Design, Build, and Evaluate [7]. In the Extends UCD Process section will be discussed broadly about this point. By following UCD method one related article has been published in 2016 by 'A. Giardi'. In the article mentioned that using the User-Centered Design methodology, 20 university students were involved in a participatory planning whose objective was the design and implementation of a "mobile course model". A preliminary part of the activity, but crucial to the course design, was aimed to the analysis of the models, used by major universities present in iTunesU platform. The objective of the experimentations was to engage students in a participatory planning to define through iterative refining of the developed prototype modules - mobile model course: how today's students organize a course for students of tomorrow [8].

A research has done by Julie. Fisher, et al. (2013). Their research explored the designing and building of a system to teach parents of deaf children and others SL (Sign Language) providing meaningful, real time feedbacks using a UCD approach. They designed a MIAC using an avatar displays a sign to the user, the user makes the sign which is captured and the image is compared with the stored version of how the sign is made. If the user's depiction of the sign is incorrect the system highlights visually the mistakes made. The process is repeated until the sign is correctly made. They have done the two important parts in their research as follows:

- Designing the Avatar.
- Alternative views for signs.

They explained on designing of MIAC using User Centered Design has given them the opportunity to explore the effectiveness of taking a UCD approach in the context of the development of a real system [9]. A field research has done by S. Büttner, et al. in 2016 with applying UCD method in the industry. They proposed a conceptual design and prototype which has mainly done by three phases: Sketching Workshop, Development of a Low-Fidelity Prototype and Development of the Interactive Prototype. When applied User Centered Design process were presented some challenges during development of the system: Limited Access to Users, Confidentiality during the Development, Bias towards Lab Studies and Conflict of Interests between Management and User [10]. In the situation of UCD process the authors Heesoo. Jung, et al. defined the member and the effects of UCD process as well

as stated the principles of Operational interface design. In the article showed five stages of User experience centered design process [11]. Z. Yovcheva, has stated UCD is one of the major concepts that emerged from early HCI research, describing an approach (and methodology) to design in which the end-users of a product shape out its final outlook. Design knowledge within HCI is, therefore, expressed as design principles, heuristics and checklists based on kernel (relevant) theories and empirical observations. One of the most tangible results from UCD is the compilation of design guidelines, heuristics and checklists based on extensive empirical user research [12].

Peter. Dorrington, et al. stated as UCD is a design philosophy that looks to overcome this by placing the needs, wants, and desires of users at the center of the design process, allowing these needs and desires to drive the development of a product, system, or service. Their research paper presented the user centered design process is active current, expert and some potential users in the development process [13]. User Centered Design method is also used in designing for Driving Simulators. The researcher Ghasan. Bhatti, et al. (2014) has developed a user centered architecture for driving simulators. They used User-Centered (UCD) approaches for the model scenarios and have built prototype software. They made clear that the design and execution of the scenario needs three main roles: the end-user (e.g. researcher, trainer, etc.), the technical team and the experiment operator. They used an interactive prototype tool name "Justinmind prototyper" to build prototype [14]. The researchers Peter. Forbrig, et al. Developed a combined SCRUM model as U-SCRUM that has appreciated by a lot of software developers for its unified approach. They extended the UCD process and combined them two. In their paper focused on a pattern that is related to their proposed U-SCRUM model [20].

### 3. Methodology

The approach of the research is to develop or extend the UCD methods from the previous methods. The Qualitative method is strongly followed in this research. Will go through this research by the following approaches are described below.

#### *Research Gathering*

The first approach in this research is to collect research articles which are related to the UCD design process, User interface and Interaction design. Several related research articles have been collected and already have cited in the Related Works section. After gathering research articles then ready for analysis and findings to further activities.

#### *Analysis Findings and Discussion*

This approach is most important methods in our research paper. After completing the research collections then starts the analysis and discussion section what we have found and what we are going to do. In this approach also will be

discussed the major research topics which are related to this article. The findings points will be highlighted to the further development stage in this research.

#### *Conceptual Model Development*

This approach is after the analysis, findings and discussion stages. After analysis have found something to develop relates to the UCD design process. We will try to develop and extend the conventional UCD process to new process as, 'Triangle Model Theory (TMT)'. After development stages will shortly follow up the difference between conventional methods and TMT methods.

### 4. Descriptive Statistical Analysis

There are diverse methodologies are used in Human computer interaction. Four methods are used rapidly in HCI for their effective functionality and robustness.

- Activity Theory
- User-Centered Design
- Principles of User Interface Design
- Value Sensitive Design

In this article we will discuss and follow up the User Centered process or methods regarding the background of our research.

#### *User Centered Design process*

Several researches have been cited in the Related Works section. User Centered Design (UCD) is process or framework or method which defines the needs, wants, limitations, services or process gets attention of the end user of a product at every stages of design process. This UCD process is multi stage problem solving process that requires and follow up in every product development requirement when design. A product model, product requirement, usability, product concepts, modifying original requirements at each stage can use the UCD process. This difficult for a designer that a product how much reliable for the first time use by an end user. The user centered designer's tries to optimize how user can use product, what want or need, rather than to change the user behavior about the product. According to the Don. Norman 's, book "*The solution is human-centered design (HCD), an approach that puts human needs, capabilities, and behavior first, then designs to accommodate those needs, capabilities, and ways of behaving. Good design starts with an understanding of psychology and technology. Good design requires good communication, especially from machine to person, indicating what actions are possible, what is happening, and what is about to happen*". The author also stated the seven cycle tools or principles for the good design [15], in general:

- What do I want to accomplish?
- What are the alternative action sequences?
- What action can I do now?

- How do I do it?
- What happened?
- What does it mean?
- Is this okay? Have I accomplished my goal?

Above the definition and the seven principles we must realize there have some rules and techniques for User Centered design process. The authors Jennifer. Preece, et al. defined four basic activities of interaction design in their books are:

- Identifying needs and establishing requirements
- Developing alternative designs
- Building interactive versions of the designs
- Evaluating designs

They also describes three characteristics is a key part for the interaction design. The three keys are:

*Focus on users* – It describes that the interaction design process should be involved by the users. It will encourage some issues and provide the opportunity for the evaluation and users feedbacks.

*Specific usability criteria* – This key will help the designers to choose alternative designs and the progress of the product developed.

*Iteration* – This key helps the designer and users engage to discuss the requirements, needs, hopes and aspirations. It also leads the designer of a vision for the required artifact. The author discussed the UCD design process that, UCD model incorporates iteration and encourages a user focus, while the outputs from each activity are not specified in the model [16].

The author Gerard. Jounghyun. Kim, stated some HCI design principles are general, fundamental and commonsensical that applicable to almost HCI design situation. The important three are:

*Know thy user* – This principle simply states the interaction and interface should cater to the needs and capabilities for the target user of the system design. User centered design process is the concept of ‘universal usability’ which roughly promotes ‘human’ interfaces that cater to a wide range of user.

*Understand the task* – Another principle is to the base of HCI design that understands the task. The task is a job that is accomplished by the user through the use of interactive system. This is important that the task model must ideally come from the users, different users have different mental model and reflects of the interface to simplify for all users.

*Strive for consistency* – The consistency must be stable for the interface or interaction design, because when the user notices same task is different for different times then the user responses erroneous command. The consistency is most acceptable and familiarity for interface and interaction design [17].

The User centered design process or approaches are apply for any kind of applications or products in HCI design perspective especially which is closely related to the

user centric. In HCI during development some issues comes to the developer and designer that’s relates to the functional requirement and user capability, it needs to ensure the efficiency of the product. There is an evaluation stage of conventional UCD design model which is most effective for the designer, but some researchers have been trying to develop and extend the model to overcome some complexity by reducing or extending steps of the UCD model. After clarifying the usability in HCI, the activities and the functional steps of conventional UCD methods and the proposed TMT model will be explained.

## 5. Demographic Factors’ Influence on the Behavioral Preferences

The Usability can be considers of something that is human made object such as device, tools or any products. The usability is a condition that a software or specific products by human made works efficiently, effectively and satisfactorily. The usability can be any software application, tools, book, machine any process and vehicles. Usability is the important role in HCI for the designer especially to the user centered design process or methods. In human computer interaction and computer science the usability studies which interaction and interface with a computer program, functions or products is designed that is desired for the users required and usable. The author James. G. Jesse, states in the book “*To understand what our users need, we first have to get a sense of who they are. The field of user research is devoted to collecting the data needed to develop that understanding*”. Also refers the user research for finding the usability, the key user research are: Market research methods, Contextual inquiry and user testing [18]. Usability is just not a general issue in Used Centered Design process. The author Travis. Lowdermilk, stated about the usability that Human Computer Interaction is rooted in Usability but it focuses how human relates to the computing products. User centered design emerges from HCI design methodology for developers and designers and it helps to understand the customer requirements. It only applicable when that is ensures the applications maintain a great user experience. By the author the usability goal is to measure the effectiveness of a feature or set a feature within an application or system. To complete a usability study need to have a plan [19].

## EXTENDS USER CENTERED DESIGN PROCESS

The User Centered Design (UCD) process or approaches is a user centric approach that we have discussed earlier. In this section we will try to discuss the difference between conventional UCD model and proposed TMT model. The activities of conventional UCD model of the each stage will be discussed into the following sections and later the proposed extended model will be derived.

### *Conventional UCD Process and Development*

The conventional UCD process, approach or model is one of the role model in Human Computer Interaction design. The conventional UCD model is slightly varies from different researcher, but the model consist about four stages or approaches in general of HCI design. According to the Alan. J. Dix, et al. the design process as follows [3]:

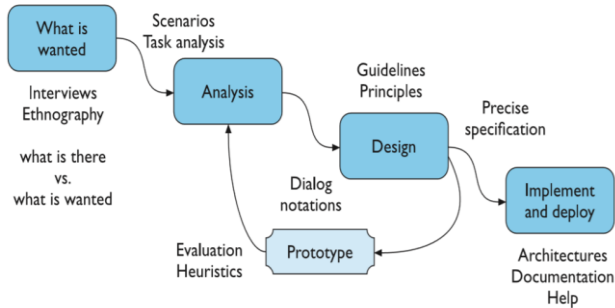


Fig 1: Design Process by Alan. J. Dix, et al. (2004)

In the figure 1 the basic components are describes by the researchers as:

**Requirement** – What exactly is needed? Following information’s are collect by some techniques used in HCI such as, by taking interviewing, make some questionnaire, prepare documents and take survey survey.

**Analysis** – This phase if after the requirement section that is collects data are analyzed here. Also analyze here that what should be the next stage design are compromised in this phase.

**Design** – This phase is all about design story. There are some rules, guidelines and principles are following for design perspectives in HCI design interaction. The collected data and analysis result are thoroughly considers in this design phase.

**Iteration and prototyping** – This phase is complex due to the human expectation and for first time design. It discusses how well are the prototypes are working and the improvements.

**Implementation and deployment** – After completion of prototyping phase the implementation and deployment stage is ready. Prototyping phase tells us the design of the product or system is meets the user requirement and satisfaction, now we can deploy our design for the final release to the customer.

The researchers Christopher. R. Wilkinson, et al. in their paper proposed an extended UCD process with adding the

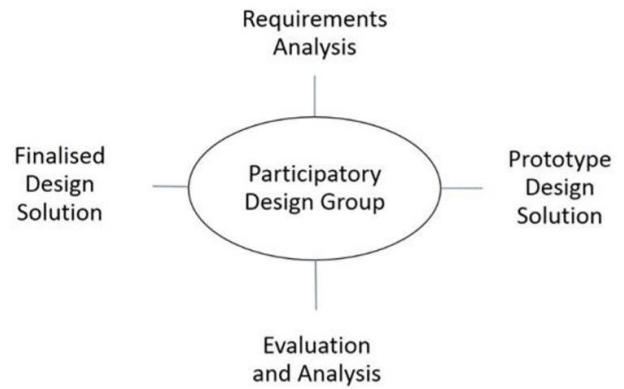


Fig 2: UCD process by Christopher. R. Wilkinson, et al. (2014)

‘Participatory Design Group’ that allows to the user informs the design process entirely. They tried in their research by adding participatory design group to develop commercial products and to overcome the stigmatization by develop the design process [21].

The author Ishrat. Begum, has proposed an extended UCD model by adding the term ‘Understand’ in the conventional UCD process.

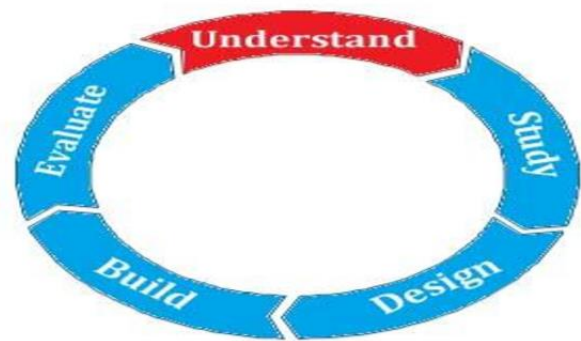


Fig 3: UCD model by Ishrat. Begum (2104)

For understanding a problem the ‘Understand’ phase has been added on the conventional model. It helps to focuses on the user, user domains, environments and culture. It provides framework a guide to design and research [7].

**Proposed Triangle Model Theory (TMT)**

Researchers are trying to extend, expand, develop or modify the conventional UCD process for improving the design process during development in Human Computer Interaction Design methodologies. Some researchers have added some terms on the center in the model, initial in the model or last in the model. But the development progress is ongoing until we cannot find a universal UCD model for interaction design perspectives. The proposed UCD model and each stages discussion are shown below.

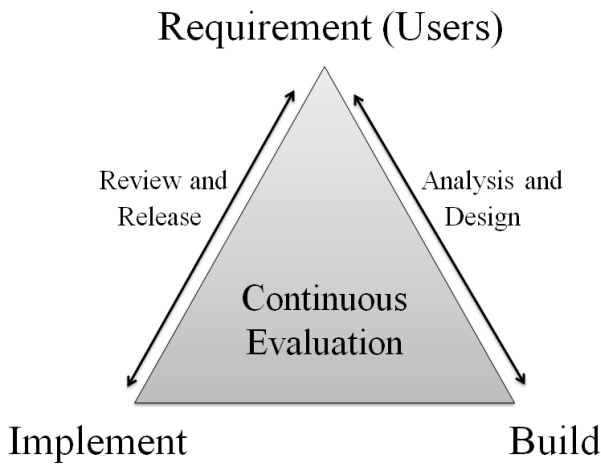


Fig 4: Proposed Triangle Model Theory (TMT)

## 6. Discussion

The discussion part is the potential option for evaluating between two methods or process. We noticed on the conventional UCD model or processes have four phases and after developing the product or something the evaluate phase is the last option before final release. In this research we can stand this is the complexity for develop and release the desired product on time. Let's think about, before release have found some technical issues, functional error or user requirements (users choice can differ any time) then we will face the complication due to the conventional UCD model has the evaluation phase on the last stage if the designer or developer has follows the conventional UCD model. For that reason we have to take more time and some requirement for recovering the complication and we cannot release the product to the users on time as well as it has a business loss also.

If we follow the proposed Triangle Model Theory (TMT) the 'Evaluation' criteria is the heart of the model. During design and development if the evaluation process is carries on then the running state will be overcome successfully. As like conventional UCD models do not need to back track of the development progress. The TMT model has three phases and the others are hidden and those are runs on during developing process. It is not recommended in TMT model for hidden Analysis and Design or Review and Release phase take separately like others three. In TMT model is the main concern is the 'Continuous Evaluation' process which has given the model importance in HCI.

The TMT model has three main phases and the evaluation period will be remains continuous during development. The each phase activities are shown below:

*Requirement* – This phase is the initial phase of proposed TMT model that collects the user requirements for the defined system and products. The collection methods would be such as survey, interviews or can be some related questionnaire sections.

*Build* – This phase is the second stage in the TMT model that acts the development steps. Before development the Analysis and Design are the hidden criteria to reach the Build phase, in the meantime the evaluation process would be continuous. There is no need to wait for build or analysis phase.

*Implement* – This Implementation phase is the last phase before release the product into the users. Continuous evaluation must be carrying on these phases which are uses in HCI evaluation. Before final releases the output should be run out through the review criteria on TMT model and go for final release to the users.

Comparison Points	Conventional UCD Model	Proposed TMT Model
1. Number of Phases	Differs from researcher, generally 4 phases	3 main phases and hidden phases during development
2. Evaluation position	Last phase in conventional UCD model	Continuous evaluation on every phase in TMT
3. If Complication Face	Need to back track and need more time for recovery	Complication overcomes during development
4. Develop and release	Difficult to do on time	Possible to on time

Table 1: Comparison between Conventional UCD Model and Proposed Triangle Model Theory (TMT)

## 7. Conclusion

Design methodologies are the basis of interaction design in Human Computer Interaction. Several methods are used by several researcher, designer or developer in the way they are related to their fields. Without proper methodologies it is nearly complicated to develop or design of human computer or machine interaction. Although conventional UCD process is widely used methods since many years in HCI, but researchers are trying to modify and extend the methods for better human computer interaction design purposes. In this paper tries to demonstrate the conventional UCD model complexity, previous research

works of its development and proposed an extended version of User Centered Design methods as Triangle Model Theory (TMT) for further development of interaction design and enhance the usability in HCI. This research has not illuminates the TMT model is the universal theory for interaction design, rather than it is developed model for interaction design in HCI which will help the designer and developer. Further research will be carried out on this field with passionately for better improvement in the future.

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