EXPLORING THE STRATEGIES COMPUTER SCIENCE INTERFACE DESIGNERS NEED TO IMPROVE VISUAL USER INTERFACE (VUI) ELEMENTS FOR DIVERSIFIED USERS

A Dissertation Presented in Partial Fulfillment of the Requirements for the Degree of Doctor of Computer Science

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Abstract

One of the primary and essential components of a digital device is the user interface. Interaction of the human with a computer device begins with the clicking of icons to execute the user's objective in using a technological device. An example, a user could not understand which icon to click from the main menu when the use aim is to adjust the background setting of the device. The trend in digital devices presents advanced technology, but the user interface designers continue to misunderstand the diversified users' needs by creating digital devices with user interface designs that do not accommodate diversified users. The inquiry is about what Computer Science user-interface designers need to strategize in improving the visual-user-interface (VUI) elements for diversified users. The execution of an intended task for the computer device is an ability of the software design to provide user-interface elements for the users' interaction with a technological device. One of the primary issues in designing a digital device is the lack of usability system design from limited user interface capabilities in accommodating the needs of diversified users. The sample population represents computer scientist, graphic designer, IT professionals, and active users of digital devices. The data collection method used was the semi-structured interviews and data analysis extracted from participants' responses with diversified backgrounds.

Keywords: user interface, diversified users, digital devices, human-computer interaction, visual interface, visual user interface designs, computer design, software design, designers' strategy, digital device development strategy

Dedication

By the grace of my Lord and Savior Jesus Christ, I am here today with the completion of my doctoral journey. I am nothing without HIM. I am dedicating this final presentation to all close friends, family members, colleagues, and most of all to my best friend-husband, Chuck--for his support and who has carried the burden of my responsibilities at home patiently and lovingly. I am dedicating my time and effort to our beloved grandchildren Ryan, Bella Rose, Tess, and Jake who had inspired me to be a better person today.

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I am grateful to Dr. James Webb, Committee Chair and my mentor, Dr. Steve Munkeby, CTU Administrative Staff and Advisors; and CTU faculty members who had assisted me and shared encouraging comments to accomplish my doctoral journey. Special recognition and appreciation to all the study participants who have unselfishly given their time and effort in contributing to the body of knowledge.

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CHAPTER ONE

The inquiry is about the strategies Computer Science and user interface designers need to improve visual user interface (VUI) elements for diversified users and individualization of digital devices. The current designs of digital devices delivered to consumers have the standard user interface that does not perform efficiently and lack of features in accommodating diversified users' need. The study is an exploration of real-life experiences shared by participants who have diversified backgrounds in user interface designs of multiple digital devices. The objective of the study is to discover users' challenges, issues, and difficulties in using digital devices' visual user interface (VUI) elements from the responses of participants. The in-depth look and understanding of users' problems in the VUI designs could serve as the guidelines to manufacturers, computer scientists, software designers, and practitioners in accommodating users' needs. Chapter one includes discussion on the topic background, research question, the purpose of the research, research methodology and design, assumption and biases, the significance of the study, delimitations, limitations of the study, definition of terms, and a chapter summary.

Human-centered design analysis and approach continued to grow by using different types of assessment tools and artifacts to evaluate users' experience from the use of tablets, iPads, smartphones, and various digital devices; however, user's level of satisfaction remained a challenge (Hashizume & Kurosu, 2016). Hashizume and Kurosu (2016) stated the importance of revisiting the ISO9241-210 to achieve high-quality users' experience by designing human-centered technology, an overall evaluation of digital designs is essential for sustainability (Hashizume & Kurosu, 2016).

The visual user interface (VUI) is a critical element in human-computer interaction connecting the psychological and emotional experience of users (Silvennoinen & Jokinen, 2016). Silvennoinen and Jokinen (2016) reported the user interface design requires an understanding of how visual user interface elements such as color, size, texts, and backgrounds affect visual user interface design and endorse users' satisfaction. The researcher has explored how user interface designers could enhance visual user interface elements such as icons, lines, images, text, and backgrounds for a positive experience in the human-computer interaction of diversified user groups (Silvennoinen, & Jokinen, 2016). The result of the study completed in 2016 was an analysis of 100 templates illustrating visual interface elements has presented a gap for future research in VUI involving participants with diversified backgrounds (Silvennoinen & Jokinen, 2016).

Topic Overview/Background

Mihajlov, Law, and Springett (2016) stated the difficulties in user interface designs which are common in the older population required a better approach of designers and manufacturers. Kirisci and Thoben (2018) recognized the need for a better strategy in designing a user interface to support an intelligent production of devices. The current standard in a visual user interface (VUI) is causing difficulties to users due to numerous complexities in the systems (Kirisci & Thoben, 2018). The need for user interface enhancements to support machine and human interaction is on the horizon but will require an intelligent method in manufacturing digital devices. The study of Kirisci and Thoben (2018) on designing user interface claimed the essential role of hardware designs in cyber-physical production.

The study has provided an in-depth understanding and guidelines to the conceptual model in identifying the strategy for specifications in individualizing products based on user's

capabilities and adjustability to a display on the screen including a hand-held remote control (Springett, Rice, & Griffith, 2013). The inquiry has collected data from lived experiences of user interface designers and diversified users from a purposive selection of participants in social and professional networking sites by conducting semi-structured interviews (Creswell, 2016; Lofland, 2017).

The study is a significant information to improve the strategy of computer scientists, user interface designers, and practitioners in designing and manufacturing digital devices with a visual user interface to accommodate the needs of diversified users (Silvennoinen, & Jokinen, 2016). The inquiry has presented the study findings from the data analysis of participants' responses from the recordings and transcriptions of the semi-structured interviews. The collection of raw data from participants' interviews and numerous methods used in data analysis for accurate reports ensure the reliability of the study.

Problem Statement

The problem addressed in the qualitative exploratory study is the strategies Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users (Silvennoinen, & Jokinen, 2016). The manufacturers and retailers delivered digital devices to the consumers with a standard user interface, and designers recognized a single user interface would not perform efficiently to all types of users; but computer designers continue to help manufacture devices with the standard user interface (Davis et al., 2012; & Miñón, Paternò, Arrue, & Abascal, 2016).

From the systematic literature review of manual and automatic searches, Bittencourt, Baranauskas, Pereira, Derneval, Isotani, and Jacques (2015); stated the significant needs for user's interface designers is to improve the strategy in software development in manufacturing

digital devices. Designers claimed the primary reason for poor user interfaces is the lack of knowledge in user-friendliness approach and costly design development (Miñón et al., 2016).

Purpose Statement

The daily interaction of people with digital device begins with a user interface such as the main menu and clicking of icons to execute the objective in using a device. The purpose of this qualitative study was the exploration of strategies of Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users (Silvennoinen & Jokinen, 2016). The justification of the completed study is a demonstration of conceptual model identifying an approach to address the visual designs issues caused by misinterpretation of users' need with diversified backgrounds. (Silvennoinen & Jokinen, 2016). Springett, Rice, and Griffith (2013) indicated designers need to facilitate products' specifications and requirements to align visual user interface with human interaction and digital device. The purpose of the study has established the implication for computer scientists' strategy in innovative user interface designs to accommodate a visual interface' needs of a multigenerational society (Biswas & Robinson, 2013).

Biswas and Robinson study on a user interface of digital devices argued the difficulty in the user's interface caused by cognitive issues on the part of the users. The study in 2013 claimed due to declining physical and other sensory attributes of older adults, a significant consideration is critical in designing a tangible user interface of computer systems and devices (Stojmenova, Debevc, Zebec, & Imperl, 2013).

The investigator has purposively recruited participants from the sample population of user interface designers, active users, and professionals with diversified background from different age groups. Interested and selected participants have more than two years of experience in the computer science professional field and users from various geographical locations in the

U.S. Facebook and LinkedIn are the sites used for recruitment. The selection criteria were used to purposively selected participants from all ages and significant experience in the field of user-interface designs, active users of digital devices, and software development. The qualitative research design was applied by conducting semi-structured interviews for data collection process (Creswell, 2016; Rubin & Rubin, 2015).

Research Question

What are the strategies Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users?

Conceptual Framework

The focus of the study has addressed the design issues of the visual user interface of digital devices to accommodate the needs of diversified user groups (Silvennoinen & Jokinen, 2016). An evaluation of the aesthetic features in the user interface design of the study could provide guidelines for an attractive and customize user interface design and a resource for a wide-area in a computer science discipline (Wang & Li, 2017). Wang and Li (2017) claimed the aesthetic characteristic of icons for visual user interface appeals as users' stimulant to click on the application.

A user interface design in mobile devices requires precise software development process because of the size and screen limitation (Wetchakorn & Prompoon, 2015). Due to the size limitation of mobile devices, a specific guideline for the development of mobile devices' user interface is critical to ensure the quality of patterns and elements for visualization (Wetchakorn & Prompoon, 2015). Wardhana, Sabariah, Effendy, and Kusumo (2017) concluded from the result of a completed usability test, the needs between parents and children are different in various aspects such as older people need more application descriptions for quicker

understanding while kids can easily recognize the applications with icons displayed on the screen.

Silvennoinen and Jokinen (2016) indicated the visual elements in the user interface had been misunderstood, and the user interface designers are more incline to underestimate the usability feature in the design. A visualization design affects the positive and negative experiences of users' interaction with the computer (Silvennoinen & Jokinen, 2016). Shaw, Horvath, Leonard, Ferranti, and Johnson (2015) reported one of the obstacles in software development is the failure to understand some challenges in users' interactions with a digital device and lack of knowledge of users' physical and cognitive needs.

The study has determined how visual user interface designers' approach can improve the users' experience in the digital world. The elicitation of data from participants included the use of the semi-structured interviews with open-ended questions (Rubin & Rubin, 2015). The phenomenology of the study has interpreted the meanings and patterns of the inquiry on how user interface designers can enhance the visual user interface of digital devices with the inclusion of users' standpoints and needs from the lived experiences shared and recorded from semi-structured interviews (Kirisci & Thoben, 2018; Lofland, 2017). Creswell (2016) demonstrated the traditional research methods in conducting a qualitative inquiry are ethnography, case study, phenomenology, narrative, and grounded theory. As the guiding principle for the central research question, a phenomenological approach is deemed appropriate to accomplish a primary focus of the study (Creswell, 2016).

Assumptions/Biases

Assumptions are statements presumed to be true and the underpinning element for a valid result of the study (Wargo, 2015). The investigator has established the primary objective of the

study by collecting meaningful data from eligible and selected participants who have shared the lived experiences at a personal or professional level. The participants' environmental and cultural factors are inevitable to influence the semi-structured interview process. An assumption of possible preconceived ideas and values of participants might have affected the experiences shared in the interviews. The primary focus of the inquiry allowed the determination of strategy in user interface designers needs to improve the visual interface of a device and inclusiveness of users' needs for interaction with a digital device. The assumptions of the study were presumed real feelings and experiences shared by participants who are representing the sample population selected for the research.

According to Durovic (1975), bias in a study exists if a test failed to use the same proportion of different groups or participants without discrimination against specific groups or individual. The mitigation tool used for the possible existence of bias in the study is the application of standardized protocol throughout the study. The use of the standardized instrument in the study has presumed a true representation of respondents in the interpretations of themes and meanings (Rubin & Rubin, 2015). A systematic analysis was performed to present the data with credibility and reliability.

Significance of the Study

The current user interface design of computer devices primarily is catering to younger users, and the study was focused on the accommodation and guidelines in enhancing visual interface for users with diversified needs (Goncalves et al., 2017). The demography of users continues to change from younger to baby boomers' generations, and software designers require a new approach to develop multi-generational computer devices (Ardito et al., 2015). Ardito et

al., (2015) claimed the need for users' participation in the development of the effective design to deliver solutions for issues in user-centered digital devices.

The significance of the study has provided an in-depth understanding and deeper look how designers can individualize a visual user interface of digital devices to accommodate the needs of diversified user groups (Silvennoinen, & Jokinen, 2016). The result of the study is essential to identify the design issues and guidelines to user interface designers in delivering solutions for customization and personalization of visual interface (Aryana, Clemmensen, & Boks, 2015). Silvennoinen and Jokinen (2016) reported the significance of the visual interface in the human-computer communication and design problems are due to the non-existence of the design method to fit with all users' needs. The current trend in designing user interface does not provide a meaningful aesthetic to users but only some functions (Silvennoinen & Jokinen, 2016).

Delimitations

Creswell (2016) stated that a delimitation is to maintain the parameters of the study. The scope of the research was confined to identifying how user interface designers can improve the individualization of a device's visual user interface. The focus of the study is the collection of meanings and interpretations from user interface designers and users with diversified backgrounds about lived experiences as developers or users in the digital world (Silvennoinen & Jokinen, 2016). The collected data were sorted into themes and categories where the analysis began. The study is limited to the use of open-ended questions for the semi-structured interviews with participants as an instrument for data collection (Rubin & Rubin, 2015).

Limitations

Price and Murnan (2004) defined research limitation a feature of research methodology and factors that influenced the interpretation of findings from the data collected. The limitation

of the study is in a small sample of the population and caused a limited data shared and affected the discovery. The constraint of resources and purposive sampling may have influenced the study. The data collected may have been a result of biases on the part of participants and predisposed the accuracy of data analysis and reports. The study is limited to the honesty and predetermined ideas of the selected participants during the time of the interview.

Definition of Terms

Affective-Use-Centered Design (AUCD): Affective-user-centered design is an approach to integrate emotions with an interface and a model design to address real-time users' needs and requirements (Yiing Y'ng Ng, Chee, & Robert, 2018).

Diversified Users: The Cambridge Dictionary defined diversified as various types of things or products. According to Moura, Singh, and Chun (2016), diversified users are the manifestations of users' influences in using products based on culture, limitations, perceptions, objectives, values, and situational events.

End-User Development (EUD): End-user development is a strategy in developing a software system or application to meet the endusers' requirements (Zhong & Liu, 2014).

Explicit information: Explicit information is defined as the collection of users' data related to profiles, activities, photos, and other tangible information via social networking sites (Raad, Al Bouna, & Chbeir, 2016).

Information security: Information security is defined as "protecting information and information systems from unauthorized access, use, disclosure, disruption, modification, or destruction" according to U.S. law," (Conteh & Schmick, 2016, p. 32).

Implicit information: Implicit information is a data set provided by users that can be used for data analysis of consumers' behavior, habits, and other types of customer relationship data (Raad et al., 2016).

ISO9241-210: ISO9241-210 is a standard required by the International Organization of Standardization for human-centered approach focusing on users' ergonomic and human-computer interaction needs. (Hashizume & Kurosu, 2016).

Social media: Social media refers to a set of online tools that are designed for and centered around social interaction," (Bertot, Jaeger, & Hansen, 2011).

Software usability: Sagar and Saha, (2017) defined software usability as the user-friendliness in using software application. *Usability* is the functionality of a device enabling users to execute intended tasks for the device with satisfaction and efficiency (Sahar & Saha, 2017).

Special-Needs Users: Special-needs users are end-users who have physical, mental., emotional, and or developmental disabilities (Kurschl, Augstein, Burger, & Pointner, 2014).

User interface (UI): The User interface is the digital device feature and design used in the interactions between users and machines. Marcus (2002) defined UI as computer-generated medium to facilitate communication and interaction between human and devices.

General Overview of the Research Design

Edmonson and McManus (2007) demonstrated the methodological fit in research starts from the inception of a central research problem. The quantitative and hybrid research methods are options, the fundamental research question directed the study to use a qualitative approach. The study was intended to narrow down a broader topic drawn from various reviews on the visual user interface delivered with the device. The focus of the research is to explore how user

interface designers can individualize a visual interface of a digital device to accommodate the needs of diversified user groups (Silvennoinen & Jokinen, 2016). Silvennoinen and Jokinen (2016) claimed software developers neglected to identify the users' needs in visual user interface design. Prior works on the user interface designers needs to individualize a device's user interface have established the lack of strategy to individualize a device 's user interface design (Davis et al., 2012; Raad et al., 2015).

The data collected from semi-structured interviews continued to shape the phenomenon surrounding the research question on what strategy user interface designers need to personalize a device's user interface. A qualitative method was selected, because, the objective of the study is to discover and provide meanings for the experiences of purposively-selected participants for the inquiry (Creswell, 2016).

The qualitative inquiry has looked through the lens of literature and involved interview questions on how user computer science designers can enhance the design of a visual user interface to meet users' needs (Creswell, 2016). The progression of sub-questions and subtopics determined the feasibility of a reflective process in qualitative inquiry (Agee, 2009). Reflecting on questions presented, the study has provided a navigational tool in the development of various stages in qualitative research (Agee, 2009). An approved data collection method and systematic literature review were used to collect data. The carefully formulated open-ended interview questions became the navigational tool for a data collection process of the study (Agee, 2009; Rubin & Rubin, 2015).

Summary of Chapter One

The discussion in Chapter one provided the navigational approach to the qualitative inquiry and addressed the research question. The topic of the study is about what computer

scientists and user interface designers need to improve the visual user interface in accommodating the needs of diversified users' groups. The significance of the study has provided specific recommendations for the improvement of visual user interface design for consumers and developers. The study finding provoked discussions on what are the approaches user interface designers need to individualize digital devices' user interface designs. The data collected from the study was a foundational guideline to various computer science fields, across other academic disciplines, practitioners, and computer designers.

The next chapter discussed the systematic literature review from more than 100 references. Chapter 2 is a presentation of a subject mastery of the researcher from analysis completed in more than 100 scholarly-written articles about essential designers' approach to individualizing a device's user interface. The foundational seminal and emerging literature substantiated a gap in the body of knowledge and linked towards a qualitative research design. The qualitative methodology presented in the conceptual framework in the next chapter has addressed the research problem on how user interface designers can enhance the visual user interface to accommodate diversified users' needs (Silvennoinen & Jokinen, 2016).

Organization of Study

The organization of the manuscript was presented in five chapters. The first chapter contains the topic overview and background of the inquiry. Chapter one stated the research question and purpose of the study with the appropriate citations. The assumptions, biases, limitations, and delimitations are also the topics of discussion in Chapter one. In Chapter 4, the narratives on data collection method, data analysis, ethical consideration, and summary of the section are the topics for discussion. Chapter 5 is the presentation of findings, limitation of the study, implications for practical use, conclusion, and recommendation for future research.

The next section is Chapter 2 which discussed the systematic literature review has discovered the unknown in the topic and determined a gap in the body of knowledge from foundational literature. Chapter 2 provided the problem opportunity statements and a brief overview of the conceptual framework for qualitative inquiry. The logical and methodological descriptions of the study are in Chapter 3. Chapter 3 contained arguments and critical comments from the literature to substantiate the research problem is the gap and a recommendation for future work from previous studies. The methodological fit of the research design appropriate for the study was one of the topics for discussion in Chapter 3. Chapter 3 has described the sampling procedure and data collection protocols. Chapter 4 includes the demography of participants, data collection, data analysis, and presentation of study findings. Chapter 5 is the overall summary of the inquiry substantiated with study findings and conclusion.

CHAPTER TWO

The discussion in Chapter one presented the background of the topic, problem statements and opportunity, assumption and biases, limitations, delimitations, and general research design to serve as the foundation towards the progression of the qualitative inquiry. The research has explored the strategies Computer Science interface designers need to improve visual interface (VUI) elements for diversified users (Silvennoinen & Jokinen, 2016). The objective of the study has addressed the strategies Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users (Silvennoinen & Jokinen, 2016). The significance of the study is an implication for computer scientists' strategy in innovative user interface designs to accommodate the approaches Computer Scientists and visual user interface (VUI) designers need to improve visual user interface (VUI) elements for diversified users (Biswas & Robinson, 2013).

Human-Computer Interactions

The user interface is a primary link of interaction between a computer device and human (Hu et al., 2014). Hu et al., (2014) reported in the study on the visual impact of the 3D user interface, the existence of a 3D interaction between users and application enhance the user's experience. The study claimed a successful transformation of text data to a graphical user interface makes the operation of devices more comfortable and abridge the remoteness between a user and program application (Hu et al., 2014). Davis et al., (2012) argued in the study of intergenerational technological designs involve a better strategy to accommodate a wide range of digital inclusiveness and closing the gap between user interface application and device's user. Goncalves et al., (2017) concluded from the study of an adaptive user interface for special needs population group; technological designers need to continue seeking solutions and strategy to

close the gap between machine and human interaction. Paul, Bhuimali, and Chatterjee (2017) reported the human-centered computing requires richer communications between users and digital devices rather than design artifacts, planning, and procedures. Pierre and Thoben (2018) claimed model prototyping of physical user interfaces design is critical in human-computer interaction. For example, the physical user interface of any types of input-output digital device and sensors embedded into the system (Pierre & Thoben, 2018).

User Interface

According to Faure and Vanderdonckt (2014) user interface is more than 50% of the cost and development time in software applications. The development of user interface to accommodate diversified users, preferences, and usability is a difficult task for some designers because of complexities to improve multi-cultural, multi-modality, and usability features of a user interface (Faure, & Vanderdonckt, 2014). The user interface is an interaction between human and computer device (Bouchrika, Zaied, Jemai, & Ben Amar, 2014). The execution of user interface started with the standard input from computer components such as a keyboard and mouse (Bouchrika et al., 2014).

The advancement of technology has opened opportunities to different types of user interfaces such as touch screen, speech, gestures, facial recognition, emotions, and robotic-based interface, but design challenges continue to occur (Bouchrika et al., 2014). Cremonesi, Elahi, and Garzotto (2017) claimed reusable-pattern-based solution for user interface design provides efficiency in a development lifecycle rather than creating from scratch. According to Cremonesi et al., (2017), a pattern-based user interface algorithm is robust for the rigorous content online applications. Boy (2017) reported user interface operational issues from hardware to software demonstrate complexities in the socio-technical environment. However, the transformation of

software issues into hardware presented the tangible user interface is the primary challenge for designers (Boy, (2017). The complexities of user-centered design require an understanding of human factors to encapsulates design process with interdisciplinary functionalities (Boy, 2017). A comprehensive analysis served as foundational to socio-technical design, Boy (2017) argued human-computer interaction designs require designers and engineers obtain and master tangibility.

Bittencourt et al., (2015) stated the mechanisms connecting human interaction with computer devices are user interfaces. Users' goals in the interaction with a user interface of a digital device vary according to users' needs, education, culture, age, tasks, socio-economic status, and culture (Bittencourt et al., 2015). Bittencourt et al., (2015) claimed software engineers' focus is on the production of high-quality products with great consideration in cost and system requirements. Song et al., (2014) reported the use of a reciprocal frame (RF) for user interface tool could alleviate some engineering issues and allow extra focus on the visual or aesthetic design. A *reciprocal frame* is a geometric approach to a design enabling previews through the use of RF patterns and user controls (Song et al., 2014).

The new generation of user interfaces requires an effective integration software engineering approach and human-computer interaction stipulations (Benbelkacem et al., (2014). Benbelkacem et al., (2014) reported the universal issue in designing user interfaces is the incoherence of functionality and lack of integrated strategy in the development process. Combining virtual and real-life interactions produce complexities of modeling and prototyping in the lifecycle development process (Benbelkacem et al., (2014). Benbelkacem et al., (2014) suggested the improvements in specification requirements could be accomplished by identifying the types of interactions between users and computer device Benbelkacem et al., (2014).

Benbelkacem et al., (2014) argued the future improvements in managing and documentation of user interface models and software engineers' methods are essentials for the sustainability of technological interface requirements. The argument of the study on the virtual environment by Butnariu, Georgescu, and Gîrbacia (2016) is how to provide users with unique and individualize experience in a virtual environment. Butnariu et al., (2016) claimed computer-based entertainment such as video games demonstrate the best and innovative technique for an interactive user interface. Butnariu et al., (2016) reported the use of natural user interface is easy to navigate by participants. However, an improvement is needed for a gesture-based interface using data filtering system (Butnariu et al., 2016). Wu, Wang, and Zhang (2016) indicated the numerous works on gesture-based interface algorithms for images and patterns recognitions have been completed, but not a study on the best strategy in freehand gesture interface design.

A design study completed in 2014 reported the need for the gesture-based user interface to alleviate the complexities of interfaces from various designs (Alcoverro et al., 2014). Users who operate Smart TV or high definition TV sets continue to deal with the limitations of interfaces such as a remote control to operate TV sets (Alcovero et al., 2014). The use of remote control provides negative users' experience when the remote is misplaced, a remote is stored in an inconvenient location; and the operation of remote control requires for a simple to complex knowledge and skills of users (Alcoverro et al., 2014). The gesture-based interface is a natural interface use for non-verbal interactions between users and computer devices (Alcoverro et al., 2014). Alcovero et al., (2014) concluded there are more challenges in the gesture-based interface than mouse-keyboard interactions, and the future studies on gesture interface are essential to improve exchanges in video games landscape. The inquiry on a gestural interface for video games substantiated while gesture-based interface holds popularity in video games; gesture

interface is a new paradigm in need of further exploration to evaluate usability for various applications in video games (Alves, Cunha, & Cunha, 2016). For example, implementation of the gesture-based interface for board games is an additional feature for players to have more fun in the interaction than moving pieces to designated spots (Alves et al., 2016).

The proposed UsiGesture of Beuvens and Vanderdonckt (2014) platform is to integrate specific independent gestures and streamline gesture interfaces provided series of steps to involve different roles of stakeholders in collaborative gesture interface development technique (Beuvens & Vanderdonckt (2014). The UsiGesture method continues to provide a useful framework for the lifecycle development, the developers decided not to use interface independent from end users; because, the findings are not conclusive (Beuvens & Vanderdonckt, (2014). The authors claimed an improved algorithm based on the selection of gestures at the right moment are critical to users' positive experience (Beuvens & Vanderdonckt, 2014). Dardas, Silva, and El Saddik (2014) argued the use of gesture interface in video games and other applications provide intuitive and dynamic interactions among users. According to Dardas et al. (2014), video games users are motivated to examine new user interface designs to gain experience and immersion to video game interactions. The study reported the hand-gestures interface is easy to use, but there is quite a holdup and inefficient in performance (Dardas et al., 2014). Zhang, Ma, Liu, Fu, & Fu, (2013) claims from the study on mobile devices collaborative interaction in multimedia applications the small screens of mobile devices limits the visual size of information on the screen and slows down the interface performance (Zhang et al., 2013).

Web-based human interaction plays a critical role for people with different types of disabilities (Ali, AlBalushi, & AlBadi, 2017). Ali et al., (2017) reported from the study on accessibility-aware methods of web engineers, a majority of Web 2.0 web pages do not cater to

people with visual and hearing impairments. *Accessibility* is a level of availability to all types of users in the functionality and usage of products and services by using proper tools and approach for accessibility design (Ali et al., (2017). *Web accessibility* means all types of users have access to information on the websites without barriers due to users' physical limitations. (Ali et al., (2017).

The Internet provides varied opportunities in cross-cultural personal and business interactions globally (Miraz, Excell, & Ali, 2016). Miraz et al., (2016) reported the current web-based user interface designs produced confusion in the multilanguage world of users. Usability issues in visual user interface designs on web applications such as colors, icons, graphics, phrases, format, phrases, time-date formats, characters, pictures, and other elements are interpreted differently in culturally-diversified user groups (Miraz et al., 2016). Common issues are known to designers, Miraz et al., (2016) claimed designing web-based user interfaces and applications to accommodate the needs of specific users' groups is an intricate task. One of the findings in a study is the use of colors for visual user interface corroborated a significant impact on multicultural user groups' online activities (Miraz et al., 2016). The authors recommended designers need to improve usability in the use of graphics for English and non-English websites (Miraz et al., 2016).

The primary feature of requirement engineering is a human-centered software development approach (Mahmoud & Williams, 2016). Mahmoud and Williams, (2016) claimed the need for universal coding practices of design engineers to determine the non-functional and functional requirements for designs necessitates automated solutions in elicitation activities and understanding of the language semantics (Mahmoud, & Williams, 2016). Hu et al., (2014) claimed the semantic of a 3D user-friendly interface is a bridge between the user and program

application bringing an innovative and unique user's experience. Hu et al., (2014) recommended the development of a 3D user interface design to promote an integrated platform for visualization and efficient usability.

Alam and Hoque (2017) substantiated from the experiment on a natural communication, the use of a non-verbal method such as facial expressions generate a user interface. Visual effects of facial expressions of emotions include happy, fear, anger, and feelings create a more real-life event in human-computer interaction (Alam & Hoque, 2017). The expressions of human emotions provide visual interface tool for interactive communication between the computer and human beings (Alam & Hoque, 2017). However, the study was limited to a few emotional expressions and adding animated emotions with sounds can enhance future experiment (Alam & Hoque, 2017). Yiing Y'ng Ng, Chee, and Robert (2018) study on user-centered-design theory used in video games presented an argument with the ambiguities about users' emotion, because, events and situations affect users' emotion. Yiing Y'ng Ng et al (2018) claimed development of the affective-user-centered design (AUCD) needs to take great consideration of the users' backgrounds such as social, age groups, culture, and national requirements. In contrast, Khalid, (2006) stated the difficulty in AUCD is the identification of users' category due to a growing diversity in users' backgrounds (Khalid, 2006; Yiing Y'ng et al., 2018). For example, video game players who have lots of experience will give positive feedbacks, but players who have not invested many hours in playing will provide negative comments about the experience in AUCD (Yiing Y'ng et al., 2018).

Intergeneration Users' Needs

While more people are reaching retiring age, researchers have shown increasing interest in the role of Internet connectivity is essential in a daily interaction after retirement (Smith,

2013). Stanciu (2017) reported the current life expectancy is longer resulting in rapid growth in the elderly population. Due to the rapid advancement in technology, senior citizens have difficulties in keeping up with the new technology and face challenges in using the advanced technological device (Stanciu, 2017). Senior citizens continue to face proficiency issue in adapting to new technology, risks threats awareness, and lagging while technology continues to advance resulting in a more significant gap between users and advanced technology (Stanciu, 2017).

The TAM (Technology Adoption Models) study about technology and aging society of Angelini, Carrino, Khaled, Riva-Mossman, and Mugellini, (2016) stated elderly users' relationship in the adoption of technology varies by age, gender, availability, price, and aesthetic designs. Angelini et al., claimed older women give more consideration in price value in using technology, but men tend to adopt technology at a later age of life. The authors recommended designers need to pay attention to a design that is more appealing and usability of a product to entice older adults in the adoption of technology (Angelini et al., 2016).

Goncalves et al., (2017) reported the use of smartphones by the elderly population had increased 6% from 2010 to 2011, but the current interface design posed some challenges in electronic communication between general and the elderly population groups. To meet the older adults' technological needs, designs of device and applications should address diversified purposes and needs (Goncalves et al., 2017). Due to the natural aging process of the elderly population, adapting to advanced technology and the user interface is challenging. (Goncalves et al., 2017). The data collected in 2017 study raised a question on the significance of technological design to address users' needs regardless of physical, age, cognitive, and emotional conditions (Goncalves et al., 2017).

The analysis suggested the designers and manufacturers of technology-related devices required an innovative approach to accommodate the needs of the older generation (Springett, Rice, & Griffiths, 2013). Kim, (2015) reported in a 2-year control-group study consisted of 120 elderly users assigned to use customized-design computers, Broadband, training in using email, Skype, and Facebook; the test result indicated more people had improved physical and mental capacities after a period of online activities. De Andrés, Pariente, Gonzalez-Rodriguez, and Lanvin (2015) argued based on the rapid growth of the elderly's usage of digital device and Internet, technological designers and developers need a strategy to improve system usability, user interface, and accessibility of a system or a device; because, standard user interface design does not perform efficiently to all users. De Andrés et al., (2015) claimed elderly users need a user interface that can provide an easy clicking. Some examples of an easy-to-click menu, icons, bigger, clickable buttons, images, links to other sources, colorful menu items, and other elements capable of delivering the positive and satisfactory experience to elderly users. De Andrés et al., (2015) suggested a need for the design model to address the needs of multigenerational technology.

De Andrés et al., (2015) claimed the rapid growth of the elderly's usage of online social networking triggered technological designers and developers took an undertaking in improving system's usability, user interface, and accessibility of a system or machine. de Lara, Affonso, De Mattos, Russo, and Freire (2016) reported elderly users need a user interface that can provide an easy clicking. Some examples of an easy-to-click menu, icons, bigger, clickable buttons, images, links to other sources, colorful menu items, and other elements capable of delivering the positive and satisfactory experience to elderly users. A design model that addressed the needs of "intergenerational technologies" provided users a value-added and positive online social

networking experience (Davis et al., 2012; De Andrés et al., 2015). The mode of information delivery on the Internet has offered many options to users, but, the current rules and regulations are not enough for providing accessibility assurance. Springett, Rice, & Griffiths, (2013) stated the designers and manufacturers of technology-related devices required an innovative approach to accommodate the needs of the older generation (Springett, Rice, & Griffiths, 2013). Lézoray et al., (2011) claimed the computer applications designed to address general purposes would not be the best solutions for elderly medical needs, but a specialized design will provide a practical solution.

Understanding the needs of an elderly population has improved the lifestyle and health care services through an innovative design model in technology. Elderly of different backgrounds presented various needs from simple to complex. Some older people have disabilities such as poor eyesight, hearing, and physical limitations. The approach to the development of technology addressed the needs of an elderly population like the graphical and menu interfaces in social networking site (Alaoui, Lewkowicz, & Seffah, 2012). The study on the deployment of independent living technologies; Doyle, Bailey, Ni Scanaill, and van den Berg (2014) reported older adults audio and visual user interfaces are critical for the navigation of icons in the menu of the digital device. A strategy and guidelines are essentials in the development of the user-centered technological design for elderly's independent living style (Doyle, Bailey, Ni Scanaill, & van den Berg, 2014). The lifestyle in the independent living technology offers great benefits to older adults' community, the challenge is the balance between functionality and usability of digital devices (Doyle et al., 2014).

Stanciu (2017) reported the current life expectancy is longer resulting in the rapid growth in the elderly population. Due to the rapid advancement in technology, senior citizens have

difficulties in keeping up with the new technology and face challenges in using the Internet. Senior citizens also are facing proficiency issue in adapting to new technology, risks threats awareness, and lagging while technology continues to advance resulting in "digital divide," (Stanciu, 2017). Goncalves et al., (2017) discovered in an industrialized country like the United States, senior citizens live an active life. The use of smartphones by the elderly population has increased by 6% between 2010 and 2011, but the current interface design posed some challenges in electronic communication between general and the elderly population groups (Goncalves et al., 2017). To meet the elderly's technological needs, designs of device and applications should address diversified purposes and needs. (Goncalves et al., 2017). Due to the natural aging process of the elderly population, adapting to advanced technology and user interface is challenging. (Goncalves et al., 2017)

The growing adoption of mobile devices by different age groups in an educational environment and other daily needs continue to present challenges in individualizing the usability of human-computer interactions (Anthony et al., 2014). Based on Anthony et al., (2014) study on 10,000 touch interfaces and 70,000 gestures collected from 70 adults and children participants; the challenges and differences of experience among users had been identified. (Anthony et al., 2014). For example, younger children with age group 7-10 years old have more challenges than the adult in recognition of gesture interface in human-computer interactions (Anthony et al., 2014). The study of Anthony et al., (2014) serves as the foundation to address gesture and touchscreen design issues and challenges of children and adults in using digital devices in classrooms and homes. The argument in the study of participatory approach to aging society in digital designs and promoting stronger collaboration between software engineers, designers, economist, healthcare professionals, and elderly users' group; the authors claimed accessibility

to digital products is the common goal of manufacturers and designers instead of meeting the needs of all users (Angelini et al., 2016).

Touro (2015) presented the use of technology by the elderly population has shown an exponential in the last several years. While more people are reaching retiring age, researchers have shown increasing interest in the role of technology and lifestyle in a retirement community. Niehaves and Plattfaut (2014) noted even if there was a reluctance in technology adoption, the use of social media by the elderly help overcome social isolation. Kung (2013) reported that overcoming social isolation by using social media interactions alleviated depression in senior population which was common among ethnic groups.

The World Health Organization predicted the worldwide population of older adults would increase to 2 billion by the year 2050 (Portet, Vacher, Golanski, Roux, & Meillon, 2013). Based on this prediction, technology has supported seniors to live independently without curtailing their control over daily activities. Smart technology for homes emerged several years ago with the objective to make people's home activities more natural –mainly elderly population has become a part of the social networking arena today (Portet et al., 2013).

The worldwide accessibility of automated mobile devices such as the smartphones has assisted people with disability in performing daily tasks such as operating lights, blinds and curtains, and other household chores (Abascal, Barbosa, Nicolle, & Zaphiris, 2016). Cozza, De Angeli, and Tonolli (2017) claimed older people have limited influence the future digital device development and designs to address future technological needs. Based on semi-structured interviews of Cozza et al., (2017), accommodating users' needs require a collaborative dialogue between software developers and users.

The exploratory research of Bernard et al., (2015); a web-based VisInfo prototype was introduced to a present user-centered approach to data visualization of a digital library for queries by computer scientists, researchers, and digital library end users. Bernard et al., (2015) claimed the most critical component of a digital library is the visual presentation of data during retrievals. The exploratory study was a collaboration of data curators, data collectors, end-users, computer scientists, and digital librarians (Bernard et al., 2015). The VisInfo produced a significant effect to the visual access of data during workflow retrieval (Bernard et al., 2015). However, one of the challenges discovered from the study is the formulation of advanced search interfaces. An improvement in DOI (Digital Object Identifier) cross referencing, advanced integration process, and deeper collaboration among researchers and publishers could improve the data visualization of digital library (Bernard et al., 2015). The argument is on the usability element of the interface needs a complete assessment during inception of the project and development of innovative concepts (Bernard et al., 2015).

The eye-tracking technology for user interface was in existence several years ago, and because of a high cost; the framework did not gain popularity (Zhang, Liu, Yuan, & Lin, 2017). The eye-tracker technology has played a significant role in psychology, marketing, and user interfaces in human-computer interactions, (Zhang et al., 2017). Zhang et al., stated while computer designers realized the potentials and benefits of an eye-tracking system, the development is limited due to high-cost and complexities of the design with an estimated cost of $30,000 ten years ago.

Digital Devices

Device Usability

Usability is the ability of software products to provide user interfaces appropriate in user-computer interactions to execute an objective for the intended task. (Prasad & Ramesh, 2015). The usability of a digital device is a result of interaction between user and device (Bittencourt et al., 2016). Bittencourt et al., (2016) reported in the study on multi-devices inclusiveness each user has a different objective to accomplish in using a device. Culture, educational, and socio-economic status are some factors influencing user's demands for efficient usability of devices (Bittencourt et al., 2016).

Sagar and Saha (2017) reported the primary cause of challenges in digital devices' usability system design is directly from the lack of efficient usability evaluation methods. A heuristic approach in usability test and evaluations is critical to design development by integrating data mining and usability engineering methods (Sagar & Saha, 2017). For example, the use of preselected criteria in design will formulate more probabilities in the evaluation results. (Sagar & Saha, 2017). Aryana, Clemmensen, and Boks (2015) argument from the study on the usability of smartphones in different countries presented the diversified solutions for usability issues with a focus on cultural differences. The different types of interactions based on specific country is a unique approach to identify usability challenges in each country and deliver user-centered products to consumers (Aryana et al., 2015). Users' participation in designing digital devices is critical to facilitate solutions applicable to individualized country's needs (Aryana et al., 2015). Aryana et al., (2015) reported the users' ideas from Iran are more focus on instructing activities, and Turkish prefer activity-based navigational elements of digital devices.

Peischl, Ferk, and Holzinger (2015) claimed the current trend in digital devices' usability have many limitations and a smaller element of the larger scale in usability designs. For example, software design has ethical and legal obligations to meet the requirements essential for providing healthcare and ensure users' safety and security (Peischl et al., 2015). The authors' recommendation based on the study completed in 2015 is to integrate usability features at an early stage of the design and development process (Peischl et al., 2015). Polatidis, Georgiadis, Pimenidis, and Stiakakis (2017) stated different assumption from a study on privacy preservation about the need for a new approach in an algorithm to bridge the gap between mobile computing and holistic software design strategy in protecting users on a different level. Peker, Kucukozer-Cavdar, and Cagiltay (2016) argued about the primary usability issue of Turkish educational websites is the visual interface design such as the inapt menus, pages lack flexibility in tabs, the navigational menu is inefficient, and other visual interface icons were not positioned in obvious locations for the users' easy visibility. However, the study is limited to one country and does not represent the more diversified usability situations (Peker et al., 2016).

Usability heuristics involved testing, evaluations, and validation of user interfaces usability based on a set of criteria (Pribeanu, 2017). Pribeanu (2017) stated when digital devices are not accomplishing the task users need; the usability issues are considered extreme. Usability issues are common to website applications for mobile devices (Bandi & Fellah, 2017). Bandi and Fellah (2017) stated designing mobile devices require a significant consideration of integrating innovations, security, and providing users' needs worldwide. Sagar and Saha (2017) claimed from the study on the usability issues in academic websites, one of the primary challenges of usability engineering design is the recognition of the common patterns in usability issues. A

proposed solution for usability issues is to perform usability testing and heuristic assessment integrating usability with data mining procedure (Sagar & Saha, 2017).

Design usability is an essential component of digital devices, but designers continue to develop poor design due to lack of understanding in human-computer interaction needs (Shaw, rt al., 2015). Weinmann, Schneider, and Brocke (2016) claimed digital device nudging from the use of a user interface could influence users' behavior. For example, the ATM uses the nudging feature to influence user not to leave a debit card from the machine. Weinmann et al., (2016) reported user interface would continue to influence users' behavior in making choices by digital nudging. Other examples of user interface nudging are defaults for selected insurance plans, opt in or out for organ donors, and displaying passwords requirements (Weinmann et al., 2016). Weinmann et al., (2016) recommended digital device designers need to take great consideration the positive and negative effects of a user interface to the decision-making activities of users.

Chu and Tanaka (2015) claimed the current design of the digital camera is a popular device to capture memories, but the current camera interface has several limitations. These limitations do not provide a life-size preview and real-time control with essential functions (Chu &Tanaka, (2015). Based on the study findings from a pilot study, Chu and Tanaka (2015) substantiated the usability of gesture interface by conducting a comparative analysis with remote control. The authors reported users preferred motion-based gesture for camera interface and offered a significant influence for the next generation of camera interface design (Chu & Tanaka, 2015). Some scholars have challenged the mainstream computer scientists to research solutions for age-related design issues (Chu &Tanaka, 2015). The exploratory design guidelines and requirements for highly interactive mobile devices in capturing real-time data are to provide users with a realistic feeling (de Sá, Shamma, & Churchill, 2014). de Sá, Shamma, and Churchill

(2014) claimed the real-time location and position of the users for the navigational mechanism while using mobile devices will enhance users' experience in capturing images and videos in combination with eyes-free interaction such as gesture user interface. The experimental study of Diaz and Payandeh (2017) discovered multimodal-sensor interface in 3D prototype for kinesthetic (haptic) communication could be a useful tool for the representation of a real object. The experiment on a recognition of the subject is open for future improvements in the effectiveness of object recognition (Diaz & Payandeh, 2017).

Software Development

Wetchakorn & Prompoon (2015) claimed the most critical segment of the user interface and digital device usability is the software development primarily in mobile devices. The limitation of physical size in mobile devices requires innovative specifications to produce efficient user interface design (Wetchakorn & Prompoon, 2015). A strategy to deliver user interface without missing users' requirements needs is to verify with users the usability of patterns and functionality of user interface design (Wetchakorn & Prompoon, 2015). Roubi, Erramdani, and Mbarki (2016) argued the current methods and tools used in the implementation of GUI (Graphic User Interface) for a web application are difficult for user interface designers to use. Also, UI (user interface) designer's knowledge in user device's platform, types of interactions, and features or traits of users are essentials and necessitate time-consuming efforts (Roubi et al., 2016).

Kirisci and Thoben (2018) reported a critical need for an efficient method to guide designers in the formulation and planning stages of design configurations on hardware and program applications. The innovative and enhanced capabilities of design tools and strategy to produce a highly sophisticated and improved prototype for production are significant (Kirisci &

Thoben, 2018). Identification of current challenges in the design method for validation, testing, and evaluation of modeling configurations in human-computer interaction is essential for future software developers and designers (Kirisci & Thoben, 2018).

Ssimoňák (2016) stated in conclusion from the findings of a study on the effectiveness of the visualization algorithm; intensive inquiry is needed to evaluate and improve the data structures transformation method. The availability of tools for design development is quite an undertaking and insufficient to meet the visualization requirements (Ssimoňák, 2016). Bittencourt et al., (2016) claimed the current algorithm for the standard in a user interface for digital devices is not capable of usage for multiple devices.

Ceret, Frey, Dupuy-Chessa, & Calvary (2013) stated the most critical solution to support design developers is a practical approach to the implementation of models and highly-skilled designers. Designers are not satisfied with the current method in modeling and prototyping devices that do not meet all users' need requirements (Ceret et al., 2013). Mayilvaganan and Kalpanadevi (2017) argued developers could use PHP language (Hypertext Preprocessor) tools in designing cognitive-model driven human interface system that will enable users' modification. The proposed model is inconclusive, but an evaluation tool may achieve the desired usability objective (Mayilvaganan & Kalpanadevi, 2017).

Qi, Bai, Li, Dong, and He (2015) reported the new trend in software development is the production of a user interface for home devices and the power grid. The interface is the solution for the communication issues between home device information exchange between the smart grid's user interface and power grid (Qi et al., 2015). Siriborvornratanakul (2018) reasoned the gap between economy and users is because of the digital world presents a significant detachment

from people. Difficulties in the mobile-based platform in augmented-reality user interface function continue to seek practical solutions (Siriborvornratanakul, 2018).

Obal and Stojmenova (2014) claimed the presence of software development and designs is contingent on users' existence. The sustainability of products and services depends on the participation of users with designers in a design process before integrating users in the software development and design method (Obal & Stojmenova, 2014). Pierre and Thoben (2018) argued the current limitations of a method in designing digital devices represent shortcomings from the functional requirements of products. A well-established guideline for design development is a good resource in products' lifecycle (Pierre & Thoben, 2018). Prasad and Ramesh (2015) argued the solution for the software development crisis is software reusability. *Software reusability* is a method to reuse existing design in another component, source codes, and attributes (Prasad & Ramesh, 2015).

A comparative study between software designers and users of mobile devices reported the significant differences in users' preference for the efficiency and reliability of mobile applications and visual interface features (Cata & Martz, 2015). However, designers are more focus on easy access, the current trend in information exchange, and the user-friendly feature of a device upon users' acquisition (Cata & Martz, 2015).

In the new paradigm of always connected—anywhere and anytime, the need for new and innovative products and services require the software developers design with a new approach (Marti, Megens, & Hummels, 2016). Marti et al., (2016) stated digital device designers need an innovative and experimental approach to visualize how data interacts with diversified users' needs. According to Marti et., al (2016); Marti and Bannon (2009) argued the users' participation in design approach require to suit the physical, socio-cultural, and emotional elements of a

design model. According to Cabitza, Fogli, Lanzilotti, and Piccinno (2017); environmental changes need to interact appropriately with a technological aspect to produce a satisfying and personalized experience in human-computer interaction. The suitability of design tools with users instead of designers creates a successful multi-modal socio-technical environment (Cabitza et al., 2017). The end-users design sustainability requires a participatory approach to enable designers and users to interact simultaneously resolving design issues and incoherencies (Cabitza et al., 2017).

Shaw et al., (2015) indicated software engineers continue to face challenges in the selection of an appropriate method and algorithm to resolve user interface design issues. Shaw et al., (2015) reported an investigative evaluation reveals small issues in user interface design, but minor errors lead to significant usability problems. An adoption of usability testing technique by developers paved the way to user-friendly system design for healthcare and other industries (Shaw et al., 2015).

According to Ceret et al., (2013), software designers need to modernize user interfaces that will adapt to changes in platforms and users' requirements in task objectives. A solution to preserving usability system is to generate a model-driven engineering (MDE) and flexible algorithm for user interface design Ceret et al., 2013). Ceret et al., (2013) stated user interface developers are expected to create a system adaptable to predefined events and situations in preserving usability feature of products (Ceret, et al., 2013).

Alegroth, Gustafsson, Ivarsson, and Feldt et al., (2017) claimed the consideration of technological aspects in software development is not enough. Innovative software development requires users' knowledge and experience to justify the impact of an automated testing tool (Alegroth et al., 2017). The cost of VGT (Visual GUI Testing) amount is more than 20% of

software development cost; the authors concluded from the study; testing can provide significant ROI (return on investment) for the business (Alegroth et al., 2017). Algeroth et al., (2017) recommended applying automated testing in software development as best practices and to standardized scripting and user interfaces of digital devices.

You, Kim, and Lim (2016) stated cultural diversity has a significant impact in the usefulness of information design. Every region in the world represents unique values in a design addressing users' needs in visualization and usefulness of data (You, Kim, & Lim, 2016). Computer Scientist designers have recognized the importance of integrating a design with cultural values (You, Kim, & Lim, 2016). However, a design addressing specific cultural value only will not accommodate users with diversified backgrounds (You, Kim, & Lim, 2016). The need for designers' strategy to maximize the integration of design with cultural-values and diversified elements in software development is a wide-open opportunity for future work (You, Kim, & Lim, 2016).

Conceptual Framework

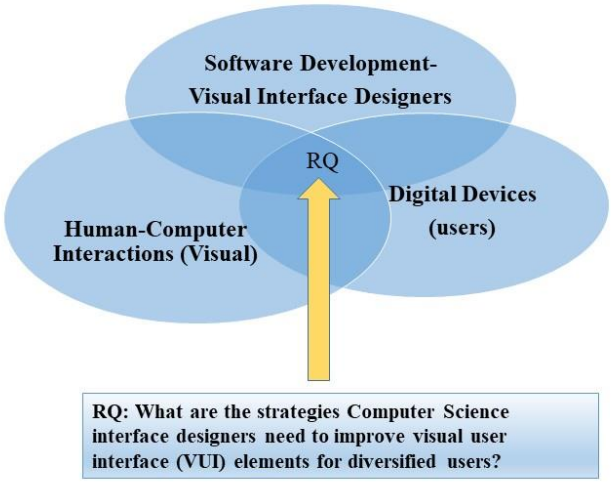

Figure I: Conceptual framework

The problem addressed in this qualitative study are the strategies computer science interface designers need to improve the visual user interface elements of digital devices in accommodating the needs of diversified users (Silvennoinen, & Jokinen, 2016). The focus of the study is to address problems on a single-user interface that does not perform efficiently with every user. Yargin and Crilly (2014) stated the need for a strategy with foundational and collaborative support to effectively deliver digital devices with user-centered design.

The inquiry has provided guidelines in helping user interface designers and manufacturers identify the specific process to develop visual user interface design in individualizing a device's user interface, because, a standard model has not performed efficiently

to all users. The prior work on the user interface designers needs to individualize a device's user interface has confirmed the lack of strategy to personalize a device 's user interface design (Davis et al., 2012; Raad et al., 2015).

Summary of Literature Review

The literature review has highlighted the qualitative study in exploring the strategies user interface designers need to individualize a device's user interface. The data analysis conducted in 2016 has presented the gap for future research to enhance visual user interface design elements by involving study participants with diversified backgrounds (Silvennoinen & Jokinen, 2016). The research question served as the reference point to study what strategy Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users. The literature review consisted of the discussion on scholarly-written articles about human-computer interactions, software designers, and the need for single-interface capable in multiple-devices' usability.

The next section has presented the knowledge substantiating the exploratory inquiry of the research topic. The next chapter is a validation of the exploratory investigations to address the problem in every device manufactured with a standard user interface delivered to consumers. However, computer scientists recognized that a single-user interface would not perform efficiently with every user. Computer scientists continue to help manufacturers the current standard user interface, because, the specific guidelines for user interface designers need a strategy to improve visual user interface (VUI) elements of digital devices has not been identified.

CHAPTER THREE

The problem addressed in the completed inquiry is the strategies Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users have not been established (Silvennoinen & Jokinen, 2016). The qualitative approach has presented study findings in exploring the strategies Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users (Silvennoinen & Jokinen, 2016). The previous section has presented the subject mastery through systematic analysis of various scholarly-written articles about user interface designs elements and users' needs. Chapter 2 discussed the research problem is what strategy Computer Science interface designers need to improve visual user interface element for diversified users. The literature review is evidence of the subject mastery through systematic analysis of more than 100 scholarly-written articles on how user interface designers can individualize a device's visual user interface (VUI) to accommodate users with diversified backgrounds and needs. (Silvennoinen & Jokinen, 2016). In Chapter 2, the discussion was the research problem to address current issues in every device delivered to consumers with a standard user interface not performing efficiently.

The conceptual framework and research methodology underlined the qualitative approach to the inquiry. This section discussed the methodological and logical fit for the qualitative research design used in the study. The researcher has considered the qualitative approach was appropriate for the study because of the exploratory nature and coherent phenomenology in gathering data in exploring the research problem (Edmonson & Mc Manus, 2007).

The conceptual framework highlighted the qualitative research methodology and approach to the inquiry on how user interface designers address the design issues in meeting the visual user interface of users with diversified needs. A qualitative approach was selected for the

study because of the exploratory nature and coherent phenomenology in gathering data to address the research problem (Edmonson & Mc Manus, 2007).

Research Tradition

Creswell (2016) defined methodology is an approach used in research to plan an inquiry from a broader view to a detailed procedure in data collection, analysis, and interpretation of a result. A qualitative methodology is used in research to collect and analyze the lived experience of individuals in the exploration of educational standards for pediatric intensive care (Hewitt-Taylor, 2011). The study used various interviews with students and educators, analysis reports, and diaries from students for data collection method (Hewitt-Taylor, 2011).

The qualitative method is suitable for the proposed study, because, the approach has allowed a sense of freedom to participants in answering or giving views, ideas, and opinions producing saturated and diversified data (Branthwaite & Peterson, 2011). The qualitative nature of the research problem is an exploratory study on what Computer Scientist and user interface designers need to improve visual user interface (VUI) elements for diversified users (Creswell, 20116).

Based on the selection of qualitative methodology, an exploratory design approach used for investigating participants' lived experiences and produced a qualitative data analysis by categorizing themes, coded data, and develop a trail of coded transcripts and documents (Hewitt-Taylor, 2011)

An exploratory qualitative approach was appropriate for the research, because, the objective of the study is to draw data from purposively selected participants by using open-ended questions in semi-structured interviews (Creswell, 2016). Three research designs were considered for options: a case study, ethnography, and grounded theory. A case study design was not be used, because, a case study is a design in which a researcher is bound with extended time

and events to collect detailed information from series of events and observations (Creswell, 2016). The ethnography was not considered an appropriate design for the exploratory inquiry, because, the qualitative approach is to study people's culture over a long period (Creswell, 2016). A qualitative grounded theory is not used in the completed study, because, the primary component of grounded theory is an abstraction through comparative analysis that may lead to several data collection methods and research sites for inquiry (Charmaz, 2006).

The nature of the research problem dictates the types of research methods best serve the methodology of the study (Creswell, 2016). The conceptual framework in the qualitative method is deemed to be suitable for the proposed research, because, the approach empowered a sense of freedom to participants in answering or giving views, ideas, lived experiences, and opinions producing diversified data (Branthwaite & Peterson, 2011).

The investigator did not consider a quantitative method, because, the primary objective of the inquiry is to draw various types of data by using open-ended interview questions. The study has used a qualitative approach to collect data from participants' lived experience and analyze data by using video and voice recorders, categorizing data by themes, categories, transcriptions, and presentation of study findings (Creswell, 2016). Data were obtained and recorded from the purposively selected participants from online recruitment sites such as Facebook, LinkedIn, and other professional organizations (Edmonson & Mc Manus 2007; Rubin & Rubin, 2015).

Research Questions

What are the strategies Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users? (Silvennoinen & Jokinen, 2016)

Research Design

The investigation of the inquiry has deliberated how user interface designers and computer scientists can improve a visual interface design to accommodate users' needs with

diversified backgrounds. The study has adopted an exploratory research design, because, qualitative study methodically fit with the objective of the inquiry to collect data from the lived experiences of the purposively selected participants for the research (Creswell, 2016). The research findings were sorted into themes, trends, habits, categories and encouraged future researchers to further the work that will give added value to the body of knowledge. (Edmonson & McManus, 2007)

Population and Sample

The population in a research study are groups of Computer Science interface designers and active users of digital devices (Leedy & Omrod, 2016). The purposively selected participants are IT professionals and digital device users from various geographical areas in the U.S. has only an estimated count of the population size (Leedy & Omrod, 2016). Interviews with participants continued until data saturation is available (Rubin & Rubin, 2015)

The population in research included professionals who have more than two years of experience and knowledge in user interface designs, computer user support specialist, software developers, trainers, programmers, and ordinary users with diversified backgrounds from various geographical areas in the U.S. only. The selected sites for recruitment were suitable because of an easy access to participants relevant to the research topic and saturated data was obtained from diversified groups (Rubin & Rubin, 2015).

According to the Bureau of Labor Statistics (BLS) report of May 2017; the regions with the highest employment level in the field of computer graphic designers for occupation are California with 30,180; New York, 21,530; Florida, 13,140; Texas, 12,120; and Illinois, 11,180 with annual salaries ranging between $46,950 and 64,820. The BLS reported in 2017; the highest employment levels of designers based on industries are Specialized Design Services 31,260;

Adverting and Public Relations, 27,390; and Publishers, 15,980 with the annual salaries from $42,930 to $60,090. According to the August 9, 2018 report, LinkedIn has 150 million members and Facebook has 146 million users in the United States (Hutchinson, 2018). The estimated size of a population of computer graphic designers is more than 66,000 plus 146 million users of Facebook.

The sample is a subset of the population selected for the research and recruitment was conducted through Facebook, LinkedIn, and social other networking sites. A pilot study with the first two participants was conducted to test the reliability of the standardized research instrument (Rubin & Rubin, 2015).

Sampling Procedure

The investigator has purposively selected study participants for the semi-structured interviews with the use of open-ended questions and identified strategy visual user interface designers need to individualize a device's user interface (Bealyer,2010). The researcher has carefully chosen a sample population of the study from numerous eligible participants who have more than two years experience in user interface design, computer science field of study, and frequent users with diversified backgrounds. (Rubin & Rubin, 2015). The selection criteria are the instruments in the screening process of eligible participants in the study (Creswell, 2016). The appropriateness of sampling procedure applied to research depended on real-life professional and personal experiences of participants in the field of information technology with a focus on a user interface design and software development (Bealyer, 2010).

The criteria used for the selection of participants are as follows: (a) participants must be 18 years or older, (b) participants who are user interface designers, software developers, and computer science professionals must have more than two years in the field, (c) users must have

used digital device(s) more than 2 years and active users, and (d) participants must be willing to be interviewed and follow the research standardized procedure and interview protocol.

Marshall, Cardon, Poddar, and Fontenot (2013) claimed saturation of data from a large sample population initially used in grounded theory, but substantial evidence for the effectiveness of the process is not in existence. Until today, a guideline on the ideal number of participants in the qualitative study is ambiguous (Marshall et al., 2013). The online social networking sites are the natural settings where numerous participants with diversified backgrounds were selected as a sample of the targeted population (Creswell, 2016). The instrument used for recruiting participants is by posting an invitation to Facebook, LinkedIn, other social media sites, and professional organizations open to the public. The sampling procedure used is a social media recruitment advertising campaign, because, an invitation for research has reached a broader range of targeted population than the traditional method; and the process was cost efficient (Kosinski, Matz, Gosling, Popov, & Stillwell, 2015, September).

Email messages, phone calls, and Facebook messenger are instruments used for the initial contacts with potential participants to request participation. When the participant agreed to participate in the study, the investigator has provided the informed consent form (see Appendix A) to each participant (Rubin & Rubin, 2015). Rubin and Rubin (2015) stated a consent form is to ensure participants understanding of nature and process in the study. An interview protocol (see Appendix B) served as a guideline for interview sessions. The investigator has conducted the interviews with the two pilot study participants in addition to 10 participants. The coded labeling technique for the captured data guaranteed the confidentiality of participants. The process has fortified participants' protection from harm includes the approval from Colorado Technical University review board (IRB). The collected data are stored securely in the

investigator's home with passwords and locking mechanism to ensure confidentiality and safety. (Rubin & Rubin, 2015).

After the participants' participation was confirmed, the investigator has explained the consent forms, research procedure, benefits of participation, possible risks in participation, contact information for any questions about the research, confidentiality of the records collected, and an assurance that participation is purely voluntary. Completed consent forms were collected and stored on a password-protected computer. Due to research recruitment method is through social media and public professional organization sites, permission to use site letter was not required. Any employment-related documents or materials are not in the best interest of the study.

Instrumentation

For qualitative research, the researcher is the primary instrument of the study for data collection, analyses, and interpretation (Creswell, 2016). The investigator has completed a data collection method through recorded interviews and the use of open-ended questions (Rubin & Rubin, 2015). Each interview session lasted approximately 30 to 45 minutes. An in-depth qualitative interviewing technique constituted the inquiry. The semi-structured interview with the use of the open-ended questions was deemed appropriate, because, the study was focused on one topic (Rubin & Rubin, 2015). The research instrument has encouraged participants to respond conversationally with more details. The hand written notes, typed field notes, and recordings have captured the words shared by participants during the interview process (Rubin & Rubin, 2015). The code name labels for each participant such as P-1, P-2, etc., ensured confidentiality. An interview protocol was explained before the interview process to ensure participant understand the procedure was standardized for all participants. An interview protocol (see Appendix B) served as an instrumentation procedure for the entire data collection method. The

data collection method included field notes, audio recordings, video recordings, and transcriptions remained confidential and stored in a secured place with locking mechanism. All documents and files from the study will be destroyed appropriately after three years from the completion date of the inquiry.

The first question has made the participant feel comfortable and asked to tell about their backgrounds and understanding of the study. The second question was a transition to the central research question and elicited information linking to the selection criteria described in the sample population section of the document. The next questions numbered 3, 4, 5, and 6 were framed towards the research problem on what computer scientists and user interface designers need to improve the visual user interface in accommodating users' needs with diversified backgrounds. The last question has provided the participant with an opportunity in reflecting on the responses from previous questions and shared final comments adding value to the inquiry.

The use of open-ended questions in a semi-structured interview was the appropriate approach to gather rich and contextual data for a qualitative inquiry (Rubin & Rubin, 2015). The seven open-ended questions for the inquiry are as follow:

1. What can you tell me about your background and how do you like being a part of information technology professionals? How did you get first involved in the computer science field?
2. Based on the functions and responsibilities you have performed in the job or your business, what strategy user's interface designers need to individualize a device's user interface? How did you implement the visual interface design strategy to accommodate diversified users such as younger children and elderly users?
3. Based on the method you have mentioned; how do you think this approach will provide an opportunity in the individualizing a device's visual user interface?

4. What kind of challenges that you may encounter in the development and implementation of the strategy to solve the issue in individualizing a device's visual user interface? How would you implement the method?

5. Can you give me some examples from your experience in visual user's interface on a personal and professional level, i.e., challenges, issues, etc.? Which user interface categories have you used more often to give better compatibility features in multiple devices?

6. Considering some problems that you have experienced from implementing the strategy user interface designers needs in the personalization of a device's visual user interface, can you identify or recommend a holistic approach or universal strategy to lead or guide manufacturers and computer scientist like you or you think might be an efficient solution to the problem?

7. Discuss any additional information and experiences that you may have to provide added value to the inquiry.

Validity

Creswell (2016) defined validity in qualitative inquiry is the accuracy of research findings by using standardized procedures throughout the study. Validity is vital in a qualitative research method, because, the strength and efficiency of a qualitative research depend on validity. (Creswell, 2016, p, 183). Validity was demonstrated in triangulation by repeated cross-referencing of the collected data to ensure the accuracy of the participants' words and experiences shared from the interviews. The investigator has asked each participant to review transcriptions for a final report and ensure the accuracy of transcriptions and interpretations of meanings (Creswell, 2016). The interview questions are open-ended and allowed freedom in sharing participants' views, lived experience, and concerns. The collected data was obtained

from video recorded interviews, transcripts; and notes provided clarity and validity of the study. (Rubin & Rubin, 2015)

Dependability is the thoroughness of an investigation with detailed examples relevant to the inquiry of the study (Creswell, 2016). Dependability of a qualitative study is an indication the study findings are analyzed accurately by using different methods (Creswell, 2016). The refining and restructuring of the questions served as an effective tool for clarity in answering the questions better (Rubin & Rubin, 2015). The credibility of the study begins with carefully selected participants by using criteria. Participants who are knowledgeable and experience directly related to the investigations became an ideal source of information for the inquiry. (Rubin & Rubin, 2015). Accuracy in recordings and transcriptions from a professional transcribing company enhanced the credibility of the study (Rubin & Rubin, 2015).

The transferability of the study is the applicability to other contexts, situations, events, and population (Lincoln & Guba, 1985). The research's investigation has addressed the transferability by filling the gap in the exploration of challenges in the current phenomenon in designing digital devices to address diversified users' needs. The data collected applies to consumers' daily lifestyle surrounding the use of Internet and digital devices (Lincoln & Guba, 1985).

Confirmability in qualitative research is to collect the real-life and lived experiences of participants instead of preferences and ideas (Shenton, 2004 January). To address confirmability; the participants were carefully and purposively selected, minimized bias by data triangulation, and maintained a research trail of evidence from the beginning to the completion of the study (Shenton, 2004).

Reliability

Reliability relates to the ability of a measuring instrument to examine the accuracy of the findings by using standardized procedures and protocols consistency throughout the study (Creswell, 2016). Reliability is the consistency of researchers in measuring the results of an instrument (Creswell, 2016). Triangulation improves the reliability of the collected data (Creswell, 2016). The reliability of collected data was obtained by asking open-ended questions allowing participants to freely shared lived experiences (Creswell, 2016).

Conducting member checking enhances the reliability and validity of the data collection process (Gall, Gall, & Borg, 2007). After reviewing the interview data, the interviewer asked the participants to verify the accuracy of transcriptions from the interviews (Gall, Gall, & Borg, 2007). Any discrepancies discovered were corrected, rewrote the report, and asked participants to review the report again for accuracy (Gall, Gall, & Borg, 2007).

Using triangulation has contributed to reliability, dependability, and validity of the study (Creswell, 2016). Through triangulation, the researcher has identified categories and themes by using multiple data sources (Gall, Gall, & Borg, 2007). Triangulation is a process of using multiple methods to ensure the data is in cohesion across the study and reconciling from one collection method with another data collection method and analysis (Gall, Gall, & Borg, 2007). The data collection involved both audio and video recordings.

The pilot study was executed as an instrument to test the effectivity of data collection, data analysis, and other procedures of the study (Gall, Gall, & Borg, 2007). A pilot study was conducted by interviewing two purposively selected and qualified participants. The interviewer has provided participants with the informed consent form, and the interview protocol was explained. The data collected from the interviews were sent and transcribed by a professional

transcriber. The investigator has presented to each participant for any discrepancies and corrections needed. Any corrections requested by participants on the transcripts, the reports were modified and presented to participants repeatedly until accuracy was obtained.

To improve the credibility of the inquiry; triangulation of the data sources was conducted by cross-referencing and reviewing, notes, recorded data, transcriptions, categories, and themes from the data collected for accuracy in the interpretation of data (Creswell, 2016).

The standardized interview protocol, instrument, procedures, and method are applied consistently from the beginning throughout the end of the study is an indication of reliability. Data collected was reviewed and analyzed several times for accuracy. The testimonies from participants and direct quotes became instrumental in presenting trustworthy findings. Detailed descriptions of the procedure for interviews and data collection method are compelling evidence in the report. Transcripts, field notes, and records are stored in the investigator's home with a locking mechanism to ensure data security, and single access to files is only the investigator. The entire study has applied a standardized approach to data collected by repeated reviews and analysis looking for any discrepancies and errors. The researcher has executed the cross-checking of data coding and analysis repeatedly. (Creswell, 2016).

Data Collection

The investigator has used the central research question in conducting a focused data collection method (Rubin & Rubin, 2015). The objective of the investigation has been established in exploring the strategy user interface designers need to individualize a device's visual user interface. The data collection method was the semi-structured and open-ended questions which provided a reliable data for the qualitative approach (Creswell, 2016).

The focus of the semi-structured interviews was on the lived experience of participants as user interface designers or users with diversified backgrounds. The interview questions were developed and included in the interview protocol. The header for the interview process stated and recorded the investigator's name, date and time of the interview; and the purpose of the qualitative inquiry (Creswell, 2016). The standardized procedure is applied throughout the data collection method. The seven interview questions were included in the interview protocol. A reasonable pause between each question has enabled participants to gather thoughts before responding. (Creswell, 2016, Rubin & Rubin, 2015)

The interviews started by using an ice-breaker question to build rapport with participants followed by remaining questions leading to answer the research question. The five interview questions included the main, probing, and follow-up questions. The probing questions were used to elicit more data on the subject such as examples, knowledge of essential concepts, ideas, and events. The last question aimed to encourage participants on the clarifications and precisions of the data shared from the interview. (Creswell, 2016)

The interview process included observation of thoroughness and encouraging participants to explore additional shared experiences significant to the research question. The investigator interviewed participants using video recording tool. In the event the participant is unable to do an audio-visual interview, the investigator will interview participants by emailing questions to a participant (Rubin & Rubin, 2015). However, all participants agreed with the investigator for video-recorded interviews.

The audio-visual recordings of the interviews are the assurance for first-hand evidence of the data collected. Recorded interviews were sent out to a professional transcriber for transcriptions. Journals, notes, and logs are used to record and track activities in the entire

duration of the research project. Data was reviewed by examining recorded interviews, emails, and other types of document obtained from the research process. A tracking record for the entire study included notifications about the data sources, events, names, audio-visual materials, and organized by categories. (Creswell, 2016, Rubin & Rubin, 2015)

Phone and emails are used in communication and establishing a schedule for the interviews. After initial contacts with participants, the investigator provided the informed consent to participants. The interview process followed the interview protocol as the standard guidelines. The researcher conducted a pilot study by interviewing two people who met the selection criteria of the study. The objective of the pilot study is to test the appropriateness of the questions and examine the practicality of the research (Majid, Othman, Mohamad, Lim, & Yusof, 2017). Majid et al., (2017) claimed a pilot study could build the reliability to interview protocol and data collection method. The audio-visual software tool was used for the semi-structured interviews by asking open-ended questions.

Each interview has applied the following procedure: (a) establish rapport with participant b) introduction of the research problem, focus, purpose, and limitations, (c) verify if informed consent form (Appendix A) was executed and received in file, d) used the interview protocol (Appendix B), (e) used probing technique to elicit more information, elaborate the question if needed, and reflection, and (f) thanking the participant for time and effort.

A digital audio-visual recorder has captured every word of participants during the interview. Raw data collected from the pilot study was sent out to a professional transcribing company. The interviewer asked the pilot study participants to review the transcription of the interviews to ensure accuracy. The result from the pilot study became an instrument in refining strategy for the research (Majid et al., 2017)

The investigator used MAXQDA software data analysis by sorting data into themes, meanings, and categories. The data were classified into themes, categories, coded segments from transcriptions, and meanings to interpret words captured from the interview. Following the completion of data analysis for the pilot study, the investigator made necessary adjustments to refine instrumentation for the research and resumed interviews with other participants until data saturation was obtained. The interview process used the same interview protocol (Appendix B), and the procedure applied in the pilot study with some adjustments to refine the research strategy.

The collected data was stored safely in a secured place with password and locking mechanism at the investigator's residence. All records will be disposed of appropriately after three years. The data collection includes notes, interview recordings and transcriptions, and other materials relevant to the study (Creswell, 2016).

Data Analysis

The qualitative methodology was selected instead of quantitative because the objective of the study is to categorize, identify themes, events, and description of the data from data sources. (Creswell, 2016; Rubin & Rubin, 2015). Qualitative data analysis approach is conceptual and involved coding data in segments representing participants responses (Creswell, 2016). A software application MAXQDA was an instrument used for data analysis and tool for data coding, categorizing data in themes and categories, and generating an analysis report (Creswell, 2016).

Data analysis begins by organizing and sorting data collected in themes, categories, and meanings of the words captured from interviews (Rubin & Rubin, 2015). The investigator has applied the exploratory data analysis with the following steps: (a) compiled the recorded interviews, notes, and other relevant documents, (b) ensured the participants' files are labeled

with code accurately for privacy, (c) sorted the data collected, (d) sent out recorded raw data to a professional transcription service, (e) after transcription of raw data, asked participants to review and reflect on the transcription for accuracy and approval from participants, (f) analyzed and coded the data in themes, categories, and descriptions, (g) identified data similarities, categories, themes, and synthesized for preliminary narratives (Creswell, 2016; Rubin & Rubin, 2015).

The coding rule is used to map out the textual units into data terms by grouping similar concepts from interview transcriptions. The hierarchical coding system was used by grouping the codes by ideas (Rubin & Rubin, 2015). An example was the use of a word "strategy" when coding concepts like method, tasks, duties, design, user interface, approach, solution, algorithm, and other similar thoughts or ideas. After the broader groupings of coded concepts, sorted and reviewed codes line-by-line. The next step, the codes were identified to the nearest meanings and themes that participants had shared in the interviews. Coded data were organized from broader categories into more focused themes relevant to the research question. A software application MAXQDA was an instrument used for data analysis and a tool for data coding and to generate an analysis report (Creswell, 2016). The researcher has developed multiple coding systems for a single item to allow high-quality data analysis, triangulation, and added credibility to the study. Continued data analysis and coding the data by segmentation of themes, categories, meanings, and descriptions. Generated code matrix for coded data, organized, reviewed, and wrote narratives for interpretation. (Creswell, 2016)

Ethical Considerations

The researcher has exercised the ethical standard for the entire process of a study indicated in the Belmont report principles which was focused on the human subject's protection of the research project. (Bromley, Mikesell, Jones, & Khodyakov, 2015). Bromley et al., stated ethical standards include informing the benefits of the study, respect to all participants, and

mitigating potential harms to the subjects of the study. The academic research standards required researchers to conduct inquiries ethically, with full honesty, respect, and care for the well-being of those who participated in the study by upholding the confidentiality and data security of the participants (Creswell, 2016; Rubin & Rubin, 2015).

Confidentiality was observed from the initial contact through the final phase of an inquiry by not disclosing the full names of participants and assigning code such as P-1 for the first participant and P-10 to the last participant. The initial communication with the participants included advisement about an option to withdraw from the study at any time. To minimized biases in the investigation that may influence the result of the inquiry, open-ended questions, and cross-referencing data are used for the semi-structured interviews with participants. Data collected from the interviews were recorded using a digital recorder and triangulated for detailed analysis and reports by multiple-codes (Creswell, 2016; Rubin & Rubin, 2015).

All participants are required to complete and sign the inform consent form (Appendix A) for the study. Prior to the signing of inform consent forms (Appendix A), the investigator has discussed with all participants the following items: (a) study procedure, (b) purpose and objective of the study, (c) benefits of the inquiry, (d) compensation, (e) confidentiality, (f) interview protocol (Appendix B), and (g) data collection methods such as video and audio recordings, and notes taking (Creswell, 2016). The participants' personal information and records are placed in a secured place with locking mechanism. The digital version of data collected is stored in a password-protected computer at home to ensure data security. The researcher is the only person who can access participants' information and will be in a secured place for three years.

Summary of Chapter Three

The previous section has defined the research design. A qualitative exploratory inquiry was adopted, because, the primary objective of the study to collect data by using open-ended questions in the interviews. A recruitment strategy was established by using Facebook and LinkedIn. A set of criteria served as the guideline for the purposive selection of participants from various geographical location in the U.S.

Data were collected from numerous participants from semi-structured interviews using open-ended questions. The researcher has interviewed two participants for the pilot study, and the data analysis was performed before interviewing the remaining 10 participants until data saturation has been obtained. Interviews were conducted by audio and video recording equipment and applications.

The researcher has applied a qualitative data analysis approach by coding data in segments that will denote themes, categories, meanings, and descriptions nearest to the captured words from participants (Creswell, 2016; Rubin & Rubin, 2015)

The validity and reliability of the study is the product of a systematic data collection, analysis, interview protocol, procedures, an approved IRB, consent form, and observance of ethical standards.

The next chapter is the presentation of demographical data of participants. Individual participant represented different backgrounds, themes, and findings from the data collected. Further discussion on what strategy user interface designers need to individualize a device's user interface is on the next chapter.

CHAPTER FOUR

This section is a discussion on the demographics of the purposively selected participants based on selection criteria for the study. The presentation of the data collected from the semi-structured interviews is on Table 2. Narratives and tables were used to display the participants' demographics and study findings for visual representation. The study findings are the highlights for what strategy Computer Scientists need to improve visual user interface (VUI) elements for diversified users.

The purpose of the study is to explore strategies of Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users. Table 1 in the next chapter displayed the demography of participants purposively selected for the semi-structured interview. Narratives for corresponding tables is a demonstration of the study findings on what strategies Computer Scientist needs to improve visual user interface (VUI) elements for diversified users. The discussion in this chapter is the summary of the data collected and analyzed for the qualitative approach implemented in the study.

Participant Demographics

In reference to the selection criteria for participants, the sites used for recruitment of participants are Facebook and LinkedIn. The purposively selected participants have two years or more experience in computer science or user interface designing or active users of digital devices. Participants who are users must be an active user of digital devices for at least more than two years. All participants are18 years or older and agreed to follow a protocol of the study. The study findings presented a discussion of the strategy Computer Scientist need to improve visual user interface (VUI) elements for diversified users.

Table 1 displays the demographics of participants for the inquiry. Each participant was labeled P-1 through P-10. The labels were used to ensure the privacy of participants. At any given time, the participants' true identities were not collected, recorded, and disclosed. Study participants have consisted of IT designers or developers, participants have experience in the IT field for more than two years, active users of the digital device, and online activities, and represent diversified occupational and field of expertise.

Participants	Occupation or Field of Expertise	Years of Experience	Age Groups (20-29, 30-40, 41-50, 51-59, 60+)	Bilingual Yes or No	Gender
P-1	Professor, Psychologist	20	60+	No	M
P-2	Professor- Engineer	30	60+	Yes	M
P-3	HR Director, Professional Trainer	20+	60+	No	M
P-4	Professor, Computer Science	20+	41-49	Yes	M
P-5	Sales Director, College Instructor	14	60+	No	F
P-6	Business Owner	50	60+	No	M
P-7	Curriculum & Training Designer	12	41-49	No	M
P-8	Computer Graphic Designer	7	20-29	No	M
P-9	Business Coach, Public Speaking Coach	20	60+	No	M
P-10	Branding Specialist, Business Coach, Professor	4	30-40	No	M

Table 1: Demographics of Participants

Participants were purposively selected and consist of different age groups. More than 50% of the participants are 60 plus years old, two participants are between ages 41 and 49, one is

between the ages of 30-40, and one is between 20-29 years old. Majority of research participants have more than 20 years of experience in the occupational field. Two participants speak foreign languages such as African, French, German, Norwegian, and Danish. All participants have significant experience as users and designers in the computer science field. The researcher has reached out widely in recruiting participants, but only two females volunteered for the study. Fifty percent of the participants have years of teaching experience in the academic institution. One of the participants is a computer graphic designer. The remaining four participants have diversified personal and professional experience. In addition to occupational fields related to computer science, all participants represented the users' population. In addition to participants' area of expertise, the study participants have been users as the starting point of understanding visual user interface in using digital devices positively or negatively. The use of semi-structured interview questions and protocol allowed the participants to express diversified real-life experience and thoughts about the qualitative inquiry on the strategy user interface designers need for the individualization of visual user interface (VUI).

Presentation of the Data

The literature review led to a gap analysis on what computer scientists and user interface designers need to strategize individualization of VUI to accommodate diversified users. The data collection method used in the study was the semi-structured interviews with the purposively selected participants. LinkedIn and Facebook were the sites used to recruit participants.

The data collection process was conducted after consent forms were executed by participants. Any document related to the study and communication record are stored in a password-protected computer with a sole access of the investigator only. To ensure privacy, participants were assigned with labels such as P-1, P-2, etc. An interview protocol (see Appendix

C) was explained to participants and exercised throughout the inquiry. Some follow-on questions were used during the interview process. Notes were taken during preliminary conversation and interviews. Each interview began to establish rapport with the participant and explanation of the purpose and constraint of the study. Probing and follow-on questions were applied in the interviews as needed. The procedure applied in the data collection technique is to obtain raw data from responses of participants and the recorded interviews were sent to professional transcribing company. Transcriptions were sent to specific participants for validation and modifications—if needed.

The inquiry is about the real-life challenges and difficulties experienced by participants in the visual user interface (VUI) of digital devices such as Ipad, mobile phone, laptop, and desktop. Based on the responses of participants, recommendations on how to improve user interface are identified and categorized in assigning codes for the collected data. The objective of the study is to determine user interface designers' strategy in individualizing the visual user interface (VUI) of digital devices in accommodating diversified users' needs. The participants were allocated up to 30-45 minutes of interview sessions. All participants are expected to share true feelings and experiences in answering the previously prepared questions included in the approved interview protocol. Some of the primary themes presented from the data collection are users' experiences in the user interface default settings, implemented design, visual elements, challenges, and recommended improvements in strategy.

The open-ended and follow-on questions were used for the recorded interviews and transcribed by a professional transcribing company. In this section, the analysis of data collected from recorded video interviews. The pilot study was conducted by interviewing two participants.

The entire process of the pilot study followed the interview protocol. Then, the researcher imported the professionally-transcribed data from the pilot study into MAXQDA, software for data analysis. The preliminary open coding technique was established to create themes and categories for inductive data analysis. Comparison of data was conducted to ensure consistency in the coding of categories reflects the research question of qualitative inquiry. The result from the pilot study was analyzed, reviewed, and compared to understand if improvements are needed before resuming to the next set of data collection by simulation of the process from a completed pilot study.

Following the pilot study, the other set of interviews was conducted with 10 participants. The researcher simulated the process used from the pilot study with some improvements to ensure the effectiveness of standardized study procedure. The investigator has collected and stored safely the consent forms from all participants. The data collection technique used is a semi-structured interview. Transcriptions were sent to specific participants to validate the data collected. The recorded audio-visual interviews were sent to a professional transcriber. The professionally completed transcriptions were imported into the data analysis software MAXQDA. Codes were established into the new project in MAXQDA for data analysis. The MAXQDA facilitated the data analysis through the groupings of codes, categories, and frequencies of words under each coded category. Transcripts were imported to MAXQDA for data analysis. An improved coding schema was established for category and themes of the study findings. Qualitative query analysis was conducted several times to ensure data saturation was accomplished.

Participants	**Coded Categories**					
	Settings	Changes	Improve	Challenges	Strategy	Total Code Frequencies
P-1 *	0	0	0	0	0	0
P-2	6	6	4	6	5	27
P-3	4	4	5	4	5	22
P-4	5	5	5	5	5	25
P-5	4	4	4	4	4	20
P-6	9	8	7	9	9	42
P-7	8	8	7	8	8	39
P-8	10	10	8	10	10	48
P-9	14	14	14	14	14	70
P-10	9	9	9	9	9	45
Total	69	68	63	69	69	338

Table 2. Frequencies of Coded Data for User Interface Elements for Strategy

*The interview failed to record for unknown causes.

Table 2 is the summary representation of data collected and analyzed. From the qualitative data analysis executed, data were sorted according to similarities, themes, categories, and descriptions. The coding rule has mapped out the concepts in the hierarchical coding system. Table 2 is a demonstration of five groups to discover what strategy will improve the visual user interface to accommodate diversified users. The groupings of concepts and ideas by codes and findings were reviewed and triangulated to ensure the accuracy of the reports for analysis.

Following the pilot study, the investigator resumed the data collection method to 10 participants by semi-structured interviews and used open-ended and follow-on questions (see

Appendix B & C). The researcher has presented the transcribed materials to participants for approval and reliability of the result.

Data analysis was conducted to sort data according to themes, categories, coding data, and interpretation of words captured from the interview. Segments were selected from individual transcriptions to assign codes. The investigator has reviewed the recorded interviews and read the transcriptions as a preliminary analysis for the qualitative inquiry. Once the participants approved the transcribed document, the data collection and analysis continued until data saturation has been obtained from numerous interviews and analysis. The information shared by participants was evaluated for the emergence of themes, meanings, and categories for the data coding system in MAZQDA. The objective is to establish the data intersection and parallels of words patterns, ideas, and categories to answer the research problem.

The coded segments were analyzed memos and notes were added for possible significance to the study. Revisiting and reviewing the coding schema for the study refined the and coding system and data analysis. Queries were conducted to extract data from coded segments of the data collected. Data queries were imported to Excel files, reviewed, and analyzed frequencies, themes, and categories. The results of the analysis presented the most frequent categories in the study of user interface individualization technique such as default, settings, changes, improve, challenges, and strategy.

Presentation and Discussion of Findings

The findings from the responses of 10 participants presented the significant data intersections between user interface of digital devices such as settings from the factory, changes in design, improvements needed, challenges in the user interface, and what strategy computer

designers need to improve VUI of digital devices. The MAXQDA code matrix is in Table 2 indicated the data intersection among coded categories and themes.

The first interview question is about the background of participants and to build rapport with participants. Table 1 displayed the demography of each participant. The second question is based on the participant's professional responsibilities, what strategy user's interface designers need to individualize a device's user interface design? The third question is what approach will provide an opportunity in the individualizing a device's user interface. On the fourth question, the question is about the kind of challenges encountered in the development and implementation of the strategy identified from the previous answer and how could the strategy be implemented? The fifth question is about examples from participant's experience in using user interface on a personal or professional level and what visual user interface categories are familiar with the participants and compatibility of multiple devices. The sixth question is about challenges encountered from the implementation of the strategy to individualized device's user interface and what universal approach will guide manufacturers and computer scientists? The last part of the interview session has allowed participants to share additional information and experience that may provide added value to the exploratory inquiry. According to participant (P-4),

> "…You got to design it right out of the gate and then can continue to work with people who can help you test different modules and be able to then say, hey, this is going to gain market acceptability. So the lack of user, uh, participation right from the beginning and also the lack of poor programming or, or development, uh, creates a final product that lacks."

The users' involvement in the designing and manufacturing digital device will prevent poor digital devices and software designs. User interface involves how software design interacts

with the hardware to accomplish the user's objectives in using the device. Users' challenges in using digital device vary but the root cause is coming from the initial design phase of the product. The VUI elements should be well-crafted and compliment with each other. For example, the dark background of the screen should compliment with the fonts and icons. Computer scientist and VUI designers need an improved approach to the richness and acceptability features of VUI when loading applications. Applications compatibility and loading requirements are critical components in designing the user interface of digital devices.

Table 2 has displayed the result of MAXQDA code matrix analysis conducted on the five categories from responses of participants based of real-life professional and personal experiences in using different elements of user interface. The personalized configuration of VUI settings requires an understanding of changes and improvements in the configuration of default settings in the digital devices. Recently, changes in technological devices like the release of 5G in smartphones maybe easier to some consumers but not to accommodate diversified and individualized needs. The expectation of participant, P-6 quoted the simplicity in design is the best approach.

> "…or simple, simple, simple, simple. And it's not because, um, people like myself, I'm a, I'm an intelligent person, but I like simplicity. I would like to say that to the designers, into our politicians and everybody make this tax code symbol. I'm sick of it. I'm tired of the complexity. Right. And emphasize simplicity to me is always the *best method*. And this is not to say that, um, that's always been the case."

The top three categories demonstrated redundancy in meanings and themes presented an equal frequency of 69 from code matrix analysis. The data collected from the interviews with 10 participants showed in the code matrix queried the data intersections of coded segments assigned

to settings, challenges, and strategy. The coded segments under the categories changes and challenges demonstrated the responses from participants are regarding the changes and challenges in using digital devices due to poor user interface designs.

The frequencies under the categories of settings, changes, challenges, and strategy resulted to 81% of the total frequency of 388 from the MAXQDA matrix analysis resulted to values of 20% for each category. The similarities in values of 20% for each category means the four categories demonstrated the same impact to the visual user interface design approach.

Based on the evaluation of analysis, the patterns of themes, words, and ideas from responses of participants demonstrated the commonality in the needed strategy in designing visual user interface (VUI) for diversified users. One participant's data did not record due to unknown reason, there was no significant effect in the study findings. The similar patterns and ideas from participants' responses are in the categories displayed in Table 2. In some cases, few participants showed some insecurities on the level of expertise and knowledge about the subject of inquiry. However, the sharing of real-life experiences and more profound thoughts affected the question positively. The analysis presented a standard recommendation for individualizing visual user interface – P-8 quoted:

> "… Is um, simplicity. You know, you want something to be very easy to understand, very easy to use. So what a lot of designers do, terms of user interface is create icons that are universal and that helps, that helps avoid language barriers. Um, you know, it's a very simple to understand, you know, you see the icon of a have a telephone and he know that have means call. Um, you see like a triangle and it means play and things like that. Just kind of functionality always comes first and trying to deliver that at the simplest way. Yeah, even just using iconology and different imagery, you, you avoid language

altogether. I think that helps someone like, like my mother who would be bilingual or even people who might have a language barrier. Specialized to the need. But, um, I don't necessarily think it has to be completely, um, redone. Does that make sense?"

Another participant (P-9) quoted:

"So, um, for simplicity sake, we on one platform, if you were to say, make it a level playing field and make it specific to the user…. So there's a crowd a difference of like, okay, so if you look at them statistically throughout the years, I think making it universal to say everyone's going to use this, everyone's being is that, I think that's just the education system and they see how that has helped our, our folks who are like, Oh, what happened? They don't have the same system,"

Simplicity is the keyword for accommodating diversified users' need. Majority of participants are in unison to one of the best strategies in designing visual user interface is simplicity. The universal approach is to deliver user interface design with high functionality and individualized for user's needs requirements such as users with language barriers and visually impaired. Unique users warrant exclusive functionality and interface for easy navigation. Based on P-9 quotation on a crowd difference, users of today are different from users of yesterday or 10-20 years ago. The challenges in using digital devices continue to change through the generations which will drive computer scientists and software designers to change strategy and methodology in visual user interfaces (VUI) elements such as icons, images, compatibilities, drop-down menus, space arrangement, and features to accommodate and personalized design. According to P-4 quote, the holistic approach in user interface design is a simple strategy.

> "… So I don't know how that holistically or let's see how to explain it. I don't know how those interfaces work and if that's a concern for most people. Is there some way to simplify that? Yeah, to simplify the strategy."

Majority of participants are in agreement with default settings of digital devices can improve by applying simple design and high functionality features. The study findings are leading to assessment methods and techniques required for the holistic approach in designing the user interface. Users' involvement through feedback, study, and surveys will provide valuable information and deeper understanding in users' preferences, functional and simple features, and important decision in manufacturing digital products with an improved visual user interface and produce user-centered devices and technology. According to a direct quote of the participant (P-7), to develop a user-centered interface in the design will require a reverse-engineering strategy by starting from the end users' needs.

> "And then also the big thing is what task are they doing, what software are they going to be using on this user interface? And, and then the design of the hardware sort of comes into a self. It's almost like reverse engineering from, uh, from the end user and the tasks to be done."

The study findings analysis revealed variation in words, patterns, meanings, ideas, and categories. The cohesion is apparent to computer scientists and user interface designers by moving towards simplicity and end-users' need requirements for the overall designs of digital devices. The familiarity, real-life experience, and true feelings of participants about visual user interface (VUI) designs were revealed from responses recorded and data analysis. The common insights are in the simplification and endusers' deeper involvement for strategy in visual user interface (VUI) designs. Overall, the study responses from participants revealed the need for

individualization of VUI through strategic planning in the configuration of digital devices' default settings, changes in the mindset, improvements in VUI approach, and the focus for overcoming challenges in users' experience. Participants noted the innovative approach in the VUI development strategy includes users' preference, needs, technological capability, interactive tutorials, flexibility in default settings, users' controls, and accommodation of diversified user groups. An increased in users' engagement before designing VUI enables to produce enhanced products with simplicity, high functionality, and personalized to the users.

Majority of participants appeared to be the focus on the usability and individualization of the digital products with easy to navigate visual user interface. The research covered the recommended strategy in the determination of users' needs, navigational challenges in the user interface, and a universal approach to guide computer scientists and interface designers in the individualization of digital device. The strategy is to focus on creating user-centered interface designs with high-performance usability features.

The flexibility in the configuration of digital devices will allow users to perform changes in settings and provide an opportunity to a personalized visual user interface. The strategy computer scientists need to engage users in the initial planning stage of the development cycle and incorporate users' needs in manufacturing digital devices. Giving more value on users' feedback provide critical data for the holistic approach in the user interface design.

Summary of Chapter 4

The previous section has presented the study findings about Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users. The findings from data analysis performed for the study presented the real-life experience in using visual user interface at a professional or personal level. In reference to participants' direct quotations presented in the previous chapter, the commonality in improving computer scientists

and VUI designers are the simplicity and individualization of the digital device's user interface. The respondents in the study appeared to share common insights on how VUI designers produce products with flexibility in configuration based upon users' preferences and needs to accommodate diversified users.

The next section will provide an overview of the research problem for the study and a brief discussion on the objective of the study. A brief discussion on the appropriate research methodology used in the study is in the next chapter. The narrative in the next section includes the findings, limitations, ethical standards applied, and conclusion for the study.

CHAPTER FIVE

This chapter is a discussion of findings from the study and conclusion. The interpretation of themes, meanings, and categories extracted from MAXQDA data analysis is discussed on this section. This section is organized by giving the synopsis of the findings discussed from the previous chapter. The investigator has interviewed 10 participants and 2 participants for the pilot study. Pilot study has provided collected data for analysis and review of study procedures and protocols for improvements. The implications of the study and recommendation for the practical application of the study are presented in this section.

Findings and Conclusions

The data collection method used for the study is conducting semi-structured interviews by using interview protocol, notes, recorded interviews, professionally transcribed materials, and MAXQDA data analysis software. The responses from participants were recorded, sent to the professional transcribing company, reviewed with investigator's inserted comments, assigned codes to segments, and executed data analysis matrix and queries. Based on data analysis and code schema, the findings resulted to four major categories where the intersections of insights and real-life experiences are demonstrated in Table 2. The categories summarized the frequencies of ideas, word patterns, themes, and meanings under each category. The major categories consist of settings, changes, improve, challenge, and strategy.

The responses from participants were recorded, sent to the professional transcribing company, reviewed with investigator's inserted comments, assigned codes to segments, and executed data analysis matrix and queries.

Settings: Most participants agreed the default settings in most digital devices provide restrictions in individualizing visual user interface and requires a better approach to improve the user interface element. More than 50% of the participants noted the need for improvement in the

default settings of the user interface in digital devices. Participants shared similar insights to allow users without significant technical knowledge change settings to personalize the device in accordance with the users' need requirements.

Changes: Participants noted the change in mindset on the part of user interface designers and computer scientists required an innovative and holistic approach in the development strategy. A change in the strategy of designers' thinking process includes a technique to develop flexible default settings configurations, easy to understand user interface control mechanisms, and tools to accommodate individualization of digital devices.

Improve: The responses from participants shared the same comments on the current user interface designs in the market today need the significant improvements to meet users' preferences which require computer scientists and VUI designers implement the innovative strategy. The insight was in agreement with the study of 2015 (Bittencourt et al.). In addition, Miñón et al. (2016) claimed the lack of users' knowledge of the VUI development strategy.

Challenge: Based on the answers to questions #5 and 6 for the interview, most users were challenged in the VUI design that does not accommodate users' needs and individualization of the device. Majority of participants agreed with the need for the usability and high-performance digital products. The recommendation from participants is to challenge VUI designers to develop user-centered digital devices. The complexities of the product design are some of the common challenges presented by participants. Based on the data collected from the inquiry, the findings in the study may fill the gap of human interaction in producing an intelligent design for devices as noted in the study of Krisci and Thoben (2018).

Strategy: The data analysis performed for the responses of participants validated and confirmed the data from the systematic literature review on the lack of strategy in the

individualizing VUI designs to accommodate diversified users (Davis et al., 2012; Raad et al., 2015). About the study of Silvennoinen and Jokinen (2016), the findings of this inquiry is to address the strategies Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users. The responses from participants and the result of data analysis validated the significance of an innovative approach to design digital devices with the individualized VUI elements. From the direct quotations of participants, study findings will provide guidelines to scientists, VUI designers, and other practitioners on how to improve strategy in the development of a design. The four categories presented in Table 2 have identified the essential elements in improving visual user interface by applying a universal and innovative approach in the strategy of individualizing VUI design process. Some limitations of the study such as the smaller number of participants may affect the practical applications of the study findings and recommendations.

Limitations of the Study

The study has some limitations. One limitation is the lack of younger participants. Majority of participants are older generation. The objective of the study is to collect the best and most diversified data by following the interview protocol and standardized procedure for the research. There were 10 participants in the study, the investigator's study findings demonstrated shared standpoints in the information shared from the interviews. Ten people were purposively selected as participants, because, the investigator aimed to conduct a manageable qualitative inquiry with few participants. The validity of the study was confirmed with the articles cited and the data collected from responses of participants. Validity of the study may improve for a larger number of participants.

Implications for Practice

The finding of the study is to address the research question on what strategies Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users? The findings from the responses shared by participants provided the real-life experiences on the challenges and difficulties of users in the visual user interface (VUI) designs. Participants have noted the common insights regarding the lack of effective strategy in the individualization of VUI in digital devices.

In reference to study findings, a deeper users' engagement in the initial phase of VUI design development will produce user-centered digital devices. Participants have shared common insights on the best strategy to improve VUI is the simplicity and usability of the design in accommodating diversified users and personalizing digital devices in accordance with users' requirement needs. The study findings are relevant to fill the gaps of other researchers' inquiries of strategy in producing an intelligent visual user interface and digital devices designs.

Implications of Study and Recommendations for Future Research

The practical implication of the study is the hope for computer scientists, user interface designers, and other practitioners to adopt an innovative strategy based on the data presented from responses of participants. The strategy may involve deeper users' engagement from the initial design phase in the development of user interface and products designs. The study also implicated users' feedback is a piece of valuable information for designers in the individualization of VUI of digital devices. A more significant number of participants from other parts of the world who are bilingual users and VUI designers will supplement the findings of this study.

Reflections

The completion of doctoral dissertation research has been a very challenging journey. I see myself as a learner and contributor in the academic environment. The realization of the differences between scholarly and daily writing skills became the most challenging but inspiring experience. Subsequently, I have learned to appreciate the discouraging comments from my professors and had made me a better writer and researcher. People asked why I am pursuing a doctoral program at a later age of my life. My answer, "I just want to be better than what I used to be." Thank you to all CTU staff, family, and friends who had encouraged me when I was discouraged and out of luck—sometimes.

Conclusion

The study findings addressed the research question of the inquiry. The quoted materials from responses of participants validated the difficulties and challenges in using visual user interface (VUI) of the current digital devices which was stated in the study completed in 2016 by Mihajlov, Law, and Springett. The result of data analysis had presented the categories of the essential elements for what strategy computer scientists, VUI designers, and other practitioners need to individualized digital devices' user interface in accommodating diversified users. The literature review of the inquiry completed by Silvennoinen and Jokinen (2016) confirmed the lack of strategy in VUI design to accommodate diversified users and develop user-centered digital devices. The qualitative inquiry of the investigator has confirmed the claim of Silvennoinen and Jokinen (2016) software designers have failed to identify the users' needs and preferences in the current digital devices and user interface designs. The findings of the study reflected the shared insights from 10 participants on the challenges in VUI settings and configurations restricting users for easy navigation and personalizing the interface based on users' preferences and needs. In conclusion, the study validated the lack of effective strategy in

the development of visual interface design to the individualization of digital devices in accommodating diversified users' needs. The study findings demonstrated alignment with the gap of knowledge discovered from the systematic literature review. The goal of the study is to guide computer science practitioners from the insights shared by participants on how to individualize visual user interface and digital products designs.

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APPENDIX A

Informed Consent

Title of Study: EXPLORING VISUAL USER INTERFACE FOR DIVERSIFIED USERS

Investigator: Zaida Fabile O'Connor

Contact Number: [redacted]

Purpose of the Study

You are invited to participate in a research study. The purpose of the proposed qualitative exploratory study is to identify how user interface designers approach the individualization of the visual user interface of digital devices to accommodate the needs of diversified users (Silvennoinen & Jokinen, 2016).

Participants

You have been asked to particpated in the research project, because, you have met following criteria: a) participants must be 18 years or older, b) participants who are user interface designers, software developers, and computer science professionals must have more than two years in the field, c) users must have used digital device(s) more than two years and active users, and d) participants must be willing to be interviewed and follow the research standardized procedure and interview protocol.

Procedures

If you volunteer to participate in this study, you will be asked to do the following: Complete and sign the Inform Consent Form, record the interview without disclosing your true identity, explain and share your experience without prejudice, show an examples of your challenges in operating your device, and recommend how visual user interface can accommodate users' need with diversified backgrounds. Interview will be conducted by using Facetime, Skype, or phone.

Benefits of Participation

There may/may not be direct benefits to you as a participant in this study. However, we hope to learn and provide insights and and identify your challenges in the visual user interface to accommodate users' need with diversified backgrounds.

Risks of Participation

There are risks involved in all research studies. This study is estimated to involve minimal risk. An example of this risk is feeling uncomfortable in sharing your experience when some probing questions are directed to you as the approach of an in-depth inquiry.

Cost/Compensation

This will be no financial cost to you to participate in this study. The study will take an approcimately 30- 45 minutes You will not be compensated for your time. *Colorado Technical University will not provide compensation or free medical care for an unanticipated injury sustained as a result of participating in this research study.*

Contact Information

If you have any questions or concerns about the study, you may contact Zaida Fabile O'Connor, [redacted] For questions regard the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted, you may contact Colorado Technical University – Doctoral Programs at [redacted]

Voluntary Participation

Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice.. You are encouraged to ask questions about this study at the beginning or at any time during the research study.

Confidentiality

The datalcollected from interview will be securely stored in a filing cabinet with locking mechanism and the investigator has the only person with access to the records. Records will be destroyed properly after three years from the date this Inform Consent was signed.

Participant Consent

I have read the above information and agree to participate in this study. I am at least 18 years of age. A copy of this form has been given to me.

_____ _____

Signature of Participant Date

_____ Participant Name (Please Print)

APPENDIX B

Interview Questions

1. What can you tell me about your background and how do you like being a part of information technology professionals? How did you get first involved in computer science field?

2. Based on the functions and responsibilities you have performed in the job or your business, what strategy user's interface designers needs to individualize a device's user interface?

3. Based on strategy you have mentioned; how do you think this approach will provide an opportunity in the individualizing a device's user interface?

4. What kind of challenges that you may encounter in the development and implementation of the strategy that you have identified from your previous responses, and how would you implement the strategy?

5. Can you give me some examples from your experience with user's interface on a personal and professional level, i.e. challenges, issues, etc.? Which user interface categories have been commonly used with compatibility in multiple devices?

6. Considering some challenges that you have experienced from implementing the strategy user interface designers needs in personalization of a device's user interface, can you identify a holistic approach or universal strategy to lead or guide manufacturers and computer scientist like you or you think might be an efficient solution to the problem?

7. Discuss any additional information and experiences that you may have to provide added value to the inquiry.

APPENDIX C

Interview Protocol

1. The purpose of the proposed qualitative study is to explore the strategies Computer Science interface designers need to improve visual user interface (VUI) elements for diversified users.
2. To ensure participant's confidentiality, individual's file will be assigned with code name according with participant's selection of code name such as Mr. or Mrs. M.
3. Since the interview is via phone, Skype, or Facetime; interviewer will ask participant if she or he has 30 to 45 minutes availability without interruptions.
4. Keep log of the interview, take notes, label all materials with the code name of participants, and prepare documents for professional transcription.
5. Encourage participants to open about their experiences.
6. Monitor participant's body language if the interview is on a video. If the interview is through the phone, ask participant if she or he needs a break.
7. Record participant's responses and annotate non-verbal responses if possible.
8. Use audio or visual recordings to capture every words of participants.
9. Ask interview questions and follow-up questions for clarifications (see Appendix B)

Interview and Follow-on Questions

1. What can you tell me about your background and how do you like being a part of information technology professionals? How did you get first involved in computer science field? If you are an active digital active user, could you please tell me what type of activities you have done and currently using your digital device?

   Follow-on question 1: Tell me more about your experiences in user interface.

Follow-on question 2: What did you enjoy the most and why?

2. Based on the functions and responsibilities you have performed in the job or your business, what strategy user's interface designers needs to individualize a device's user interface? As an active user of computer device, can you give an examples of user interface that you like the most or least and why?

   Follow-on question 1: Can you give me a specific example of a design you have developed and what improvement have you done?

   Follow-on question 2: Which of visual interface elements are essentials for you as user or designers and how can you improve them?

3. Based on strategy you have mentioned; how do you think this approach will provide an opportunity in the individualizing a device's user interface? As an active user, what kind of strategy do think Computer Science designers will help a user like you?

   Follow-on question 1: What approach will you apply in individualizing a device's user interface? What VUI (visual interface elements) is critical in designing digital device.

   Follow-on question 2: Why do you think this element or these element(s) need(s) improvements?

4. What kind of challenges that you may encounter in the development and implementation of the strategy that you have identified from your previous responses, and how would you implement the strategy? Based on your experience as an active user, how did you overcome some of the issues on a visual interface while using your device? Examples are the presentation of the main menu and icons in your computer device.

   Follow-on question 1: Have you had any success in improving visual user interface design and how did you handle the approach.

Follow-on question 2: Can you tell me more about the success and how your supervisor reacted to that?

5. Can you give me some examples from your experience with user's interface on a personal and professional level, i.e. challenges, issues, etc.?

   Follow-on question 1: In your experience, which user interface categories have been commonly used with compatibility in multiple devices?

   Follow-on question 2: If you are using multiple devices, how do you differentiate the interface between devices that you have used or designed?

6. Considering some challenges that you have experienced from implementing the strategy user interface designers needs in personalization of a device's user interface, can you identify a holistic approach or universal strategy to lead or guide manufacturers and computer scientist like you or you think might be an efficient solution to the problem?

   Follow-question 1: As an active user, what kind of suggestions will you give a computer designer in developing the elements for visual user interface that will improve the usability of a device.

   Follow-up question 2: If you will apply a universal or holistic approach in designing a digital device, what approach will you apply?

7. Discuss any additional information and experiences that you may have to provide added value to the inquiry.

   Follow-on question 1: If there is something not very clear to you about the interview or study, could you please elaborate that to me?

   Follow-on question 2: Once I have the transcription of this interview is completed, could I have your permission to contact you again to make sure the transcription is accurate?