USING MULTIMODAL METAPHORS TO COMMUNICATE CUSTOMER KNOWLEDGE: AN EVALUATION ON EFFICIENCY

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ABSTRACT

This paper describes a comparative evaluation study conducted to examine the impact of incorporating avatars with facial expressions into Electronic Customer Knowledge Management Systems (E-CKMS) on efficiency of E-CKMS. Although the implementation of E-CKMS encounters several challenges, such as lack of trust and information overload, few empirical studies were devoted to examine the role of metaphors of audio-visual nature. As a result, an empirical investigation was carried out by implementing avatars-enhanced multimodal E-CKMS (ACKMS), and comparing it with text with graphics E-CKMS (VCKMS), and another multimodal E-CKMS (MCKMS) that utilises speech, earcons and auditory icons. The three experimental systems were evaluated by three independent groups of twenty users each (n=60) performed eight common tasks with an increasing complexity and three different styles of Customer Knowledge Management (CKM). Results and analysis revealed that ACKMS outperform MCKMS and VCKMS with regard to the percentage of task accomplishment per unit of time.

Keywords: Expressive Avatars, Facial Expressions, Usability and Trust, Customer Knowledge Management

INTRODUCTION

Harnessing intangible assets is regarded as one of the primary sources of creating, and sustaining superior performance in the age of knowledge (Goh, 2005). Knowledge, as a concept, covers a vast area of various taxonomies, principles, levels, and views. knowledge can be categorised based on the source of elicitation into internal and external knowledge (Bolloju et al., 2002). External knowledge or Customer Knowledge (CK) is elicited from beyond the organisational boundary, during the customer-company interaction (Dous et al., 2005), under a great deal of time pressure (Lesser et al., 2000), and regarded as the most valuable type of knowledge (Rowley et al., 2007). However, the lack of customer willingness to share knowledge (Gurgul et al., 2002) is a common CK elicitation issue that can be alleviated by incorporating multimedia systems (Gibbert et al., 2002), and interactive components. Although the potential of multimodal interaction is well recognised, empirical studies that evaluate this role is generally lacking in the current literate to Customer Knowledge Management (CKM).

This paper describes an empirical investigation carried out to assess the effect of incorporating multimodal interaction metaphors into Electronic Customer Knowledge Management Systems (E-CKMS) interfaces on efficiency. It was noteworthy that this paper is as an extension of an earlier study that evaluated the effect of multimodal metaphors on usability (Alotaibi and Rigas, 2008a; Alotaibi and Rigas, 2008b; Rigas and Alotaibi, 2008). In order to achieve the research aims, two experimental platforms were implemented (Multimodal), and compared to a control one (text with graphics) in terms of the user's attitudes and knowledge. The paper contributes to the literature to CKM, especially to the manner in which knowledge is communicated to the customer, and introduces CKM as a new application domain of audio-visual metaphors. The remainder of the paper is organised in six sections. In Section 2, draws current knowledge on three key themes: CKM, trust and customer interaction. Section 3 describes the three E-CKMS experimental platforms. Design of the empirical study is presented in Section 4. In Section 5, we presented analysis and discussion of results. Conclusion is provided in Section 6. Finally, we describe future work in Section 7.

CUSTOMER KNOWLEDGE MANAGEMENT

CK can be best described as "the dynamic combination of experience, value, scenario information and expertise, insight which is needed, created and absorbed during the process of transaction and exchange between the customers and the enterprise" (Feng and Tian, 2005). CK is categorised into three basic types: knowledge for customer (prepared inside the company), Knowledge about customer (discovered by the powerful analytical systems), and knowledge from customer (customer expectations) (Feng and Tian, 2005). Knowledge from customers can be gathered via feedback mechanisms (e.g. customer reviews and ratings), which is provided by customers for peer customers, and introduced by web-based retailing systems, such as Amazon.com (Rollins and Halinen, 2005). This type of CK develops through the constant use of products, which may include knowledge about products provided by competitors (Feng and Tian, 2005), and it is vital for product development and innovation (Bueren et al., 2005). In addition, Gibbert et al. (Gibbert et al., 2002) proposed the five styles of CKM that included Communities of Customers (COC) and co-production, and introduced lack of trust as an issue that can be addressed by interactive multimedia cues.

Communities of Customers (COC)

Amazon.com can be regarded as a typical example of COC, which are deeply rooted in the traditional Knowledge Management (KM) (Gurgul et al., 2002). COC facilitates CKM by establishing a knowledge sharing space, which included ratings and reviews, for customers (Gibbert et al., 2002). Experienced customers tend not to share (knowledge hoarding), due to the fear of losing power or intellectual rights, but they can be encouraged to do so by means of intensives or multimedia solutions (Davenport and Prusak, 1998). Besides the KM aspects, the COC context involved Customer Relationship Management (CRM) ones, in which CRM components analyse customer buying behaviour in order to leverage selling opportunities (up-selling and cross-selling) (Pan and Lee, 2003). In brief, Amazon.com introduces knowledge obtained from CRM analytical components (recommendations), knowledge elicited by means of KM (ratings and reviews), and product information (Stefanou et al., 2003).

Co-Production

Co-production can be seen as another CKM style (derived from KM) that allows customers to participate in the New Product Development (NPD) process, by proposing products, and then testing them. Electronic Products (E-Products), in particular, do not require a complete line of production, in which the customer may experience repeated shifts from production lines to customer care departments and visa-versa (von Hippel, 2001b). Instead, E-Products requires only a software (Gurgul et al., 2002) to be produced, such as the open source software and user innovation communities (Von Hippel, 2001a). a full detail is provided in Microsoft case study (Rollins and Halinen, 2005). More recently, Etgar (Etgar, 2008) argued that co-production is linked to customisation, which reflects customer intimacy and one-to-one marketing aspects. Etgar presented four co-production outstanding issues, alongside with a theoretical model that addresses them. Decision of customer engagement in co-production is among these issues, and it requires trust in the first place.

Trust

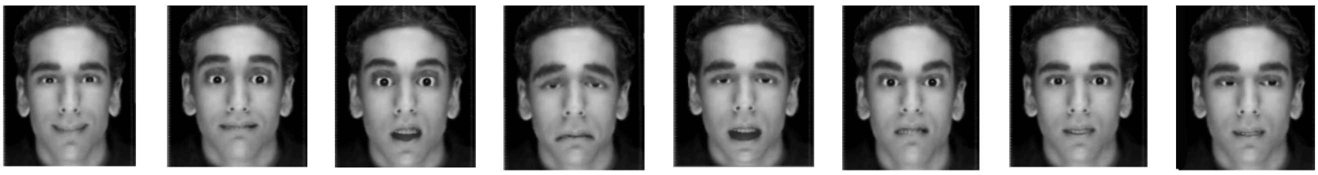
Trust is an important aspect of E-Business (Alotaibi and Alzahrani, 2004) settings, due to the lack of interpersonal interaction (face-to-face), and formal assurance (printed receipts) typically found in traditional retailing (Aldiri et al., 2008). The concept of trust covers a cognitive assessment of the goodwill and credibility of the partner (trusting beliefs), as well as behavioural intentions that reflects the willingness to rely upon the partner (Casalo et al., 2008). It has been argued that behavioural trust is influenced by cognitive trust, and measuring both components is regarded as redundancy (Casalo et al., 2008). This argument is based on the theory of reasoned action (TRA) that stated that behavioural intentions are influenced by attitudes, which are built around beliefs (Fishbein and Ajzen, 1980). Beliefs are categorised, in cognitive trust, based on the level of perceptions of individuals into ability (beliefs of the partner skills), benevolence (beliefs of the partner personal interest), integrity (match between perceived and expectation value (Feng and Tian, 2005)), and honesty (beliefs of the partner desire to keep promises) (Aldiri et al., 2008). In the context of CKM, lack of customer trust was raised as an issue in customer loyalty (CRM aspect) (Casalo et al., 2008; Feng and Tian, 2005), knowledge sharing (Davenport and Prusak, 1998) (KM function), E-CKMS (Gibbert et al., 2002), and even in face-to-face CKM (García-Murillo and Annabi, 2002).

Customer Interaction

Interactive technologies that produce high levels of social presence plays a crucial in improving users' perception of trust (Gefen and Straub, 2004). In E-Business contexts, trustworthy web-based systems should introduce a set of features that compensate the absence of skilful sale representatives (Katsikas et al., 2005), who can establish a persuasive communication of product information. In the literature to interactive multimodal interfaces, information was conveyed visually (text with graphics (Rigas and Bahadur, 2006)), vocally (speech recognition (Rashid and Rigas, 2008)), aurally (speech and non-speech sounds (Ciuffreda and Rigas, 2008)), or by combining speech with other modalities (e.g. facial expressions and body gestures (Rigas and Gazepidis, 2007)). Synthesis and recoded speech, in particular, represent the speech sounds utilised, whereas earcons (Brewster et al., 1993) and auditory icons (Gaver, 1986) used as non-speech sounds. Earcons can be defined as abstract sounds produced by instruments to convey single value, and once it was communicated, the only reference to it is the user's memory (Brewster et al., 1993). Auditory icons (Gaver, 1986) simulates natural sounds derived from the surrounding environments to convey the occurrence of events, and users are usually familiar with it, due to its metaphorical nature. In addition, facial modalities utilises human-like characters, which reflect higher levels of social presence, and convey verbal and non-verbal information by means of speech and facial expressions (Rigas and Gazepidis, 2006) (e.g. happy, sad, neutral).

Table 1 Differences between the VCKMS, MCKMS, and ACKMS experimental systems

Condition	Information / Metaphors	Communities of Customers (COC)				Co-production		Product Information	
		Trends	Reviews	Ratings	Website advices	Cost	Comparison	Price	Features
VCKMS	Text		√			√	√	√	√
	Graphics	√		√	√				√
MCKMS	Text		√				√	√	√
	Graphics	√		√	√	√			√
	Speech		√				√		√
	Earcons	√		√	√		√		
	Auditory icons		√		√		√		√
ACKMS	Text							√	√
	Graphics	√		√	√				√
	Visual special effect		√			√			√
	Speech		√				√		√
	Earcons	√		√	√				
	Facial expressions		√				√		√



Happy Amazed Surprised Sad Tired Disgusted Neutral Thinking

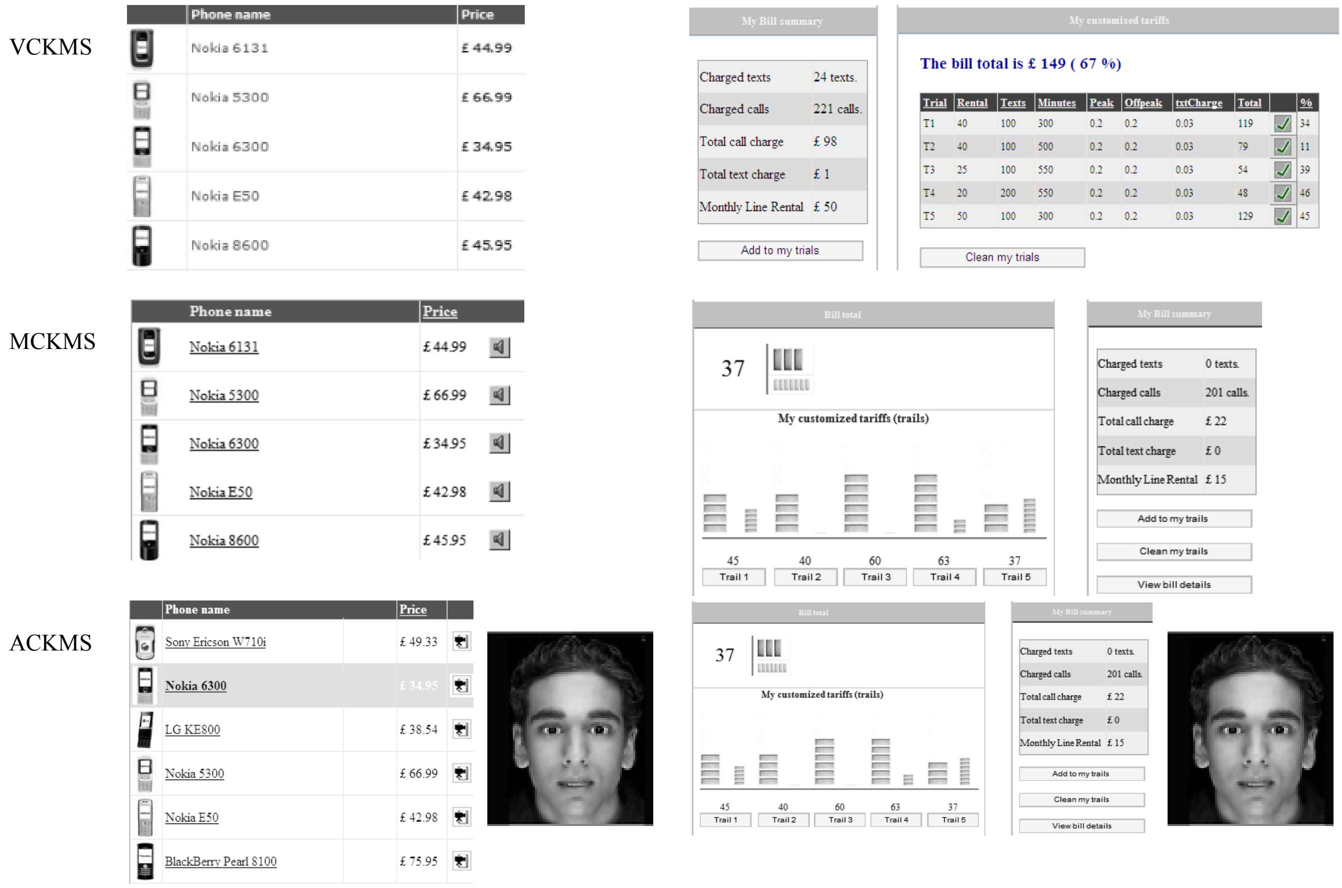
Positive Expressions (a) Negative Expressions (a) Neutral Expressions (c)

Figure 1 Positive (a), negative (b), and neutral (c) facial expressions used in the ACKMS experimental system

EXPERIMENTAL PLATFORM

The E-CKMS experimental platform presented knowledge and information usually found in web-based retailing systems, alongside with two CKM styles (COC and co-production). In the COC context, four basic categories of knowledge were communicated including trends (e.g. best and worst rated), customer reviews, customer ratings, and website advices (e.g. recommended, not recommended, top or least recommended products). Furthermore, co-production components enable an experimental NPD for E-Products (billing schemes) by offering a trial-and-error mechanism. The platform was implemented with three different interfaces: text with graphics only (VCKMS), multimodal that utilised speech, earcons, and auditory icons (MCKMS), and multimodal with natural recorded speech, earcons, and enhanced by human-like avatars (ACKMS). Metaphors used in these platforms were text, graphics, speech, earcons (including timbre, rhythm, and rising pitch), auditory icons, special effects, and facial expressions. Table 1 shows the association between CK category and the way by which it was communicated in the VCKMS, MCKMS, and ACKMS experimental systems. In summary, the E-CKMS Interface was designed and implemented differently based on the three environments: VCKMS, MCKMS, and ACKMS, in which different metaphors were assigned to communicate CK.

In order to implement multimodal user interfaces, several technologies was utilised, such as text-to-speech engine, speech agent, and sound recording software (KYDsoft, 2006). Furthermore, environmental sounds (Gaver, 1986) was introduced, such as sound of *typing, cheering, clapping, laughing, gasping, foghorn, side whistle, and camera shot*. In addition, earcons were created using multi-timber synthesiser software (Shah, 2006), and based on guidelines provided by Brewster (Brewster et al., 1995). Timbre, for instance, was utilised to differentiate first level of families of earcons (e.g. *guitar, violin, trumpet, drum, organ, and piano*) (Rigas and Alty, 1998), and rhythms to differentiate the second level. Furthermore, facial modalities were employed to convey different types of CK, alongside with speech, and categorised based on the nature of facial expression into positive, negative, and neutral expressions. Eight of the most popular expressions (Gazepidis and Rigas, 2008) were selected and employed including three positive (*happy, positively surprised, and amazed*), three negative (*sad, tired/bored, and disgusted*), and two neutral (*neutral and thinking*). The illustrations of facial expressions are presented in Figure 1.



Product Catalogue (a) Co-production Interface (b)

Figure 2 Snapshots of the VCKMS, MCKMS, and ACKMS interfaces according to product catalogue (a) and co-production interface (b)

Product Catalogue Implementation

The product catalogue was implemented as typical tabular one, and assumed that VCKMS presents as much information and knowledge as Amazon.com interface, such as product image, name, rating, and price. Both MCKMS and ACKMS were designed to present the same information, but with additional features that allow the user to utilise auditory cues, and video clips respectively to assess each product directly from the catalogue. In MCKMS, product features and CK, other than those provided in the product catalogue, can be evaluated aurally by clicking a button associated with each product. This button plays a sequential combination of environmental sound, speech, and rising pitch metaphors to communicate knowledge and information about the product and trends of customer opinions. Similarly, the same button is provided in ACKMS product catalogue, but it plays a video clip that presents a presumed sales representative who introduces the product features orally, and conveys knowledge about trends of customer opinions emotionally, alongside with earcons playing in the background to communicate knowledge about product rankings (e.g. worst or top rated, and top or least recommend). In contrast, VCKMS users were required to assess such information by navigating through to product details page and, if necessary, to customer review pages.

Co-production Implementation

Co-production allows repetitive NPD until the final design is reached via trail-and-error engine that stimulates the billing process. The customer manipulates billing scheme parameters, such as monthly rental, free minutes and free tests, and invokes a billing engine, which then provides customised bill (trial). The trial is stored in a trial comparison array to facilitate trials comparison, and hence support customer decision making. The trial comparison feature was lacking in VCKMS, because it listed the trials in a typical tabular form. In contrast, MCKMS and ACKMS utilised a graph aided by audio-visual metaphors to present trail comparison information (see Appendix A). Similar to the product catalogue approach, the comparison information was presented by auditory stimuli, and expressive avatar in MCKMS and ACKMS respectively. Figure 2 shows the differences between the VCKMS, MCKMS, and ACKMS according to product catalogue (a), and co-production interface (b).

Table 2 Summary of task description, styles, complexity, and complexity influential factors

Complexity	Task			Task Type			Complexity Factors	
	Code	Description	Product	COC	Non-COC	Co-production	NOTR	NOAS
Simple	T1	Product selection in the presence of COC	Phone	√			6	18
	T2	Product selection in the absence of COC	Tariff		√		4	22
Moderate	T3	Product selection in the presence of COC	Phone	√			7	8
	T4	Product selection in the absence of COC	Tariff		√		5	9
	T5	Co-production with two trails	Tariff			√	3	N/A
Complex	T6	Product selection in the presence of COC	Phone	√			7	2
	T7	Product selection in the absence of COC	Tariff		√		4	2
	T8	Co-production with five trails	Tariff			√	6	N/A

DESIGN OF EMPIRICAL STUDY

Sixty participants (all were students at University of Bradford, and regular internet users) were assigned randomly to three groups (n=20 each) based on the non-probability sampling, in which the probability of selecting an individual is unknown, and convenience-sampling method (Salkind, 2006), which targets captive audience. Participants were instructed to use the three system versions independently, by performing eight common tasks of three different types (COC-based product selection, non-COC product selection, and Co-production), increasing in complexity. In COC-based tasks (T1, T3, and T6), subjects were provided with a product selection scenarios in the presence of COC context, whereas in non-COC tasks (T2, T4, and T7) users were required to select products in the absence of COC. In the co-production style, the user was required to participate in the NPD process that produces E-Products (billing schemes). Tasks of each style were designed in an increasing complexity: simple, moderate, and complex. Although, task complexity is subjective in nature, three aspects were devoted to distinguish task complexity levels: number of task requirements (NOTR), number of available selections (NAOS), and Intensity of Customer Interaction (ICI). NOTR represented how many task requirements needs to be fulfilled in order to consider the task as successfully completed, while NAOS was to refer to the number of available products that when selected by the user, the task is regarded as accomplished. When the task was designed to be complex, NOTR was increased, while NAOS was decreased. It was categorised also based on ICI into low (T1 and T2), moderate (T3, T4 and T5) and high (T6, T7 and T8), which represented levels of complexity. Table 2 summarises task descriptions, CKM styles, complexity levels, and complexity influential factors. In summary, the present study identified three task types, three complexity levels, and proposed four dimensions to distinguish task complexity levels.

Experimental Procedure

This experimental research evaluated the difference between groups in order to uncover the causal relationship between factors. In fact, the evaluation of the three systems relied on a selected sample to evaluate the three conditions, and set of variables are measured. Subjects were assigned randomly to three groups (n=20 each), and then offered a short training session on the corresponding E-CKMS experimental platform. The users were introduced to examine a platform that they have never had an experience with before, to control user familiarity with the system. The three groups were provided with the association between information represented and the metaphors used to communicate them. The ability of users to interpret such metaphors was tested prior to the experiment through a specially design tasks, in which the user can be provided with help needed until the full understanding of perceptual context is demonstrated. Then, subjects were asked to perform the eight tasks, and the task order was balanced as so to eliminate any possible task learning effect.

Research variables

Variables can be regarded as the key focus of any scientific endeavour, due to their role in the representation of characteristics that needs to be recorded and precisely measured. Independent variables are manipulated in an experimental context in order to examine their effect on a particular outcome (Dancey and Reidy, 2004). In fact, E-CKMS interaction mode, task complexity and type reflected the three independent variables with three levels manipulated in this experiment. The dependent variable reflects the outcome measured during the experimental treatment (Dancey and Reidy, 2004). In fact, Percent of task accomplishment per unit of time was measured and calculated by dividing tasks success to failure ratio by task accomplishment time. The former was measured by counting the successfully completed tasks. In tasks that involved product selection, the accuracy of the selection was used to determine the task accomplishment. If the selection was accurate, the task regarded as successfully accomplished. In other tasks (i.e. co-production), task success to failure ratio was calculated to asses the extent to which the task requirements were fulfilled by determining the number of fulfilled requirements, and relating it to the total number of task requirements. The latter was observed during task accomplishment and one of the factors obtained from this observation was the time taken to accomplish the task. The unit of time used in this study to represent the time was 100 seconds.

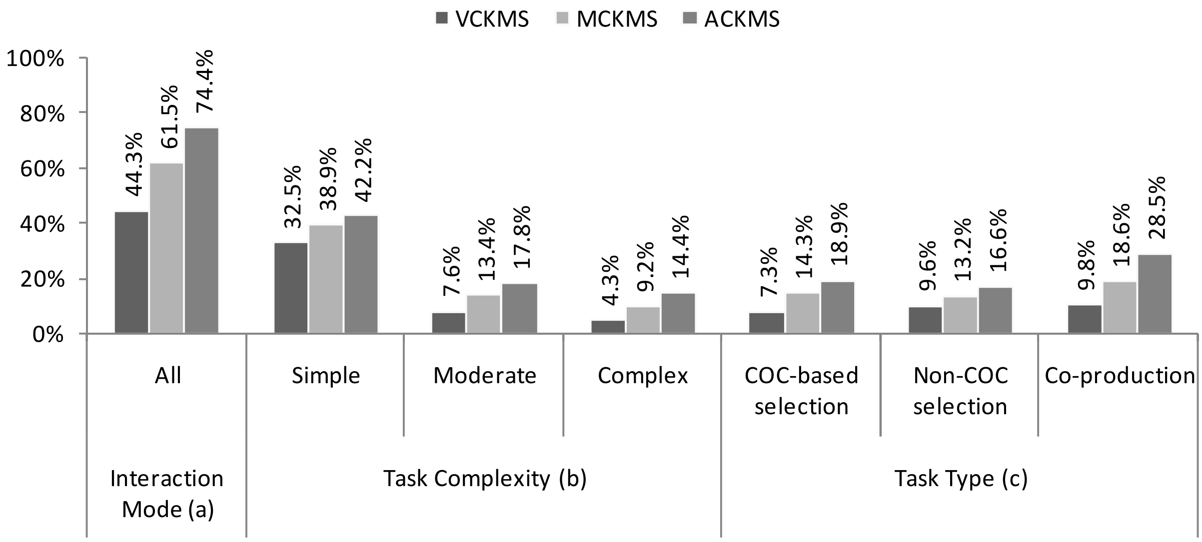


Figure 3 mean values of task completion per unit of time according to interaction mode (a) task complexity (b) and task type (c) using the VCKMS, MCKMS and ACKMS experimental systems

RESULTS AND DISCUSSION

Figure 3 shows the mean values of task completion per unit of time according to interaction mode (a), task complexity (b) and task type (c) using the VCKMS, MCKMS and ACKMS experimental systems. Overall, efficiency of using ACKMS was considerably improved, compared to that for MCKMS and VCKMS. In Figure 3 (a), it can be noticed that the mean value of task accomplishment per unit of time for ACKMS was higher than that for MCKMS, and considerably greater than that for VCKMS. The t-test results showed a significant difference in the percent of task accomplishment per unit of time between ACKMS and MCKMS (t_{37}=6.2, CV=2.03, P<0.05), as well as ACKMS and VCKMS (t_{37}=15.4, CV=2.03, P<0.05). In Figure 3 (b), the mean value of percentage of task accomplishment per unit of time for using ACKMS was affected by task complexity, because complex tasks have scored higher values, compared to the simple tasks. In simple tasks, the mean value for ACKMS was slightly lower than that for MCKMS, as the t-test results revealed that the difference between the two interfaces was insufficient (t_{35}=1, CV=2.03, P>0.05). However, the mean value for ACKMS was considerably higher than that for VCKMS, and the difference was found significant (t_{38}=2.9, CV=2.02, P<0.05). In moderate tasks, it can be seen that the mean value of task accomplishment per unit of time for ACKMS was considerably higher and over double that for MCKMS and VCKMS respectively. The statistical tests showed a significant difference in moderate tasks performance between ACKMS and MCKMS (t_{37}=4.3, CV=2.02, P<0.05), as well as ACKMS and VCKMS (t_{35}=12, CV=2.03, P<0.05), with regard to task accomplishment per unit of time. In complex tasks, it can be noticed that the mean value of task accomplishment per unit of time for ACKMS was considerably higher than that for MCKMS, and just triple that for VCKMS. This difference was examined by t-test, and found to be significant between not only ACKMS and MCKMS (t_{35}=6.6, CV=2.03, P<0.05), but also ACKMS and VCKMS (t_{38}=15, CV=2.02, P<0.05). In Figure 3 (c), it can be noticed that ACKMS user performance was considerably improved with regard percentage of task accomplishment per unit of time for the three task types. The co-production performance was particularly improved, compared to the two product selection tasks, and the lowest improvement rate was found in non-COC product selection performance. In fact, it can be seen that levels of task accomplishment per unit of time for ACKMS was considerably increased, in comparison with MCKMS and VCKMS. In COC-based product selection tasks, the rate of task accomplishment per unit of time for ACKMS was considerably higher than that for MCKMS and VCKMS. In non-COC product selection tasks, the mean value for ACKMS was considerably higher than that for MCKMS and VCKMS. In co-production tasks, the mean value of task completion per unit of time for using ACKMS was 53% higher than, and almost triple that for MCKMS and VCKMS respectively. The difference between ACKMS and MCKMS was examined by the t-test, and found significant in COC-based product selection (t_{32}=3.2, CV=2.03, P<0.05), non-COC product selection (t_{37}=3.8, CV=2.02, P<0.05), and co-production tasks (t_{38}=4.4, CV=2.02, P<0.05). In addition, the variance between ACKMS and VCKMS was highly significant in COC-based product selection (t_{38}=12.6, CV=2.02, P<0.05), non-COC product selection (t_{38}=8.3, CV=2.02, P<0.05), and co-production tasks (t_{37}=9.1, CV=2.02, P<0.05). In summary, levels and trends of task accomplishment per unit of time were improved considerably in the ACKMS user performance as opposed to MCKMS and VCKMS.

Discussion

During the experiment phase, it was noteworthy that ACKMS users were generally capable to complete tasks of different CKM styles, and increasing complexity considerably better than VCKMS and MCKMS users. The presence of avatars with facial expressions has been shown to be the key factor in the generation of positive feelings that have been linked to various considerable outcomes, such as increased user confidence, and improved interface friendliness. Users appeared to be more confident, and felt that the system was obviously very intelligent and had a pleasant appearance. In addition, it is becoming evident that incorporating expressive avatars into E-CKMS interface has, to some extend, compensated the absence of interpersonal interaction, and has been shown to be particularly useful to build and retain trust, due to the lack of human warmth and sociability in the traditional E-CKMS. To conclude, the social aspects of expressive avatars led to several positive emissions, which have showed to be particularly contributing towards the improvement of user engagement on CKM related activities, and the promotion of the user-website interaction.

CONCLUSION

This paper explored the efficiency of using audio-visual metaphors to communicate CK. E-CKMS environments encounters lack of trust and knowledge hoarding, but implementing audio-visual E-CKMS interfaces had the potential to address these issues, as this approach has demonstrated to be useful in other disciplines. This hypothesis was investigated, and the experience gained the investigation suggested that E-CKMS efficiency could be improved by enhancing textual and graphical representation of knowledge with metaphors of audio-visual nature. In particular, it is becoming evident that incorporating facial modalities, alongside with speech and earcons into E-CKMS interfaces has a positive effect on system efficiency, due the role of its social presence, in comparison with interfaces that incorporated speech, earcons, and auditory icons. Therefore, it is essential to designers of E-CKMS interface to be aware of the potential of, and foster multimodal interaction, not as an alternative approach to the visual communication of knowledge, but as a complementing method.

FUTURE WORK

This experiment revealed that incorporating interactive metaphors into E-CKMS has demonstrated to be useful with regard to the system efficiency, but users' experience had a potential effect, as it was controlled during the course of this experiment. Hence, a further investigation is needed to examine the role of interactive multimodal metaphors in enhancing the user's attitudes and knowledge with experienced users, compared with inexperienced ones. In addition, due to the nature of between-subjects experimental design, the design lacked three major factors. First, users could not choose the most preferred interface because each group of users has examined only one version. It is vital for users to view more than one interface in order to rate the perceived usefulness and ease of use for an approach, in comparison with the other one. Secondly, the performance of users was measured in different usability and complexity levels, which naturally affected the user's attitudes. Therefore, the effect of complexity and usability needs to be controlled and kept at the minimum levels. Finally, the experiments dealt with the user's satisfaction and trust in a vague manner, in which not all aspects of the user's attitudes were covered, such as cognitive and behavioural trust components, and perception of interface ease of use and usefulness. Therefore, measuring user attitudes towards using the systems in larger and more comprehensive scales merits further investigation.

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