BRAIN. Broad Research in Artificial Intelligence and Neuroscience
ISSN: 2068-0473 | e-ISSN: 2067-3957
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2021, Volume 12, Issue 1, pages: 229-250 | https://doi.org/10.18662/brain/12.1/180

A Review of Human-Computer Interaction Design Approaches towards Information Systems Development

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Abstract: *Nowadays modern information systems (emerging technologies) are increasingly becoming an integral part of our daily lives and has begun to pose a serious challenge for human-computer interaction (HCI) professionals, as emerging technologies in the area of mobile and cloud computing, and internet of things (IoT), are calling for more devotion from HCI experts in terms of systems interface design. As the number of mobile platforms users, nowadays comprises of children's, elderly people, and people with disabilities or disorders, all demanding for an effective user interface that can meet their diverse needs, even on the move, at anytime and anywhere. This paper, review current articles (43) related to HCI interface design approaches to modern information systems design with the aim of identifying and determining the effectiveness of these methods. The study found that the current HCI design approaches were based on desktop paradigm which falls short of providing location-based services to mobile platforms users. The study also discovered that almost all the current interface design standard used by HCI experts for the design of user's interface were not effective & supportive of emerging technologies due to the flexibility nature of these technologies. Based on the review findings, the study suggested the combination of Human-centred design with agile methodologies for interface design, and call on future works to use qualitative or quantitative approach to further investigate HCI methods of interface design with much emphasis on cloud-based technologies and other organizational information systems.*

Keywords: *HCI design approaches; Information systems Development; Emerging-technologies; Mobile platforms; Agile methodology; User interface*

How to cite: Yakubu Bala, M., & Damla, K. (2021). A Review of Human-Computer Interaction Design Approaches towards Information Systems Development. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 12*(1), 229-250. https://doi.org/10.18662/brain/12.1/180

1. Introduction

Nowadays, there is a considerable growing interest in the area of Information Technologies (IT), (Bertola & Smith, 2019). as new technologies or in other word emerging technologies continues to affect how peoples carry out their day-today activities (Zotti & Neubauer, 2019). how organizations change their mode of operations (Loizides et al., 2019). using modern information systems platforms such as crowdsourcing platform (van Roy & Zaman, 2019). to gain competitive advantage over others (Matallaoui, Koivisto, Hamari, & Zarnekow, 2017). get user feedback (Yang, Ye, & Feng, 2020). measure the performance of new products or services (Sailer, Hense, Mayr, & Mandl, 2017). and encourage workers engagement through the use of gamification systems (Schöbel et al., 2020). There are so much debates among academic researchers and other fields of human endeavours concerning the effects of these technologies (Šumak, Špindler, Debeljak, Heričko, & Pušnik, 2019). Literature Rotolo, Hicks, and Martin (2015). showed that, an "increasing attention has being paid to the phenomenon of these emerging technologies (Joung & Kim, 2017).

Since the emergence of Human-computer interaction (HCI), there are so many debates among scholars as to which field does it belong to?, either engineering, computer science, psychology, sociology, communication or ergonomy (Jeon, Fiebrink, Edmonds, & Herath, 2019). but Tosi (2020). stressed that "human-computer interaction" encompasses all fields of human endeavours as it's concern with the evaluation, design and implementation of an interactive computing systems (Kocsis, 2019). The major aim of HCI as a field of study is the design and implementation of an effective user interface (Punchoojit & Hongwarittorrn, 2017). because effective user interface improve information systems performance (Nishant, Srivastava, & Bahli, 2020).

However, emerging technologies such as "cloud computing and/or virtualization technologies" has begun to shape & transform how businesses are conducted across the globe (Grenci & Hull, 2020). Virtualization include but not limited to the creation of virtual resources such as "servers, computer hardware platforms, file storage, network systems & operating systems". It reduces organizational cost and helps improves services/products quality via enhance systems performance (Hoxmeier & Lenk, 2020). These technologies provide a great challenge to HCI practitioners [13-19]. as designing and integrating an effective user interface that satisfy different individual needs requires better understanding of different information systems, for different disciplines (Kim & Choi, 2020).

for instance, "sociological contexts, individuals cognitive & physical capabilities, science and engineering, design & graphics, and work environment" as interface become effective only when they are created upon a particular discipline perspectives (Gutiérrez, Htun, Schlenz, Kasimati, & Verbert, 2019). For instance, Nishant et al. (2020). suggested that "virtualization capabilities" influence information systems performance in an organization. Hence, the need to have an effective user interface that can be integrated into information systems design methodologies (Rantala et al., 2020).

In the same vein, as emerging technologies in the areas of cloud computing and virtualization systems are requiring for more from HCI practitioners, so also mobile computing technologies (Islam, Karim, Inan, & Islam, 2020). as mobile platforms nowadays are calling for more effective approach from HCI practitioners [22-23]. to address some of the growing challenges that emerged, "ever since the introduction of mobile devices with touchscreens" instead of those with "keypads" by some corporation e.g., "HTC, LG, & Apple" in 2007 (Punchoojit & Hongwarittorrn, 2017). As more and more people continue to adopt, users begin to requires some technological changes in the areas of "interfaces and interactions design" (Samara, Galway, Bond, & Wang, 2019). as mobile devices with keypads are no longer attractive to generation "y" (younger people), (Šumak et al., 2019). Literatures Joung and Kim (2017). and Islam et al. (2020). have shown that there are over one billion users of modern smartphones in the world, some of whom are children's, (Nishant et al., 2020). elderly people (Righi, Sayago, & Blat, 2017). and users with "disabilities or disorder" (Lin, Xia, Wang, Tian, & Song, 2016). Although mobile devices are "becoming indispensable in our day-today activities" (H.-C. Hsu, Chang, Chen, & Wu, 2020). a standard design approach for mobile user's interface does not exist (Grenci & Hull, 2020). Simply, because most the design approach used by HCI practitioners are based on "desktop paradigm" in nature (Jeon et al., 2019). Similarly, Tosi (2020). and H.-C. Hsu et al. (2020). stressed that there are some differences between "desktop and mobile devices" such as "visual attention", "tactile feedback", (Grenci & Hull, 2020). "screen sizes" (Islam et al., 2020). Apart from contexts and "physical qualities difference" mobile devices also differs from desktop computers in the sense that they can be use anywhere, anytime even while users are on the move (Bertola & Smith, 2019). Therefore, desktop paradigm does not fully address "mobile contexts" (Islam et al., 2020).

Internet of Things (IoT) is another emerging technologies that provide a greater challenge to HCI professionals (Dziak, Jachimczyk, &

Kulesza, 2017). as they are now being face with the challenges of designing an interface that works compactible with modern information systems for both "indoor and outdoor" use (Righi et al., 2017). Nowadays, people's with disability or elderly people's with health issues requires an autonomous information systems, which can sense "people's position", "vital signs" (Ahmad, Riaz, & Hussain, 2011). and has the capability to differentiate between several situations (Dziak et al., 2017). and different activities (Zotti & Neubauer, 2019). and responds accordingly to the "degree of danger and alarms", via appropriate actions or cares [17-19]. Similarly, information systems such as Decision Support Systems (DSSs) are increasingly used in agriculture (Gutiérrez et al., 2019). as nowadays, Decision Support Systems are designed with virtualization technologies (Rotolo et al., 2015), in order to assist agricultural stakeholders in making decisions that are effective (Gandhi, Petkar, & Armstrong, 2016).

Literature , He, Parra, and Verbert (2016). and E. Han et al. (2019). have shown that participants in agricultural field such as agriculturalists, policymakers & consultants now requires more farming software tools to ease farming process (Lundström & Lindblom, 2018). via Big Data applications which will allows them to get data from different source, in different format, (Lin et al., 2016). in large volume (Machwitz, Hass, Junk, Udelhoven, & Schlerf, 2019). and analysing these data in order to get some suggestions via pictorial outputs (Van Hertem et al., 2017). Nowadays, integrating picturing approach to information systems design e.g., DSSs can provide farmers and other stakeholders in agricultural industry the opportunity to interact with one another (Van Hertem et al., 2017). and understand inflow of data via collecting, clarifying, probing or otherwise with the view of obtaining relevant information (Gutiérrez et al., 2019). However, the effort of HCI to address these challenges is not sufficient enough (E. Han et al., 2019). Despite the potential benefits of emerging technologies such as Internet of Things applications e.g., Health-based information systems (Dziak et al., 2017). Big data applications e.g., virtualization competences (Nishant et al., 2020). mobile technologies, game and gamification systems in education & marketing (Jeon et al., 2019). and calls by some current research works for the design of an effective user interface for these emerging technologies, from HCI specialists. Although, the prior studies have been beneficial to investigate evolving technologies. However, these studies have some limitations, as the previous works fail to examined the various HCI, UI design approaches to information systems development and comment on the effectiveness or otherwise of these approaches in relation to modern information systems development (i.e.,

emerging technologies). Therefore, this study will investigate the present methods of user interface (UI) design employed by HCI professionals from existing literatures. In order to achieve the study objective, the following research questions were asked; i) what are the HCI design approaches to information systems development, ii) are the HCI design approaches effective for user interface design, iii) do the present HCI design approaches support modern information systems development?

2. Literature review

In the following sections, the study will give details analysis of the reviewed works related to information systems design and human-computer interaction design approaches by synthesising the previous works.

2.1. Information Systems Design

Nowadays, systems design in the context of emerging information and communication technologies is very challenging (Chepken, 2016). It requires negotiations between systems designers and users in order to ensure users requirements are met (Crişan, 2017). and certain level of satisfactions are also met (Day, Humphrey, & Cockcroft, 2017). in terms of interface functionality, flexibility and usability. The tasks of systems design is getting more complex with the emergence of new technologies in the areas of mobile and cloud based technologies (Islam et al., 2020). as these new technologies provide opportunities for elderly peoples (Punchoojit & Hongwarittorrn, 2017). and peoples with disabilities to experience and enjoy the benefits provided by these emerging technologies (Rotolo et al., 2015).

Furthermore, organizations are also requesting for more flexible, and interactive user interface in order to meet up with the growing demands of individuals (Al Mahdi, Naidu, & Kurian, 2019). Similarly, Chepken (2016). also stressed the needs to place the Information Systems design procedures in the wider context of the user. Similarly, Gonçalves, Oliveira, and Kolski (2018). in their work argued that for organizations to derive the maximum benefits of investment on the design and deployment of modern information systems, then employees needs must be considered as they are the ones that uses these systems first (Al Mahdi et al., 2019). and encourage other users to use it too (Kocsis, 2019). Therefore, the need for teamwork among "employees, managers, information technology professionals, HCI professionals" (Bertola & Smith, 2019), in order to achieve effective user interface design.

Another area of emerging technologies that is asking for more devotion from "human-computer interaction practitioners" in terms of effective user interface design are "mobile platforms" (Punchoojit & Hongwarittorrn, 2017). as mobile devices nowadays, comes with diverse functionalities & features (He et al., 2016). with different applications that requires different "user interface and interaction design" (Rantala et al., 2020). Research have shown that, there are over a billion of "smartphone" operators across the globe, comprising of "elderly peoples, children's and people disabilities" (Punchoojit & Hongwarittorrn, 2017). Despite, the widespread of mobile smartphones among peoples of the world, and the increasing important of mobile platforms in our day-today activities (Lin et al., 2016). factual standard for "mobile users interface designs outlines does not exist (Righi et al., 2017). This is because, majority of the "designs pattern" are based on the standard established for desktop design (Punchoojit & Hongwarittorrn, 2017).

Desktop design procedures may be valid, but there are some noteworthy variances between "modern smartphones and desktops" (Gottschalk, 2020). which include but not limited to "lack of tangible feedback, limited screen extent, and high demands of pictorial care" (Nishant et al., 2020). In addition to variances in physical potentials, between the two, mobile technologies allows individuals usage anywhere, anytime or even while "users are on the move" (Punchoojit & Hongwarittorrn, 2017).

2.2. Human-Computer Interaction (HCI)

Human-computer interaction is defined as a discipline concern with the "evaluation, design and implementation" of an effective computing systems (Tosi, 2020). it's considered by many (Y.-C. Hsu & Nourbakhsh, 2020). as an integral part of "man-machine systems", HCI is the most important activity in the design process of any form of computer systems (Kocsis, 2019). whose presence is not only about the job itself, but also to realize a shared communication (Jeon et al., 2019). and create a common platform between "users and machines" (Gutiérrez et al., 2019). in order to understand the actions performed on the machines, e.g., "designing input and output ways of information". The success of any interface design, lies on the interface effectiveness in achieving comprehensive functions of "human and computer systems communication" (Righi et al., 2017). Similarly, Šumak et al. (2019). stressed that an effective user interface is one that achieve a faultless and harmonious interactions between human and computer systems, as this is the only way people mental load can be

condensed basically and improve their "operational abilities" (Tosi, 2020). Nowadays, users perceived the interface as the system, because the interface is "composed of regulator board consisting of display and organiser, touch screen merged by regulatory and showing, and other software interface" (Samara et al., 2019). that can be used in complicated goods or systems.

2.3. HCI Design Approaches

Interaction between "human and computer" is a procedure that involves "entering & extraction" of data and information (Mao, Li, Zhang, & Liang, 2017). via interface designed for that purposes, as peoples input their commands to the system via the interface, while the system will look at the commands and then compute and process, and sends back the results to users through the same interface (Rautaray & Agrawal, 2015). The entering and extraction between peoples and systems nowadays occurred in different ways, e.g., "data communications, number and symbolic interaction, speech interaction and intelligent interactions" etc., (Righi et al., 2017). Furthermore, Tosi (2020). and (Jeon et al., 2019). argued that interface design process for human and computer communications, is broadly categorized into three portions "the interactive design, structure design, and visual design", and the three were further subdivided into sub classes (Pimenta, Carneiro, Neves, & Novais, 2016). For instance, interactive design which focuses on how individuals interact with system can further be divided into "the forms of interactions", and "how the interaction take place" (Y.-C. Hsu & Nourbakhsh, 2020). Similarly, Esposito, Esposito, and Vogel (2015). stressed that "interactive design" must considered the following "peoples orientation, consistency, users operation ability, shortcuts, helps & feedbacks" while designing an interactive interface, because it's the only way that an interface can be effective to users (Shilton, 2018). Again, structure design can further be divided into three "analysis of user needs, task design & purpose of task", (Eide et al., 2016). which are aim at analysing individual's needs, reason for carrying out the task and how the task was design (Jacucci, Spagnolli, Freeman, & Gamberini, 2015).

Finally, "visual design" that has to do with incorporating, "complexion & pictures" is aim at making users happy with the interface (Jacucci et al., 2015). However, study have shown (Gray, 2016). that debate about new approach for the design of modern information systems (emerging technologies) has reached the "HCI discourse" over the last decade, and has repeatedly call for the review of the present methods used in interface design (Jacucci et al., 2015). Nowadays, the standard of HCI interface approaches to emerging technologies has become a topic of

discussion among information systems expert with an increasingly consideration to understand HCI approaches to information systems development (Mao et al., 2017). Information systems studies Hoxmeier and Lenk (2020). Gottschalk (2020). Dziak et al. (2017) and Gray (2016). argued that majority of the design approaches presently used by "Human-Computer Interaction" professionals are not functional either due to absence of fit or acknowledgement of how design is experienced in the "real world" (Kumar, Verma, & Prasad, 2012). Similarly, Blandford (2019). stressed that "digital technologies" in the area of health care are posing a greater challenge for HCI professionals, as "we now live in time of change" from healthcare services being distributed by medical experts to an era where individuals are probable to be involved in decision making concerning their health's (Jeon et al., 2019). via new technologies that braced information resources. Hence, the need for new approach to information systems developments. **Table 1,** gives summary of the reviewed articles.

Table 1: Summary of authors/year, objectives, methods, and findings of viewed articles on HCI design approaches to information systems and other emerging technologies

Authors & Year	Topic	Objectives of the study	Methods	Findings
Bernonville, Kolski, Leroy, and Beuscart-Zéphir (2010).	Integrating the SE and HCI models in the human factors engineering cycle for re-engineering Computerize d	To prove the advantages of using the SE/HCI methods and models when designing or reengineering interactive systems that support user activities in complex organizations.	Survey	Highlights the importance of human-factors in design or re-engineering of an interactive information systems design or re-engineering Because all the different project "partners have their own domain-specific vocabulary and methods".
Brhel, Meth, Maedche, and Werder	Exploring principles of user-cantered	To capture & analyze the current state of	Hierarchical coding system	Present the current state of ASD and UCD

(2015).	agile software development: A literature review	the art in UCASD		integration and identifies generic principles that constitute an integrated UCASD approach
Dwivedi et al. (2015).	Information systems downfall and progress and status update and directions for the future.	To highlight the current debates on IS success and failure	One-shot survey	Ineffective user interface contributes to information systems failure. i.e., user interface that do not meet user expectations or non-functional systems.
Kupiainen, Mäntylä, and Itkonen (2015).	A systematic review of industrial studies on the Used of Metrics in Agile and Lean Applications Design.	To find the speciality of Lean Software Development among Agile methods.	Hierarchical coding system	Viewed Lean as a special case of Agile software development, and categorised the metrics found in empirical Agile studies and compares the found metrics with the metrics suggested by Agile literature.
Chepken (2016).	The Absence of One-Size-Fits-All in the Day ICT4D Designs.	To understand the challenges of designing information systems UI for different organization with different people and needs.	Case study	UI designers need to know more about their users than what is given "about users" descriptions.

Day et al. (2017).	How do the design features of health hackathons contribute to participatory medicine?	To provide a rich picture of the role of hackathons in participatory medicine through effective health information systems	Experimental	Highlights the important of involving people in the design of information systems, as there are many stakeholders with different point of view and interest.
Dziak et al. (2017).	IoT-Based Information System for Healthcare Application: Design Methodology Approach	To suggest "an Internet of Things (IoT)-based healthcare information system intended for indoor and outdoor users using a methodological approach to the design process"	Case study	Highlight the important of life quality and safety via emerging technologies. Proposed a design methodology for interactive UI for elderly people.
Punchoojit and Hongwarittorn (2017).	Usability Studies on Mobile User Interface Design Patterns: A Systematic Literature Review	To provides a systematic review of the existing studies on mobile UI design patterns	Manual literature coding	True standards for mobile UI design patterns do not exist. Most of HCI approach to UI designs are based on the desktop paradigm. Though, desktop paradigm may be applicable, but there are notable differences between mobile devices and desktops.

Righi et al. (2017).	Talk about elderly persons in HCI. Turning towards a community' in the design of technologies for the development of ageing populace	To address a certain number of challenges HCI designers and researchers deal with when designing digital technologies for older people.	Experimental	HCI approach of assuming different people have unique needs and interest in UI design is no longer effective. Therefore, they should adopt participatory design approaches UI design.
Gonçalves et al. (2018).	Identifying HCI approaches to support CMMI-DEV for interactive system Development	To identify the appropriate HCI approaches for each practice of systems development in engineering and other fields	One-shot case study	Identified certain approaches that could assist in in the development of interactive systems.
Al Mahdi et al. (2019).	Evaluating the Role of HCI Principles for Electronics Learning Solution Design	To analyze HCI design techniques and highlight the methods that can be use to integrate those identified techniques into the design framework for electronics learning packages.	Manual literature coding	Identify the needs for the correct users interface UI) design, for divers users. Mobile devices require different UI design, than the conventional desktop paradigm approach.
Jeon et al. (2019).	From rituals to magic: Interactive art and HCI of the past, present, and	To find the connection between interactive art and Human–	Experimental	Present discussions on the important/benefits of working together

	future	Computer Interaction (HCI) in the past and present, and how to move forward to the digital age.		between art, systems designers and HCI communities.
Kocsis (2019)	A conceptual foundation of design and implementation research in accounting information systems	To understand the design, development, and implementation issues in information systems, from Accounting information systems context (AIS)	Manual literature coding	People are the primary users of any systems, hence the need to include them or their opinions on design and implementation of any systems. So that effective UI can be design for them
Tosi (2020).	From User-Centred Design to Human-Centred Design and the User Experience	Understanding and interpreting the needs of users in the use of the product/system and the overall quality of the interaction between people and the products/systems with which they relate.	Experimental	That human-centred approach currently used to address UI design problems is not effective enough, as the world is moving from human-centred to user-experience

As seen in **Table 1**, (Punchoojit & Hongwarittorrn, 2017). argued that a true standards design principles for emerging technologies e.g., mobile devices does not exist, and others (Day et al., 2017). emphasized the needs for participatory design, as there are "many stakeholders with different point of view and interest". Similarly, (Righi et al., 2017). stressed that, the assumption of different people having unique needs is no longer effective in terms user interface design. Therefore, HCI professionals should adopt

participatory design approaches to UI design, in order to identify people needs.

3. Methodology

3.1. Research design

The study is a systematic literature review one as per (Gutiérrez et al., 2019). the study attempts to review prior studies related to human-computer interactions approaches to information systems development and user interface (UI) design principles.

3.2. Databases search.

Having identify the area of our review, then search for related studies begin from some recognize scholarly databases. Four comprehensive databases IEEE Explore, Web of science, ScienceDirect, SpringerLink and Google scholar were searched for articles related to the review topic.

3.3. Search strategy

The study began the exploration for related works using keywords that best describe the review topic such as "Human-computer interaction approaches", "HCI design paradigm", "user interface (UI) design", "information systems development", "systems design methodologies", "internet of things - IoT", and mobile platforms. A reasonable number of articles were extracted for analysis, as shown in **Fig. 1**.

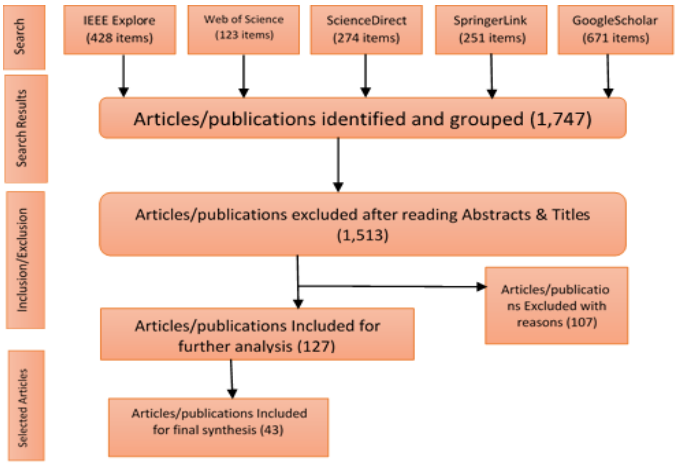

Fig. 1. Literature selection process

3.4. Selection criteria

As seen **Fig.1**, searched outcomes from the databases produced (1,747 articles), which were group together and exported to excel for screening. There's no time limit with regards to articles publication period. In the second stage of our selection process, 1,513 articles were excluded after reading their abstracts and titles, as they were found to have no relevance to the study. Furthermore, articles written in other languages, other than English language, with inadequate details on the role of HCI in information systems design, so much emphasis on engineering aspect of HCI, or focused more on information systems activities without considering design problems were also excluded. The remaining articles were included for further screening, after which 84 articles were excluded either due to lack of full access or duplication. Finally, 43 articles were fully read and analyzed in the review.

4. Result and Discussion

For HCI design approaches to information systems development, the study discovered that despite the emergence of new technologies in the areas of cloud & mobile computing, and IoT ("Internet of Things"), such as mobile platforms, IoT based information systems in healthcare, visualisation systems in Agric sector. The approaches to systems design are almost the same, as in the last two decades, as HCI professionals are still utilizing "structure, visual and interactive" design methods of interface design for emerging technologies that are requiring for more in terms of effective user interface. This result is in line with the findings of (Blandford, 2019), that the noticeable impact of the present HCI design principles in relation to interface for "modern information systems", e.g., healthcare information systems and on the knowledges of medical specialists and users of these systems has been quite limited, as the usability of those interface designed using "collaborative, assembly and graphic designs", (Jeon et al., 2019). never met people's expectations with regards to health systems that are complex.

For effectiveness of HCI design approaches with regards to user interface design, the study discovers that the used of "task design, user needs, systems functionality, consistency design, systems operationality, short cuts, coloured and images design" principles by HCI experts in designing users' interface for mobile platforms and other emerging technologies were not effective, as most of these methods are based on desktop standard of interface design (Islam et al., 2020). where's modern

technologies in cloud and mobile application provide location-based services which allows users to use their systems and/or applications while on the move, i.e., anywhere, anytime. This outcome support the findings of (Punchoojit & Hongwarittorrn, 2017). that nowadays, "mobile technologies" are calling for more devotion from HCI experts, as the number of peoples using mobile apps now is above one billion worldwide, some of whom are ageing individuals, young people, and some with disability challenges, all requiring for more perceptible response from the device than before (Islam et al., 2020).

Furthermore, the study also discovered that the used of "user-centred design approach by human-computer interaction" professionals in an attempt to address the problems of interface design in relation to user's requirements and satisfaction is not supportive of modern information systems design [30]. as the world is moving from "user-centred -to- human-centred design, and now to user-experience approach" (Loizides et al., 2019). as the world continues to witness new technologies that change our daily lives. Similarly, this finding is in alignment with the findings of (Tosi, 2020). that "Human-Centred design approach" meant for evaluating and interpreting the excellence level of interaction between individuals and systems by which they interact, should also take not of "User-Experience" in its approach.

Finally, the study recommends the use of "Human-centred approach together with Agile software development", an information systems development methodology with "incremental and iterative process where systems requirements, design, implementation and testing"(Keramati & Mirian-Hosseinabadi, 2008). occurred in all stages of system development. Furthermore, "Agile" methods stress the importance of "people, communication, small release of working software, and responding to changes", as peoples have the opportunity to interact with some aspect of the system before the full design is completed, thus the possibility of making changes to some of the system functionalities & interface will be well accommodated since the method is iterative. Therefore, combining "Human-centred design and agile methods", man help in addressing some design issues and also lead to the design of an effective user interface for modern information systems in other word "emerging technologies" as shown in Fig.2.

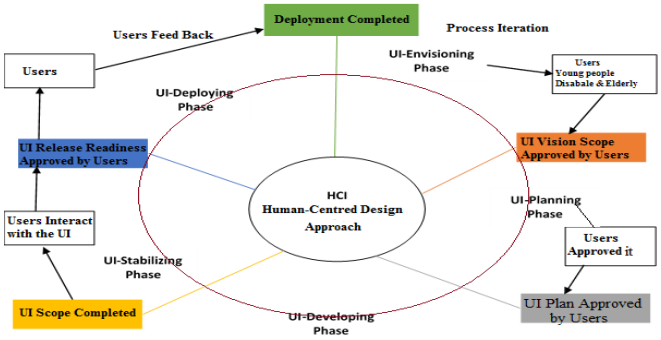

Figure 2: Study proposed integrated user-interface design methodology

As seen in **Fig.2**, in the envisioning phase the HCI experts conceived the User Interface (UI) to be design for an information system, after which they comminated it to different group of users comprising of young people, elderly people and people with disabilities for approval. The users will analyze the propose user-interface according their needs and approved with or without adjustments and return it to HCI expert for UI planning, which must also be approved by users. Having getting approval from users, the HCI experts then develop the UI according to the users' needs and send it to users for testing before release. Where the users require some adjustments, then HCI experts stabilized the UI before final release (deployment phase), to users. Finally, the users received the final version of the UI and make used of it before sending their feedback, and the process begin again and again, in an iterative manner. As seen in **Fig.2**, users were involved in all the design process and can have the opportunity to interact with the interface before it final release.

5. Conclusion and future work

The study was conducted on 43 papers. Scanty of literature and growing debates of where HCI field belongs to, contribute to the number of articles reviewed. Some of the papers focused on interface design from an engineering method, with little emphasis on information systems design. To summarize, the study evidently shows that emerging technologies in the areas of mobile, cloud and internet of things (IoT), were the major reasons why the current HCI user interface design approaches to information systems development were in-effective, and not supportive of modern information systems design. As the study discovered that the current HCI

design approaches were based on desktop paradigms which static in nature, compare to modern systems that requires location based-services.

In recent days attention is slowly shifting from human-centred – to – user-experience, as new technologies such as "virtualization, new smart home control systems, knowledge-based systems, gamification systems, IoT-based information systems for healthcare", were making peoples to request corporal feedback, unseen gesture, and more visual care. The study also exposed that even the user-centred approach that HCI experts think can address some of the interface design problems is not actually addressing the problems. Even though, the study suggests the combination Human-centred design with agile methods, the review is limited to investigating HCI user interface design approaches to information systems development with so much emphasis on mobile platforms applications. Therefore, future studies should employ quantitative or qualitative research approach in order to further investigate HCI design approaches in relation to other organizational information systems with much emphasis on cloud-based systems.

References

Ahmad, N., Riaz, N., & Hussain, M. (2011). Ad hoc wireless sensor network architecture for disaster survivor detection. *International Journal of Advanced Science and Technology, 34*(9), 16. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.359.7416&rep=rep1&type=pdf

Al Mahdi, Z., Naidu, V. R., & Kurian, P. (2019). Analyzing the Role of Human Computer Interaction Principles for E-Learning Solution Design *Smart Technologies and Innovation for a Sustainable Future* (pp. 41-44): Springer. https://doi.org/10.1007/978-3-030-01659-3_6

Bernonville, S., Kolski, C., Leroy, N., & Beuscart-Zéphir, M.-C. (2010). Integrating the SE and HCI models in the human factors engineering cycle for re-engineering Computerized Physician Order Entry systems for medications: Basic principles illustrated by a case study. *International journal of medical informatics, 79*(4), e35-e42. https://doi.org/10.1016/j.ijmedinf.2008.04.003

Bertola, N. J., & Smith, I. F. (2019). A methodology for measurement-system design combining information from static and dynamic excitations for bridge load testing. *Journal of Sound and Vibration, 463*, 114953. https://doi.org/10.1016/j.jsv.2019.114953

Blandford, A. (2019). HCI for health and wellbeing: challenges and opportunities. *International Journal of Human-Computer Studies, 131*, 41-51. https://doi.org/10.1016/j.ijhcs.2019.06.007

Brhel, M., Meth, H., Maedche, A., & Werder, K. (2015). Exploring principles of user-centered agile software development: A literature review. *Information and software technology, 61*, 163-181. https://doi.org/10.1016/j.infsof.2015.01.004

Chepken, C. (2016). The Absence of One-Size-Fits-All in the Day Labour Organisations ICT4D Designs *Human Development and Interaction in the Age of Ubiquitous Technology* (pp. 308-333): IGI Global. https://doi.org/10.4018/978-1-5225-0556-3.ch013

Crişan, C. (2017). Design thinking: what it is and how it works. A case study on romanian libraries. *Euromentor Journal-Studies about education, 8*(4), 181-194. https://www.euromentor.ucdc.ro/euromentor-december-2017.pdf#page=181

Day, K., Humphrey, G., & Cockcroft, S. (2017). How do the design features of health hackathons contribute to participatory medicine? *Australasian Journal of Information Systems, 21*. https://doi.org/10.3127/ajis.v21i0.1383

Dwivedi, Y. K., Wastell, D., Laumer, S., Henriksen, H. Z., Myers, M. D., Bunker, D., . . . Srivastava, S. C. (2015). Research on information systems failures and successes: Status update and future directions. *Information Systems Frontiers, 17*(1), 143-157. https://doi.org/10.1007/s10796-014-9500-y

Dziak, D., Jachimczyk, B., & Kulesza, W. J. (2017). IoT-based information system for healthcare application: design methodology approach. *Applied Sciences, 7*(6), 596. https://doi.org/10.3390/app7060596

Eide, A. W., Pickering, J. B., Yasseri, T., Bravos, G., Følstad, A., Engen, V., . . . Lüders, M. (2016). *Human-machine networks: towards a typology and profiling framework*. Paper presented at the International Conference on *Human-Computer Interaction*, pp. 11-22. https://doi.org/10.1007/978-3-319-39510-4_2

Esposito, A., Esposito, A. M., & Vogel, C. (2015). Needs and challenges in human computer interaction for processing social emotional information. *Pattern Recognition Letters, 66*, 41-51. https://doi.org/10.1016/j.patrec.2015.02.013

Gandhi, N., Petkar, O., & Armstrong, L. J. (2016). *Rice crop yield prediction using artificial neural networks*. Paper presented at the 2016 IEEE Technological Innovations in ICT for Agriculture and Rural Development (TIAR). https://doi.org/10.1109/tiar.2016.7801222

Gonçalves, T. G., Oliveira, K. M., & Kolski, C. (2018). Identifying HCI approaches to support CMMI-DEV for interactive system development. *Computer Standards & Interfaces, 58*, 53-86. https://doi.org/10.1016/j.csi.2017.12.003

Gottschalk, P. (2020). E-government interoperability and information resource integration: Frameworks for aligned development. *Information Systems*, 193. https://doi.org/10.4018/978-1-60566-648-8

Gray, C. M. (2016). "It's More of a Mindset Than a Method" UX Practitioners' Conception of Design Methods. *Paper presented at the Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (pp. 4044-4055) https://doi.org/10.1145/2858036.2858410

Grenci, R. T., & Hull, B. Z. (2020). New dog, old tricks: ERP and the systems development life cycle. *Journal of Information Systems Education, 15*(3), 7.

Gutiérrez, F., Htun, N. N., Schlenz, F., Kasimati, A., & Verbert, K. (2019). A review of visualisations in agricultural decision support systems: An HCI perspective. *Computers and Electronics in Agriculture, 163*, 104844. https://doi.org/10.1016/j.compag.2019.05.053

Han, E., Baethgen, W. E., Ines, A. V., Mer, F., Souza, J. S., Berterretche, M., . . . Barreira, C. (2019). SIMAGRI: An agro-climate decision support tool. *Computers and Electronics in Agriculture, 161*, 241-251. https://doi.org/10.1016/j.compag.2018.06.034

Han, W., Yang, Z., Di, L., & Mueller, R. (2012). CropScape: A Web service based application for exploring and disseminating US conterminous geospatial cropland data products for decision support. *Computers and Electronics in Agriculture, 84*, 111-123. https://doi.org/10.1016/j.compag.2012.03.005

He, C., Parra, D., & Verbert, K. (2016). Interactive recommender systems: A survey of the state of the art and future research challenges and opportunities. *Expert Systems with Applications, 56*, 9-27. https://doi.org/10.1016/j.eswa.2016.02.013

Hoxmeier, J., & Lenk, M. M. (2020). Service-learning in information systems courses: Community projects that make a difference. *Journal of Information Systems Education, 14*(1), 10. http://jise.org/Volume14/n1/JISEv14n1p91.pdf

Hsu, H.-C., Chang, S., Chen, C.-C., & Wu, I.-C. (2020). Knowledge-based system for resolving design clashes in building information models. *Automation in Construction, 110*, 103001. https://doi.org/10.1016/j.autcon.2019.103001

Hsu, Y.-C., & Nourbakhsh, I. (2020). When human-computer interaction meets community citizen science. *Communications of the ACM, 63*(2), 31-34. https://doi.org/10.1145/3376892

Islam, M. N., Karim, M. M., Inan, T. T., & Islam, A. N. (2020). Investigating usability of mobile health applications in Bangladesh. *BMC Medical Informatics and Decision Making, 20*(1), 19. https://doi.org/10.1186/s12911-020-1033-3

Jacucci, G., Spagnolli, A., Freeman, J., & Gamberini, L. (2015). Symbiotic interaction: a critical definition and comparison to other human-computer paradigms. *Paper presented at the International Workshop on Symbiotic Interaction.* pp. 3-20. https://doi.org/10.1007/978-3-319-13500-7_1

Jeon, M., Fiebrink, R., Edmonds, E. A., & Herath, D. (2019). From rituals to magic: Interactive art and HCI of the past, present, and future. *International Journal of Human-Computer Studies, 131*, 108-119. https://doi.org/10.1016/j.ijhcs.2019.06.005

Joung, J., & Kim, K. (2017). Monitoring emerging technologies for technology planning using technical keyword based analysis from patent data. *Technological Forecasting and Social Change, 114*, 281-292. https://doi.org/10.1016/j.techfore.2016.08.020

Keramati, H., & Mirian-Hosseinabadi, S.-H. (2008). Integrating software development security activities with agile methodologies. *In 2008 IEEE/ACS International Conference on Computer Systems and Applications* (pp. 749-754). IEEE. https://doi.org/10.1109/aiccsa.2008.4493611

Kim, S., & Choi, M. (2020). Educational requirement analysis for information security professionals in Korea. *Journal of Information Systems Education, 13*(3), 11. http://jise.org/Volume13/n3/JISEv13n3p237.pdf

Kocsis, D. (2019). A conceptual foundation of design and implementation research in accounting information systems. *International Journal of Accounting Information Systems*, 34, 10024. https://doi.org/10.1016/j.accinf.2019.06.003

Kumar, P., Verma, J., & Prasad, S. (2012). Hand data glove: a wearable real-time device for human-computer interaction. *International Journal of Advanced Science and Technology, 43*. https://doi.org/10.1109/rait.2012.6194548

Kupiainen, E., Mäntylä, M. V., & Itkonen, J. (2015). Using metrics in Agile and Lean Software Development–A systematic literature review of industrial studies. *Information and software technology, 62*, 143-163. https://doi.org/10.1016/j.infsof.2015.02.005

Lin, K., Xia, F., Wang, W., Tian, D., & Song, J. (2016). System design for big data application in emotion-aware healthcare. *IEEE Access, 4*, 6901-6909. https://doi.org/10.1109/access.2016.2616643

Loizides, F., Jones, K., Girvan, C., De Ribaupierre, H., Turner, L., Bailey, C., & Lloyd, A. (2019). Crowdsourcing Real-World Feedback for Human–Computer Interaction Education *Macrotask Crowdsourcing* (pp. 233-252): Springer. https://doi.org/10.1007/978-3-030-12334-5_9

Lundström, C., & Lindblom, J. (2018). Considering farmers' situated knowledge of using agricultural decision support systems (AgriDSS) to Foster farming practices: The case of CropSAT. *Agricultural Systems, 159*, 9-20. https://doi.org/10.1016/j.agsy.2017.10.004

Machwitz, M., Hass, E., Junk, J., Udelhoven, T., & Schlerf, M. (2019). CropGIS–a web application for the spatial and temporal visualization of past, present and future crop biomass development. *Computers and Electronics in Agriculture, 161*, 185-193. https://doi.org/10.1016/j.compag.2018.04.026

Mao, X., Li, K., Zhang, Z., & Liang, J. (2017). Design and implementation of a new smart home control system based on internet of things. *In 2017 International Smart Cities Conference (ISC2)* (pp. 1-5). IEEE. https://doi.org/10.1109/isc2.2017.8090790

Matallaoui, A., Koivisto, J., Hamari, J., & Zarnekow, R. (2017). *How effective is "exergamification"? A systematic review on the effectiveness of gamification features in exergames.* Paper presented at the Proceedings of the 50th Hawaii International Conference on System Sciences. https://doi.org/10.24251/hicss.2017.402

Nishant, R., Srivastava, S. C., & Bahli, B. (2020). Does Virtualization Capability Maturity Influence Information Systems Development Performance? Theorizing The Non-Linear Payoffs. *In Proceedings of the 53rd Hawaii International Conference on System Sciences.* https://doi.org/10.24251/hicss.2020.677

Pimenta, A., Carneiro, D., Neves, J., & Novais, P. (2016). A neural network to classify fatigue from human–computer interaction. *Neurocomputing, 172*, 413-426. https://doi.org/10.1016/j.neucom.2015.03.105

Punchoojit, L., & Hongwarittorrn, N. (2017). Usability studies on mobile user interface design patterns: a systematic literature review. *Advances in Human-Computer Interaction, 2017*. pp. 1-22. https://doi.org/10.1155/2017/6787504

Rantala, J., Majaranta, P., Kangas, J., Isokoski, P., Akkil, D., Špakov, O., & Raisamo, R. (2020). Gaze interaction with vibrotactile feedback: Review and design guidelines. *Human–Computer Interaction, 35*(1), 1-39. https://doi.org/10.1080/07370024.2017.1306444

Rautaray, S. S., & Agrawal, A. (2015). Vision based hand gesture recognition for human computer interaction: a survey. *Artificial intelligence review, 43*(1), 1-54. https://doi.org/10.1007/s10462-012-9356-9

Righi, V., Sayago, S., & Blat, J. (2017). When we talk about older people in HCI, who are we talking about? Towards a 'turn to community'in the design of technologies for a growing ageing population. *International Journal of Human-Computer Studies, 108*, 15-31. https://doi.org/10.1016/j.ijhcs.2017.06.005

Rotolo, D., Hicks, D., & Martin, B. R. (2015). What is an emerging technology? *Research policy, 44*(10), 1827-1843. https://doi.org/10.1016/j.respol.2015.06.006

Sailer, M., Hense, J. U., Mayr, S. K., & Mandl, H. (2017). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Computers in Human Behavior, 69*, 371-380. https://doi.org/10.1016/j.chb.2016.12.033

Samara, A., Galway, L., Bond, R., & Wang, H. (2019). Affective state detection via facial expression analysis within a human–computer interaction context.

Journal of Ambient Intelligence and Humanized Computing, 10(6), 2175-2184. https://doi.org/10.1007/s12652-017-0636-8

Schöbel, S., Janson, A., Jahn, K., Kordyaka, B., Turetken, O., Djafarova, N., . . . Adam, M. (2020). A Research Agenda for the Why, What, and How of Gamification Designs Results on an ECIS 2019 Panel. *Communications of the Association for Information Systems*, 46(1), 30. https://www.alexandria.unisg.ch/258977/3/JML_776.pdf

Shilton, K. (2018). Values and ethics in human-computer interaction. *Foundations and Trends® Human–Computer Interaction, 12*(2), 107-171. https://doi.org/10.1561/1100000073

Šumak, B., Špindler, M., Debeljak, M., Heričko, M., & Pušnik, M. (2019). An empirical evaluation of a hands-free computer interaction for users with motor disabilities. *Journal of biomedical informatics, 96*, 103249. https://doi.org/10.1016/j.jbi.2019.103249

Tosi, F. (2020). From User-Centred Design to Human-Centred Design and the User Experience *Design for Ergonomics* (pp. 47-59): Springer. https://doi.org/10.1007/978-3-030-33562-5_3

Van Hertem, T., Rooijakkers, L., Berckmans, D., Fernández, A. P., Norton, T., & Vranken, E. (2017). Appropriate data visualisation is key to Precision Livestock Farming acceptance. *Computers and Electronics in Agriculture, 138*, 1-10. https://doi.org/10.1016/j.compag.2017.04.003

van Roy, R., & Zaman, B. (2019). Unravelling the ambivalent motivational power of gamification: A basic psychological needs perspective. *International Journal of Human-Computer Studies, 127*, 38-50. https://doi.org/10.1016/j.ijhcs.2018.04.009

Yang, C., Ye, H. J., & Feng, Y. (2020). Using gamification elements for competitive crowdsourcing: exploring the underlying mechanism. *Behaviour & Information Technology*, 1-18. https://doi.org/10.1080/0144929x.2020.1733088

Zotti, G., & Neubauer, W. (2019). Beyond the landscape: analysis of Neolithic circular ditch systems of Lower Austria with advanced virtual archaeoastronomy. *Virtual Archaeology Review, 10*(21), 90-102. https://riunet.upv.es/bitstream/handle/10251/124741/10772-44268-2-PB.pdf?sequence=4