

THE ROLE OF AUDIO-VISUAL METAPHORS IN AIDING THE COMMUNICATION OF CUSTOMER KNOWLEDGE

User Satisfaction Prespective

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Keywords: Customer, Knowledge, Multimodal, Interaction, Satisfaction, Sound, Speech, Earcons, Auditory Icons, Audio-visual.

Abstract: The purpose of this paper was to examine the implications of employing multimodal user interaction in Electronic Customer Knowledge Management Systems (E-CKMS). There are various challenges to E-CKMS mentioned in current literature and reported (trust and knowledge hoarding, structured transfer of knowledge and content and relevancy issues). As empirical CKM studies that examine the role of multimodal interaction in this field are generally lacking, this paper reports research conducted to evaluate this role and measure user satisfaction. This evaluation was undertaken empirically by developing two E-CKMS experimental platforms (text with graphics only and multimodal). The major findings indicated that user satisfaction was significantly improved by using multimodal metaphors. Further investigation is needed to determine the usefulness of two multimodal versions on E-CKMS instead of comparing text with graphics only with multimodal.

1 INTRODUCTION

The new means of IT, such as internet, extranets and intranets, leads to dramatic shift from information to knowledge societies (Thierauf, 1999, Goh, 2005). Harnessing invisible assets is becoming one of the primary sources of creating value and competitive advantage in the current age of knowledge (Goh, 2005). Knowledge as a concept covers vast area of various views (Becerra-Fernandez et al., 2004), levels (Davenport and Prusak, 1998, Rowley, 2002), principles (Such et al., 2001), taxonomies (Davenport and Prusak, 1998, Thierauf, 1999, Hahn and Subramani, 2000), strategies and trends. One classification of knowledge is based on the source from which knowledge has been elicited (external and internal) (Davenport and Prusak, 1998). External knowledge (CK) can be regarded as one of the most organisations valuable types of knowledge (Osterle, 1995), which is gathered at the customer point of contact under a great deal of time pressure (Lesser et al., 2000). The Utilisation of CK helps organisations to grow, innovate and compete against competitors (Gebert et al., 2002a, Gebert et al., 2002b), but it is not easy to gather, identify, interpret and integrate, because it flows to the organisation

form multiple communication channels (Bueren, 2005). This led to integrating both Knowledge Management (KM) and Customer Relationship Management (CRM) in E-Business contexts. More details on the determination and characteristics of KM, CRM and E-Business can be found in (Becerra-Fernandez et al., 2004, Tiwana, 2001, Skyrme, 2001, Alotaibi and Alzahrani, 2004).

E-CKMS is derived from the integration between KM and CRM in E-Business (Tiwana, 2001), and its typical example is represented in Amazon case study (Gebert et al., 2002b, Gurgul et al., 2002, Rollins and Halinen, 2005), which illustrates how Communities of Customers (CoC) works. There are several similarities between CoC and Communities of Practice (CoP), which mean that CoC is rooted in the traditional KM (Lesser et al., 2000, Gurgul et al., 2002). In CoC, peer customers share opinions and insights about products and services, which can lead to more effective and guided decisions made by any member of this community (Gibbert et al., 2002). From CRM point of view, storing and analysing customer historical transactions leads to understanding customer buying patterns, and hence leveraging up-selling and cross-selling opportunities (Tiwana, 2001, Pan and Lee, 2003). Amazon case study involves KM and CRM aspects that can be

benchmarked by efforts devoted to evaluating E-CKMS. Interactive systems can be seen as one of the CRM components that enable E-CKM by establishing learning relationship (learn while interact) (Massey et al., 2001). Interacting with customers in real-time and adopting CoC can be counted among several proposed approaches that improve the elicitation (Gibbert et al., 2002), expand the exploitation (Lesser et al., 2000) of CK, reduce cost, and hence replace the traditional approach that rely on understanding of sales representatives or results market research.

There were several challenges to E-CKMS that can be tackled using the interactive multimodal metaphors. Knowledge hoarding (Davenport and Prusak, 1998, Gibbert et al., 2002), for example, can be seen as the lack of customer willingness to share knowledge, and solved by several approaches that include optimising customer-company dialogue (Interaction) (Massey et al., 2001, Gurgul et al., 2002, Gibbert et al., 2002). Gibbert et al. (2002) stated that trust and knowledge hoarding could be tackled by not only establishing continuous two-way dialog with customers, but also employing interactive multimedia systems. Another challenge is that customers when interacting with E-CKMS needs to have their ideas well-structured and organised, which can be aided by what so-called Customer Innovation Toolkits (CIT) (von Hippel, 2001b, Von Hippel, 2001a). CIT can be incorporated into E-CKMS in order to facilitate an optimal transformation of customer expertise and expectations (knowledge sharing) into valuable suggestions, which can be afterward used to offer customised and personalised products and services. This context involves knowledge sharing, and hence encouraging customer to share knowledge is needed, which leads to the assumption that there is a potential role for multimodal interaction metaphors to play. Another challenge is information overload and relevancy, which is, actually derived the web-based environment. Authors (Davenport and Prusak, 1998, Bueren, 2005) in E-CKMS field raises information overload and relevancy as a concern, and include it with content issues, but some mention identification of relevant knowledge (Urban and von Hippel, 1988). Brewster (1997) argued that this could be addressed by enhancing the text with graphics only manner of information display with means of auditory metaphors (Brewster, 1997). To sum up, multimodal interaction is anticipated to address trust, structure and content questions in E-CKMS.

The remainder of the paper is organised in seven sections. In Section 2, we introduced relevant work.

Section 3 described the experimental platform. Design of the empirical study is shown in Section 4. In Section 5, we presented results and discussion. Conclusion is provided in Section 6. Finally, we described future work in Section 7.

2 RELEVANT WORK

Researchers in the CKM field tend to analyse CKM case studies, identify cultural, structural and managerial mechanisms that facilitate CKM success and propose models and frameworks for theory and practice. García-Murillo and Annabi (2002) proposed a model of social relationships, and put emphasis on interpreting knowledge directly by human (García-Murillo and Annabi, 2002). Some other authors consider structural aspects, such as organisational boundaries, culture, structure and climate (Bose and Sugumaran, 2003, Dous et al., 2005, Bueren, 2005). Others look at rewards systems, incentives, management support and perception (Gibbert et al., 2002, Gurgul et al., 2002). In addition, there were several authors who discussed CK characteristics, approaches, applications and relations (Feng and Tian, 2005, Lesser et al., 2000, Rowley, 2002, Skyrme, 2001). Business Engineering (BE) (Osterle, 1995) perspective suggests separating strategy, process, system and change levels (Bose and Sugumaran, 2003, Dous et al., 2005, Bueren, 2005). Several studies presented styles of CKM and types of CK (Gibbert et al., 2002, Gurgul et al., 2002, Feng and Tian, 2005, Rowley, 2002). Although, these studies commonly studied CK based on several perspectives and points of view, other than empirically examining the role of multimodal interaction, it provided insights into the underlying principles and theoretical foundations of E-CKMS.

There is little known about efforts in CKM field has been devoted to evaluate the potential role that multimodal metaphors can play in E-CKMS. Nevertheless, a great deal of studies in several fields of study have been conducted to evaluate such role, and found that user interface can be improved by the augment of speech (Kehoe and Pitt, 2006) (synthesised and recorded speech) and non-speech sounds (earcons (Rigas et al., 2000, Rigas and Alty, 2005) and auditory icons (Gaver, 1997, Cohen, 1993). In software engineering, There were several studies that support this view, such as (Sonnenwald et al., 1990, Cohen and Ludwig, 1991, DiGiano et al., 1993, Rigas et al., 1997, Rigas and Alty, 1998). Overall, user satisfaction and other usability

attributes can be improved in general Information Systems (IS) by employing multimodal interaction.

Table 1: E-CKMS visual and auditory metaphors.

CK category	VCKMS		MCKMS					
	T	G	T	G	S	E	A	R
Trends (top 10)		√		√		√		
Customer review	√		√		√		√	
Customer rating		√		√		√		
Website advice		√		√		√	√	
Co-production	√		√	√	√	√	√	
Product features	√	√	√	√	√	√		√

Burke et al. (2006) carried out meta-analysis investigation into the effectiveness of multimodal interaction, in forty three studies, and found that audio-visual metaphors have a significant role to play in improving user performance in IS compared to the visual-only display. In addition, this finding was supported by the results obtained from two experiments carried out by (Rigas and Memery, 2002), who investigated the use of auditory stimuli (speech, earcons and auditory icons) to communicate information to users in both email and stock control applications. Additionally, two studies (Rigas and Alty, 2005, Alty and Rigas, 2005) investigated utilising rising pitch metaphors in the communication of graphical information, and found that it was possible for visually-impaired users to interpret graphical information with the aid of rising pitch metaphors, even in the absence of a visual display.

Since E-CKMS is a web-based environment, it can be linked to similar fields of study, such as web-based browsing and email applications (Rigas and Memery, 2002, Rigas and Memery, 2003, Rigas, 2003). In web-based browsing systems, a prototype has been develop as an online help system with sound support (Kehoe and Pitt, 2006), and extended later by incorporating no-speech sound and other auditory metaphors (Kehoe et al., 2007). In addition, another web-based browsing prototype was built to browse musical notes with the help of sound, and proven successful performance improvement (Fernström and McNamara, 2005). In email applications, several experiments (Rigas and Memery, 2002, Rigas and Memery, 2003, Rigas, 2003) were conducted to evaluate the potential of audio-visual metaphors in reducing visual complexity and tackling information hiding, and concluded that this hypothesis was true, besides that visual display have to be synchronised with means of auditory stimuli.

3 EXPERIMENTAL PLATFORM

The experimental platform developed for this research provided typical functions of web-based mobile phones retailing systems, and included an additional function labelled as *co-production*, which defined by (Gibbert et al., 2002) as the manner in which customers practice New Product Development (NPD). Typically, E-CKMS consists of three main components: CKM, infrastructural and user interface components, and can incorporate any additional function, such as the one included in this study (co-production). This study assumed that CKM and infrastructural components were previously implemented.

Co-production function facilitates the dual role of customers (producer and consumer) by offering CIT that aid customers to manipulate elements in solution space to test new products (billing scheme). In fact, solution space included several elements, but the scope of this study limited these elements to loyalty, billing and taffies schemes. Furthermore, co-production function offered a trail-and-error engine that enabled experimental NPD, allowed its repetition until final product design was reached. This engine received customised schemes from CIT, sent it to billing engine, received customised bill, stored it in trails comparison array and provided comparison of results obtained from other trails in order to support customer decision making.

This platform was implemented with two interfaces. These two versions were text with graphics only E-CKMS (VCKMS) and Multimodal E-CKMS (MCKMS). In VCKMS, CK was communicated to E-CKMS users using text with graphics only, while the communication method was audio-visual in MCKMS. The communication of CK required classification of CK and auditory and visual metaphors, and utilisation of a wide range of technologies. First, Types of CK were organised into six categories (trends, customer reviews, customer ratings, website advices, co-production CK and product features). Some of these CK were communicated visually, auditory or simultaneously. Second, the visual metaphors employed were text (T) and Graphic (G), whilst the auditory metaphors were synthesised speech (S), earcons (E), auditory icons (A) and recoded speech (R). Table 1 shows each CK category and the way by which it was communicated.

4 DESIGN OF THE EMPIRICAL STUDY

The research undertook explored customer satisfaction aspects related to the use of audio-visual metaphors in three levels of task complexity.

Table 2: Summary of task levels influential factors.

Task	CKMA			Complexity factors			
	PSA	TSA	PRA	CKI	CI	NR	NS
E	A1	A2		L	L	10	40
M	A3	A4	A5	M	M	15	17
D	A6	A7	A8	H	H	17	4

The three levels are task easy (Task E), task moderate (Task M) and task difficult (Task D). In this study, task levels were created based on six influential factors: number of task requirements (NOTR), number of available selections (NOAS), number of CKM activities (CKMA), customer Interaction (CI) and CK intensity (CKI). If the task was to be designed as difficult, NOTR, CKMA, CKI and CI needed to be increased, while NOAS was to be decreased. In CKMA factor, there have been a various types of CKMA: phone selection activity (PSA), tariff selection activity (TSA) and Co-production activity (CPR). In CKI and CI factors, there were three important levels: low (L), moderate (M) and high (H). Table 2 reviews the task complexity influential factors, and illustrates the association between tasks and CKMA. More information on task levels, types and workload is provided on (Burke et al., 2006).

Forty subjects (all were students at University of Bradford, and regular internet users) were selected randomly, based on the non-probability sampling strategy (convenience-sampling method) (Salkind, 2006b). Subjects were divided into two groups (20 each): control and experimental, and then offered a short training session on the corresponding version of E-CKMS. Subsequently, subjects were asked to perform the three tasks and then fill a questionnaire devised for this study. The order of tasks was counterbalanced between participants in order to neutralize possible task learning effect.

5 DISCUSSION OF RESULTS

Satisfaction was measured by a set of user provided answers to questionnaire questions, which include

ease of the system (EOS), extent of user confusion (EOC), extent of user frustration (EOF), ease of navigation (EON) and overall comfort (COM). Measuring user attitude towards the system appears to be difficult. However, asking to specify the extent, to which the user agree or disagree with a set of statements, tend to support the pursuit of this measurement (Jordan, 1998).

Table 3: The mode and frequency values of the five aspects of customer satisfaction.

Group	Value	Aspects of customer satisfaction				
		EOS	EOC	EOF	EON	COM
VCKMS	Mode	4	3	3	5	5
	Freq.	50%	40%	45%	85%	55%
MCKMS	Mode	5	2	2	5	5
	Freq.	70%	55%	50%	65%	65%

User agreement and disagreement utilised a six-point scale ranging from agree strongly to disagree strongly (Salkind, 2006a). The values of the scale were six for strong agreement, five for moderate agreement, four for slight agreement, three for slight disagreement, two for moderate disagreement and one for strong disagreement. After completing all user satisfaction questions, responses were summed up to generate an overall score for user satisfaction, based on the system usability scale (SUS) (Brooke, 1996).

It was noteworthy that multimodal interaction reduced customer response time, which led to greater customer satisfaction and eventually loyalty. Participants in the experimental group expressed interest in CK communicated aurally more than those in the control one. Our experience with this platform suggested that users tend to be more comfortable with aural communication when sounds conveyed more rapidly than for the first time. At first glance, the mean value of customer satisfaction for using MCKMS (77%) was higher than that for VCKMS (63%). Significance of the difference between the two conditions was tested (at 0.05 significance level) using the t-test. The difference was found significant ($t_{38} = 4$, $CV = 2.03$ $P < 0.05$).

Table 3 shows the mode values for the aspects of user satisfaction with the values for using VCKMS and MCKMS, in addition to the frequency of the mode. User responses suggested that the multimodal E-CKMS is easier to use, less confusing and less frustrating. In fact, 70% of users agreed moderately that the multimodal system was easy to use compared to 50% agreed slightly that the text with graphics only version was easy to use. In user confusion and frustration, half of the sample agreed

moderately that the multimodal E-CKMS is neither confusing nor frustrating, in comparison to 40% and 45% of users disagree slightly that the text with graphics only version was confusing and frustrating respectively. Furthermore, Mann-Whitney statistical test was performed, and showed that there were significant differences in all aspect of customer satisfaction expect in the ease of navigation.

6 CONCLUSIONS

The role E-CKM has become increasingly important to public and private organisations due to the cost savings it offers. However, it is considerably complex, vague and challenging discipline due to the many aspects involved. This study shed light into three challenges to E-CKMS (trust and knowledge hoarding, structured knowledge transformation and content and relevancy issues), which can be tackled by utilising multimodal metaphors. This hypothesis was tested empirically by two independent groups in two E-CKMS. Subjects took part in this research were satisfied and expressed interest in the use of audio-visual metaphors. The significance of this approach was found in all aspects of customer satisfaction, except in the ease of navigation. Therefore, it can be concluded that audio-visual metaphors has contributed positively towards the improvement of customer satisfaction. In summary, results showed that the use of multimodal interactive metaphors in E-CKMS is more satisfactory than to text with graphics display.

7 FURTHER WORK

This experiment reported here proved to be successful. However, it was noticed during the previous experiments that users tend not to take into account various types of presented CK, such as customer ratings and reviews. Therefore, further investigation into additional multimodal metaphors is needed to determine how speech with aviator can promotes further utilisation of customer reviews, and this is expected to yield a set of useful guidelines.

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