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Analysis of Human Computer Interaction (HCI) Model in SMEs

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Abstract – In Small and Medium-sized Enterprises (SMEs), Human-Computer Interaction (HCI) is considered as a cross-disciplinary segment applied in ergonomics, psychology and the engineering departments. HCI deals with the evaluation, implementation, designing and theoretical evaluation of means in which humans utilize and relate with computing applications. The term 'Interaction' is differentiated from other terminologies in the same application interface. The term refers to the abstract system which allows humans to interact with devices of computing for a particular industrial task. An application interface in this case applies to the selection of the technical (software and hardware) realization of a specified interaction system. Because of extensive research to incorporate diversified HCI into an understandable model, this paper evaluates HCI model in SMEs to provide the projected guidance to designers of the system using Information Technology (IT). The choice of a good model provides the recommendable direction for presentation languages e.g., Task Action Grammar (TAG) and the design actions determine the feel and look of the system. In this contribution, critical design projects in every discipline are identified alongside the present study trends and future research directions.

Keywords - Small and Medium-sized Enterprises (SMEs); Human-Computer Interaction (HCI); Information Technology (IT); Task Action Grammar (TAG).

1. Introduction

For over 3 decades now, Information Technology (IT) has been used to enhance the various sections of Small and Medium-sized Enterprises (SMEs). The advancing application of IT projected unparalleled increment in the productivity level of the end-users. However, this projection is not accomplished because of the incapacity to comprehend the behaviors of the end-users. Productivity for the end-users is connected to the functionalities and the capacity to master use and learn the level of functionality in SMEs. Apart from that, the designers of the system lack the essential guidance and frameworks meant to apply effectively what is identified about Human-Computer Interaction (HCI) during the designing of the system. The developers of software have to develop their concentration beyond functional needs to incorporate the behavioral requirement of the end-users.

Whenever the functionality of the system fits the real work and the model is easy to learn and utilize, the model will be adopted by organizational professionals and the office workers. The wide disciplinary of research suggest HCI in modern SMEs activities. The issue of HCI, such as the inconsistent command and the cryptic error message are accurately documented and reviewed based on computer revolution and the advent of IT in SMEs. The implication of problematic HCI designing is magnified significantly by the introduction of desktop computers which were utilized by experts for developing their productivity works. The department of HCI designing attracts the users in mystifying and unintended circumstances.

Consequent to that, the end-users may not be able to adopt the model in their workplaces due to lack of learning or issues faced with using the system or the system seems to consume too much time. As such, the SMEs might risk losing significant amounts of investment because of the same. Since the concern about the issue of HCI continued to advance, SMEs analysts and practitioners have found remedies regarding the same. Earlier on, researchers in [1] concentrated on developing programming environments to enhance the productivity of programmers. With the evident proliferation of desktop computers, it is presently discovered that non-technical system users are not contented with the same form of environment which were used by programmers. Since then studies have since been developed beyond more technical considerations to evaluate the behavioral concerns such as the human motor perception, cognition and skills for enhancing learning, usable software.

HCI is presently a fundamental scientific discipline that is based on computer science, social science, psychology, linguistics and ergonomics. The designers of systems in the modern SMEs world are projected to apply the interdisciplinary rules and standards meant to enhance the productivity and satisfaction of the users. This is a formidable obligation since HCI enhancement is not considered as a software aspect design which can be based on one design methodology. More significantly, there is no guidance in applying HCI study results to the design practices. Consider a normal interface design based on the decisions which objects, functions incorporate and how these are displayed and labeled; whenever the interface has to involve the command icons, menus and languages and the manner in which online assistance can be rendered.

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Every decision in SMEs incorporates the consideration of conflicting and complicated human factors. When the various decisions are considered at a go, the designing of the interface started to become overwhelming. In that regard, the main purpose of this research is to differentiate the HCI model into various segments, identify the most essential human factors and design objectives. In every segment, the design tasks are evaluated within the contexts of the present HCI analysis. The intentions of this segmentation are to aid the designers to relate the study results to the HCI model procedure. The past literature in [2] focused on the enhancement of the design rules and standards. However, after focusing on writing and using these rules and standards, it is identified that whenever the design is dependent on the context of the tasks and the behavior of the users, the significance of the rules and standards diminishes. The major solution to this issue design is to structure the behaviors of the end users in completing specific tasks. The systems provide a framework for evaluating the reasons for design's success or failure.

Resultantly, this amounts the emphasis to comprehend the cognitive procedure applied in HCI i.e., Task Action Grammar (TAG) and Model Human Processors (MHP). These are HCI theoretical frameworks for evaluating the behaviors of the users and these will be evaluated later in this research. These frameworks provide a framework for explaining why the design rules and standards operate. Another key objective of this research is to elaborate on the present rules with their theoretical bases and task constraints to allow the designers to connect them to untested and novel situations. Another objective is to identify the available opportunities for the HCI study [3].

HCI is rapidly advancing and becoming an essential segment in the modern SMEs world since embedded devices (computers) have started being a common place in the various facets of life. Apart from the establishment of essential computing functionalities present, the initial focus of HCI has been based on the designing of interaction and implementation of interfaces for usability. The terminology 'usability' implies that the resultant interface is easier to utilize, effective for task accomplishment, safety and amounts to correct completion of the tasks [4]. Effective interaction and usability with the devices of computing translates to the highest degree of productivity. Figure 1 shows the differentiating concepts of interacting framework and interface.

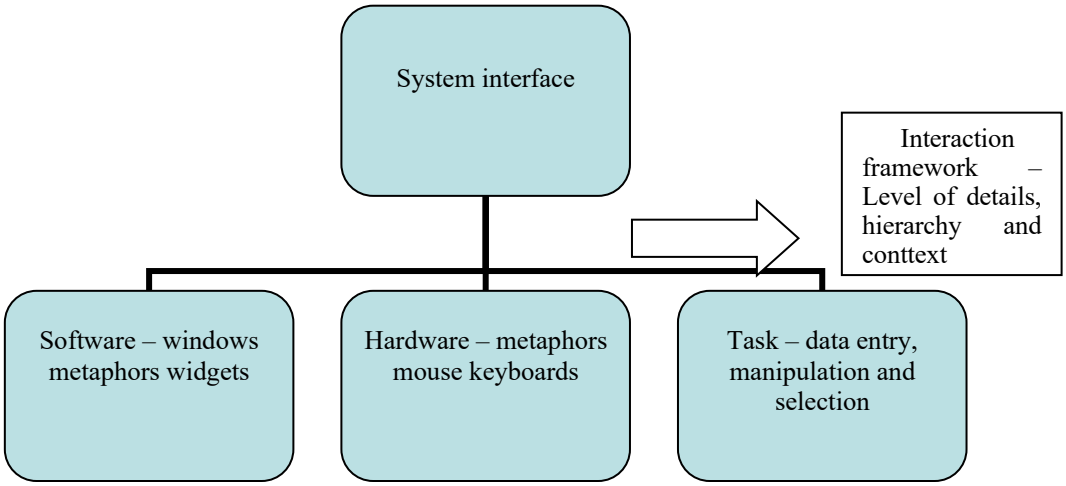

Fig 1. Differentiating concepts of interacting framework and interface

We start with the model for managing the design of HCI and different theoretical methodologies to evaluate HCI problems. This is succeeded by the designing of the study opportunities and recommendations for every problem in the model and in drawing the best conclusions. The remaining part of this paper is organized as follows: Section II is the background analysis. Section III is the literature review section. In Section IV, the HCI model design is presented whereas Section V is the discussion section of the paper. Lastly, Section VI concludes the paper and provides future research directions.

2. Background Analysis

Researchers in [5] have projected the users' recognition action cycle which is viewed as the basic behavior for comprehending the HCI psychology. The cycle incorporates their various stages: the end-users perceive the computer presentations and encodes them, evaluates long-term and short-term memories to tell the responses and considers the responses by providing the motor sensors which are in motion. Researchers in [6] have proposed a more elaborated 7-stage HCI model. According to the model, there is an expansion of the memory stage to incorporate the various mental activities e.g., evaluation of the framework, interpretation of the framework, formulation of individual intentions, goals and specification of the sequences of actions. Four various recognition action cycles i.e., memory, cognition, perception and motor movement. With the exception of the long-lasting memory, the processors have limited capacities, constrain individual's behaviors and therefore affect the HCI model [7].

There is need to satisfy the individual's motor and perception requirements where signals have to be perceived and the responses fall within the range of the individual's motor skills. However, more significantly, the interface has to empower the memories and the cognition capacities of

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the users to master and reason out critically concerning the behavior of the system. If this is not the case, the interface of the users will affect the individuals' ability to master the aspects of the system. Bad interfaces imply that the users will not utilize the model to mitigate novel and challenge issues.

Overview of the Model

Whereas the HCI aims are clearly-defined, it is not completely obvious how the designers of the model have to proceed on the development of the interface which meets the sole objectives. Recent studies suggest that the framework model has to be employed based on the HCI design. The scheme model represents the conceptual depiction of a collection of objects, permissible operations concerning the objects, the connections between the operations and these objects that are in the interface. Choosing a good system model allows the designers to develop consistent and clear interfaces. This represents the premise of the interface design model as shown in Figure 2 below.

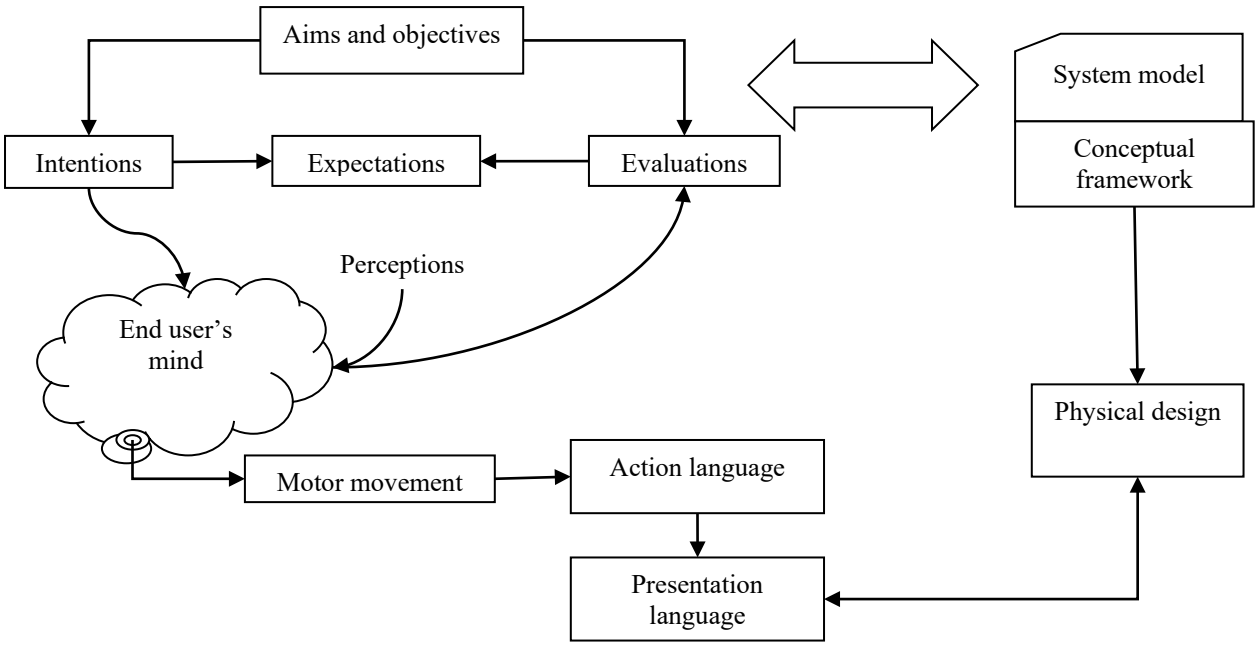

Fig 2. HCI Model

The conceptual framework reflects on the designing of the model such that the underlying procedures of computing are done indirectly pertinent to the users in mode that is compatible to the individual's understanding of the complete process. The physical aspects of the model include the presentation languages and the design actions that include the symbol and sign patterns which allow the users to communicate in the system. The design actions and the languages of presentation are based on the coherent model which allow the users to develop the mental framework through repetitive application. The mental framework is individual's personal conceptualization of the model component, interrelationships and procedures which transform their components.

The mental framework gives explanatory and predictive power to comprehend the interactions hence allowing the users to reason how goals can be accomplished. Therefore, the closer the model is matched to the expectations of the users, the more quickly and easier the process of learning happens. Enhancing the model necessitates the research of the expectations of the end-users.

3. Literature Review

A model, according to researchers in [8] provides the projected direction regarding how presentation languages and design actions can be implemented. These are used to determine the look and feel of the system in subject. As for the positions with close correspondence between languages and the model, the end-users are capable of manipulating the various parts of the model easily. This forms an interface of naïve realism which denotes the one that users do and it is not familiar with the computation technicalities incorporated in the software. However, naïve realism cannot be achieved with ease since the technological restrictions affect the selection of the dialog style and impose the required rigid syntax guidelines and the procedures of recovery.

Therefore, in specifying the language actions, the tradeoffs of design have to be structured between the satisfaction of the individual's cognitive needs and the technological constraints [9]. The presentation language incorporates the action languages through the process of displaying the findings of model execution such that the users can integrate and evaluate the findings. It also

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incorporates the design tradeoffs in selecting proper objective representation, information formats, spatial layouts, user-assistance systems and the confirmative mechanisms.

As shown in Figure 2, the model acts as a basis for presenting the language and developing the actions. The significance of the rule is shown through the user interface IFPS and '1, 2, 3's'. The model of IFPS resembles the algebra (linear) with the Fortran programming languages whereas '1, 2, 3's' represents the paper spreadsheet and the electronic calculators. The model selection amounts to clear differentiation of actions and the presentation languages of the two interface packages [10]. IFPS action languages recommend the users to follow the syntax guidelines of account reports which can be visualized in the top-down way. Moreover, the model presentation and the user actions are disjointed using IFPS which means that the users start by entering the algebraic formula, waiting for the model to process the formula and receive outputs when the model completes the process.

Contrary to that, '1, 2, 3's' actions and the presentation language are interchanged. '1, 2, 3's' permits the end-users to use the spreadsheet by shifting the cells, column and row to an order that enters specific formula and data. Presentation users use the same row and column format utilized for the inputs and allows the users to obtain instant results for every action. The features of '1, 2, 3's' presentation language and actions are acknowledged more than the IFPS' although they provide the same capability. There are potential successes of the spreadsheet packages i.e., '1, 2, 3's' can be the conceptual model which matches the understanding of the users regarding the tasks in the spreadsheet.

As discussed earlier, enhancing the system model necessitates the research of the end-user's expectations. One methodology is to formulate the prototypes which gives an ecosystem the refining and testing system model [11]. Nonetheless, this is costly and time-consuming. As such, different cognitive frameworks can be utilized to define and analyze the behaviors of the users. This form of theoretical evaluation is crucial for the system designers to choose the best design from the various alternatives amounting to less time required for the HCI design. Researchers in [12] evaluate the performance of the users used in the GOMS framework, a segment of cognitive models. The model includes four cognitive elements: aims of the task; operators incorporating the key presses and inner operators; approaches of operators for attaining goals and the selection of guidelines for selecting the competing approaches to accomplish the same goals.

The major segment of the GOMS analysis is based on the evaluation of experts undertaking repetitive and well-learned tasks. This has amounted to the discovery of the parameters like the time for the keystroke's entry and the evaluation of the framework outputs which is essential for projecting the skills-user performances. However, other essential aspects of the users' behavior cannot be modeled using GOMS i.e., recovery from errors and production of errors which also incorporates the usage of sub-optimal methods and goals in performing the routine editing obligations, even when efficient methods and goals are identified [13].

SOAR is considered as a generalized cognitive model for human intelligence. However, it is applicable widely in HCI study and has the capacity to answer questions not focusing on GOMS. SOAR represents an application for human intelligence which models the end-users to undertake the novel routines and novel tasks. Moreover, adding to the knowledge base and engines performing tasks, SOAR utilizes a learning approach. It gives an account of how users assess the response of the model and formulate novel intentions and goals. With SOAR, it is possible to evaluate the time it taken by end-users to identify the impasse in their skills and set novel actions and goals meant to overcome an impasse.

The formal grammar determined by BackusNaur Form (BNF) can be utilized to define the guidelines of the action language. Based on this, analysts can possibly project the cognitive efforts required to master the language through the determination of consistency and volume of the guidelines [14]. TAG is considered as a language that makes explicit knowledge required for the users to comprehend syntax and semantics for the user interface. Moreover, to identify the consistencies of the grammar guidelines, TAG is applicable to research the effective match of the task characteristics of the languages against the user goals.

TAG, GOMS and SOAR are used to provide the guidance required in the designing of system actions, presentation languages and models. For instance, GOMS suggest that model designing has to be based on the evaluation of the end-user goals to identify the techniques for attaining these goals. SOAR highlights the significance of modeling the knowledge of the end-users of the model to mitigate novel and challenging issues. TAG shows how the action language influences the organization and learning of the users. It has to be considered that every theory can illustrate some of the aspects of the human behaviors in HCI. For instance, GOMS framework can define the task of choosing options from a collection of choices. However, this might fail to project the errors made by the users when utilizing the line editors [15].

Lastly, TAG gives the purpose why the errors can occur but cannot tell the time-by-time performance. Moreover, psychological features such as attitude, preference and cognitive elements such as cognitive style and mental imagery are not referenced in these theories. The specificity of every theory amounts to the uncertainty segments in HCI design, limiting out capacity to apply them practically. A significant need for incorporating theories and practices is still a basis of HCI study.

4. HCI Model Design

The design of the HCI model is a key aspect of the conceptual definition of how human systems operate. This necessitates an evaluation of the users' tasks which means that the model can be structured according to the comprehension capacity of the users regarding the tasks. It also necessitates an evaluation of the abstract frameworks and metaphors which can portray the functionality of

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systems. The findings of the latter evaluation may also aid in the process of choosing representations for model functions/objects and in training the users.

Work Cases and Activities

Objects, methods and goals can be discovered by evaluating users focusing on work-based scenarios. The case represents the record of users interacting with devices in response to events that are critically constructed so that a user performs definite actions (such as re-ordering document paragraphs or computing returns on fiscal investments). Critically structured events ensure that detailed range of conditions are evaluated and the findings are applied to actual-world situations. Case evaluations provide the records of the users' actions with certain individuals' goals, objects and methods required to accomplish these objectives which are identified. The records of different users in the same case allows the designers to contrast various techniques to the accomplish same task situation and produce a set of objects and methods for wide-range individuals.

Complex Work and Routine Tasks

Task evaluation followed by the analysis of the cognitive procedures include in dealing with events. Analysts have witnessed that individuals' mental procedures happen at two different levels: low level and high-level processing. In the low-level processing, there are well-rehearsed and well-learned processes for dealing with routine occurrences such as word deletion and data entry. High level processing depends on the competencies of the model and this is utilized in producing plans and actions meant to deal with non-routine tasks.

To effectively support the low-level processing, objects have to be structured into operational chunks and logical chunks which have to match the relevant actions which individuals typically make with the objects in actual world scenario. In that regard, mastering how to associate the operations with objects is easier with operational practices and can be applied automatically and parallel since the evaluation of information content and definition of every individual's actions is unneeded. For instance, the spreadsheet model supports minimal level processing by managing the spreadsheets into columns, rows and cell operations such as 'delete' can be applicable to any of these data levels with just a typical cursor movement and the menu action selections. The high-level processing is signified by the top-down approach and is determined by the users' motives and goals. The planning is conscious, serial and slow.

The structure of action is a goal plan which defines how the users decompose the issue into a series of techniques when applied effectively handles the work conditions. When dealing with complex tasks, users may divide the complete task into various subtasks and handle the subtasks separately at various moments. Therefore, to support the high-level processes, it is fundamental to ensure that users' goals can be attained with ease through the combination of operations highlighted by the model in a distributed and sequential manner.

This form of flexibility can be visualized in the Xerox Star Workstation, whereby operations for a single goal (such as creating documents) can be suspended with the ease to undertake operations for goals (such as forming spreadsheets). Stars permit the users to cut segments of a single object i.e., spreadsheet and paste it as an object i.e., document to attain a high-level goal for forming a report. Task evaluation findings can be documented with the application of SOAR, TAG, BNF or GOMS. To finish the interface methods, details and designs, operations have to be performed on objects which have to be specified during the physical designs.

Simulation Anti-Rule Evaluation

Necessitating individuals to define their work needs in their language can potentially identify the abstract models and metaphors. The pencil and paper simulation of projected interface allows the users to operate out from the normal working cases. This methodology is joined with the think-aloud rule analysis which makes it potentially possible to determine how work is arranged and completed. It is significant for deriving the estimate of the individuals' set of based data objects and functions.

Another fundamental technique is known as the Wizard-of-Oz. This method incorporates two connected mechanisms, one for the users and the other one for the designers. Both the designers' display and users' display indicate a simulated perspective of the framework. To focus on the tasks, the individuals enter the command that has been routed to the screen of the designers. The designers are capable of simulating the computers based on the assessment of the individual input and transferring the responses to the individual screen.

This technique is advantageous since it places the users in the work-like condition well before the last system is completely programmed. Lastly, the user interface control model such as dialog/domain, prototype and Guide or the hypermedia framework such as the HyperCard. These models can be utilized for the rapid prototyping to assess the needs of the users. Nonetheless, these are more expensive compared to the Wizard-of-Oz based on the manpower and the moment required for evaluating the prototype

.

5. Discussion

Wide-range research is still required if we are to comprehend the model design of HCI. Our experience and skills regarding the cognitive procedures of HCI is considerably scarce. However, the recently done analyses focus on this segment indicating an enhanced awareness of its importance among the practitioners and researchers. One fundamental approach is to apply the theories such as SOAR, TAG and GOMS to evaluate the wide-range computing tasks for comprehending mental activities included in mitigating the present and future problems.

This contribution has been underway and the artificial intelligence programs adding to the means-ends in evaluation and multiple issue spaces have been evaluated for the users' task knowledge. This evaluation can alert designers about possible issues of the projected interface.

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Another essential strategy is to enhance the psychological techniques to master the individuals' prior competency and the cognition procedures. These techniques are applicable while evaluating the manner in which the users create the mental system and assess the inconveniences between the system models and the users' mental system.

This gives the feedback concerning the quality of the model design to the potential designers, who can therefore enhance their design approaches. Adding to this, guidance is required for applying metaphors to the model design. Whether the system is based on the metaphors or not, the users of the system will provide comparisons of the metaphors. Actually, what will happen if the comparison leads to the confusion of the users since the inconvenience between the users' individual comparative ideas and the designers' metaphor selection are considered?

Stages of Transformations of the Metaphors

Approaches are required to portray the metaphors so that the comparison of the metaphors is obvious but somewhat distracting. It is also fundamental for approaches to evaluate the alternative metaphors. Researchers have hypothesized the transformations of the metaphors into the precise comprehension of the model following three stages as shown in the Figure 3 below.

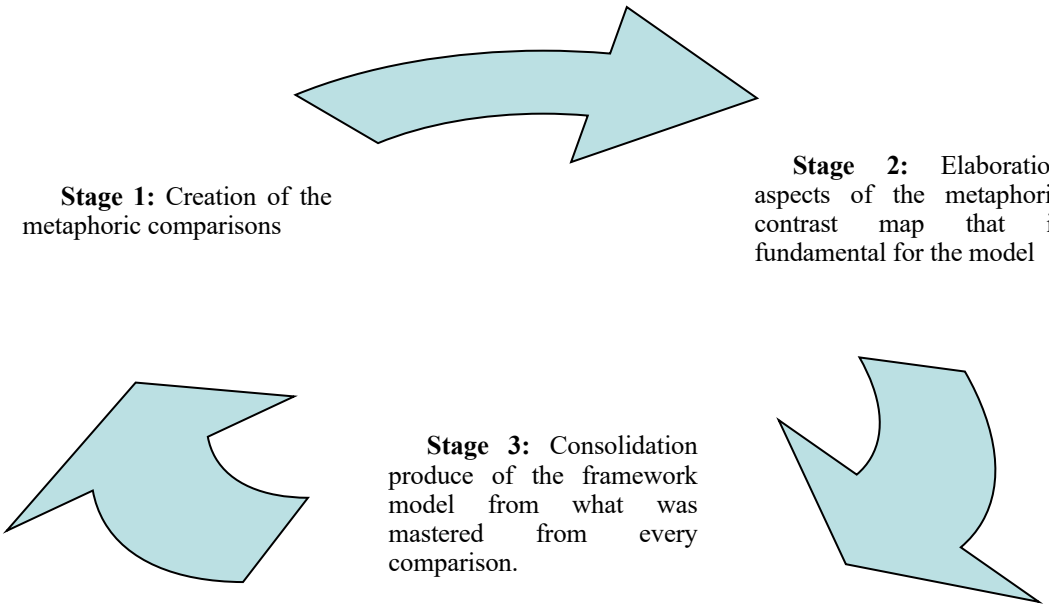

Fig. 3: Stages of transformations of the metaphors

Nonetheless, it is considerably clear how theories can be applied to evaluate the metaphoric learning. Lastly, the confusion of the users arises whenever the model concepts have no single analogical illustration such as the variation between the hard carriage controls and the aline wrap-arounds.

Presentation of the Language Design Model

This is the final segment of the HCI model. A fundamental design aim is for interface designs to guide the actions of the end-users. This aim necessitates the selection of the representation which fit the description of the individuals' task knowledge. The format of information provided by the model has to satisfy the preferences and requirement of the tasks. The display design is to be managed and structured so that the collective presentation of different outputs eases users' interpretation and perception. The presentations are meant to convey the responses to attract the attention of the users and confirm the users' actions. Lastly, internet assistance has to be designed to assist the users to master the operation of the system and rectify any potential errors.

Object Representation

In case the presentation is to reflect the metaphors where the model is centered, the model designers have to select the appearance of the display which helps the users to establish the kind of analogy between the displays and metaphors. The same appearance allows the users to identify and interpret the representations with ease. Some of the rules are identified in the spreadsheet-like interface of '1, 2, 3's' and the desktop computers of Stars. The icons in this signify the data that can be differentiated. Icons can be taken from the concrete picture replication of familiar object i.e., trash can icon the start.

The abstract icon involving the geometric figures and shapes can depict the model concept with no pictorial icon replication. The abstract and concrete icons can also be linked to form the hybrid icon, such as deleting the features. Different from the concrete icon, the hybrid and abstract icons have to be mastered by the users. When this process is complete, essential system concepts are conveyed.

Presentation Format

When presenting the findings, the table and graph format can be utilized to satisfy the decision forms and the task

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needs which is of a significant interest to the models of the decision support frameworks. Whenever the task necessitates a significant volume of information, graphs are critical that the tables are utilized for permitting the users to summarize information. Apart from that, the graphs are also effective for tasks such as forecasting, trend evaluation and interpolation which necessitate the identification of patterns from the wide-range volumes of information. Converse to that, when the tasks necessitate pinpoint information with upmost accuracy, tables are needed. The tables also surpass the graphs for simplified production of properly scheduled choices. However, for complex choices, graphs are considered more superior. Lastly, linking the table and graphs formats can amount to effective decisions although they have slower performance contrasted to the utilize the displayed ones.

6. Conclusion and Future Directions

In conclusion, interfaces are internet-based models which can be structured promptly, but are challenging to structure. The challenges and complexities require the decomposition of the complete interface of the user's design issue into minimal but manageable issues alongside re-evaluation of their interconnections. The model discussed in this contribution services the fundamental purpose. The HCI model organizes the study into three core groups: presentation language, action language and system model. This research evaluates the present HCI study results and evaluates their impractical effects. The purpose of this research is to allow the HCI model practice to be systematic and minimally intuitive compared to how it is in the modern SMEs age. In the attempt to evaluate the purpose of the designers to document the design the rationale, it is noted that design process should further be comprehended. As such, future research should focus on the contrast and comparison of the design rationale of the different system which allows analysts and practitioners to capture constraints influencing the HCI model design. The collection of the model designs and rationale can be utilized to establish the practical principles and guidelines that have to be revisited to structure theories about the HCI model in SMEs.

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