Applicability of Agent Based Systems in Customer Knowledge Management

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ABSTRACT

Customers were introduced as one of the brilliant resources of knowledge for the companies and enterprises. This paper proposes to integrate the agent-mediated knowledge management and the customer knowledge management systems. This is to provide a framework to acquire the cryptic knowledge from and related to the customers and provides required knowledge for them. The abilities of agents in knowledge management systems are reviewed in advance then these capabilities are collated to the requirements of the customer knowledge management. A simple model for agent-mediated customer knowledge management systems is proposed as the final goal of this paper.

Keywords

Agent-Based System, Customer Knowledge Management, Knowledge Management.

1.0 INTRODUCTION

The customers can be considered as the partners of the companies in producing the products or providing the services. Customer relationship management (CRM) has been widely regarded as a company activity related to developing and retaining customers through increased satisfaction and loyalty (Xu and Walton, 2005). According to Ahn *et al.* (2003), CRM is a process designed to collect data related to customers, to grasp features of customers, and to apply those qualities in specific marketing activities. Garcia-Murillo and Annabi (2002) stated that gathering, managing, and sharing customer knowledge is a valuable competitive tool for the companies.

Human is known as the ultimate user of all the knowledge-based activities. The knowledge should be managed and classified to facilitate its accessibility for the users. Knowledge management (KM) is defined as a systematic, holistic approach to the sustainable improvement of the knowledge handling at all levels of an organization (Eppler, 2002). KM is primarily a management discipline combining methods from human resource management, strategic planning, change management, and organizational behaviour (van Elst, 2003). Dignum (2004) stated that the final goal of the KM is to provide suitable knowledge for the users.

One approach to address future CRM systems development is to link knowledge management and CRM in order to maximize not only operational, but strategic efficiency of CRM through gaining and sharing knowledge about customers (Rowley, 2002).

Gebert *et al.* (2003) demonstrate that CRM and KM have a high synergy potential and should be used in conjunction with each other. Integrating the KM and CRM provides a new framework for the companies addressed as customer knowledge management (CKM). The current research focuses on the application of the agent-based systems in the area of CKM (CKM model and its requirements are reviewed in section 2). The principles of the proposed model came from the requirements of CKM which can be covered using agents' abilities in KM (discussed in length in section 3). An introductory model for agent-mediated customer knowledge management (AMCKM) system is proposed in section 4. Through this section the applicability of agents in CKM is investigated. Finally the discussion about the proposed model and the conclusion remarks are gathered in section 5.

2.0 CUSTOMER KNOWLEDGE MANAGEMENT

The preferences of the customers are so important in ever increasing competitive global market. The companies have to know these preferences. Rowley (2002) defines customer knowledge as: knowledge about customers, which includes knowledge about potential customers, customer segments and individual customers; and knowledge possessed by customers. Gebbert *et al.* (2003) stated that customers gain their own expertise while using a product or services. According to Xu and Walton (2005), 71 percent of the managers believe that gaining and using knowledge and experiences of the customers is a new competitive battleground for the companies.

CKM needs to provide customer insight, profiles, habits, contact preferences and understanding to improve an organisation's contact with the customer (Xu and Walton, 2005). Garcia-Murillo and Annabi (2002) delineated that knowledge of market, product needs, and product characteristics, are required for the customers to make their purchase decisions. Knowledge from customers enables companies to make more intelligent decisions about products, services, and communication gateways with customers.

Rowley (2002) posed eight different questions about implementing CKM in e-business environment. She claimed that e-business environment offers a number of new opportunities for collecting customer data, and knowledge creation.

Garcia-Murillo and Annabi (2002) stated that CRM and CKM follow different objectives. While CRM tries to identify profitable customers, CKM tries to gather customer ideas. On the other hand CRM uses customized marketing but CKM tries to identify the service improvement areas and new product developments. Gebbert et al. (2003) stated that the final goals of CKM are transparency, dissemination, development, efficiency of knowledge in CRM processes.

Bose et al. (2003) described the capabilities of KM in CRM and developed a simple and overall framework to integrate the CRM functions with the management and application of knowledge in the context of marketing decisions. Gebert et al. (2003) proposed a model for CKM to acquire knowledge from and about customers and provide knowledge for them. They describe the responsibilities of various departments of the companies through CKM processes. Knowledge for customers is gathered through campaign management, and distributed to offer management and contact management. Knowledge about and from customers is captured by offer, service, and complaint management and distributed to campaign, and service management (Gebert et al., 2003). Using KM aspects in CRM processes allow a structure approach for the identification of business process improvement opportunities through KM.

Garcia-Murillo and Annabi (2002) proposed a model for CKM which considered the potential of simple personal interactions between sales person and the customers. Through this interaction the preferences of the customers, information about competitors, and the data about future of the market can be gathered. Furthermore the knowledge about various products/services helps the customer to make his purchase decision. Additionally this model proposes the sharing of knowledge with company officials to help in the development of future services and products.

Salomann et al. (2005) provide a managerial framework for CKM. The proposed framework enables practitioners to successfully utilise knowledge for, from and about customers in order to achieve superior performance of CKM initiatives. They stated that in order to unleash the full potential of customer knowledge, the companies must manage all three knowledge flows (for, from, and about customers) simultaneously. Lin et al. (2006) presents a proposed model for CKM. They implemented this model in two test cases. The results show hard measures such as market share, repeat purchases, cost savings, and customer retention and soft measures such as customer satisfaction, market leadership, and customer loyalty are improved through CKM implemented in these companies. Su et al. (2006) proposed the incorporation of a data mining technique into the CKM model. They stated that product innovation must link with the knowledge of customers' needs and preferences.

3.0 AGENT-BASED KM SYSTEMS

As mentioned earlier, KM is a management science which is in charge of supporting and extending human interactions and learning. The above considerations identify a novel direction in KM, that of collaboration management. According to Dignum et al. (2004) the new aspect of KM provide enough and on-time knowledge, prevent information overload and stimulate sharing of relevant knowledge in a dynamic, collaborative environment.

According to Dignum (2006), KM must be "reactive", to be able to respond to changes in the environment and user preferences. Moreover it should be "pro-active", to take initiatives to attend to user needs. According to Huang et al. (2004), two problems arise in the deployment of KM. Firstly the knowledge is distributed among many individuals, departments, and data stores. Secondly, the heterogeneous issues of knowledge sources also present a challenge in business. KM systems must therefore provide uniform access to a diversity of knowledge and information sources of different degree of formality (Dignum, 2006). Huang et al. (2004) enumerated many of the literatures tried to solve these problems using agent-based systems. Agent-based knowledge management (ABKM) is introduced as the new approach for implementing the KM systems.

An agent is a computer system capable of flexible autonomous action in a dynamic, unpredictable and open environment (Luck et al., 2003; and Monstori, 2006). The agents are *autonomous*, *reactive*, *pro-active*, and has the *social ability* (Wooldridge et al., 2001). An agent may have an environment that includes other agents or physical world. The community of interacting agents, as a whole, operates as a multi-agent system (MAS). In MAS systems the global objectives of the system are beyond the capabilities of each of the agents. So the agents have to follow their own goals and negotiate with other agents in case of conflicts. Agents make decisions based on their comprehension from the environment without direct intervention of humans. Agents do not simply act in response to their environment; they are able to exhibit goal-directed behaviour by taking the initiative (Wooldridge et al., 2001). Table 1 (Chira et al., 2006 and Wooldridge et al., 2001) provides the basic required characteristics for an agent.

Agents can be considered as natural metaphors for modelling KM systems. Agent-based architecture may help maintain integrity of the KM systems. Autonomy and social ability of the agents are the basic means to achieve this. Reactivity and pro-activity of agents help to cope with the flexibility needed to deal with the "wicked" nature of KM tasks. Pro-activeness as well as autonomy helps to accommodate the reality that knowledge workers typically do not adopt KM goals with a high priority (vanElst, 2003).

According to (Dignum, 2004), A BKM services include:
   a. Search to acquire, analyze, integrate, and archive information from multiple heterogeneous sources;
   b. Inform users when new information of special interest becomes available;
   c. Negotiate to purchase and receive information corresponding to goods or services;

d. Explain the relevance quality and reliability of that information; and

e. Learn to adapt and evolve to change conditions.

Table 1- Characteristics of agents

No.	Agents' Characteristics	Description
1	Autonomy	Agents make decisions based on their perceptions of the environment, without the direct intervention of humans or others
2	Reactivity	Agents can respond to environmental changes.
3	Pro-activeness	The initiative is required for the agents to pursue their individual goals
4	Cooperation or Social ability	Agents interact with other agents (and possibly humans) via some kind of agent-communication language
5	Learning	An agent should have the ability to learn while acting and reacting in its environment
6	mobility	A mobile agent has the ability to move around a network in a self-directed way

Chira *et al.* (2006), proposed an agent-based framework for the knowledge management in designing distributed virtual environments. They stated that extended enterprises need to develop distributed virtual environments. The aim of proposed framework is to optimise design process operation and management by supporting the dialogue among distributed design actors. The autonomy, pro-activeness and reactivity of agents and MAS represent a potential solution to these complex distributed design problems (Chira *et al.*, 2006).

Froelich *et al.* (2006), proposed an approach based on the agent paradigm to enable the integration and co-operation of different knowledge acquisition and representation techniques, together with the evolutionary optimization of the population of co-operating algorithms. Their experiments and realization on the proposed approach showed that this approach fulfils requirements of the knowledge acquisition.

4.0 PROPOSED MODEL OF AMCKM

This section is organised to introduce a basic model to illustrate the application of agents in CKM. The requirements of the CKM model can be covered by abilities of agents in knowledge management. This is addressed as agent-mediated customer knowledge management (AMCKM).

One of the most important methods for gathering the knowledge from the customers is to interact personally with them. This type of interaction helps to gather knowledge from the customer and identify knowledge that the customer needs. The knowledge can be obtained by both parties of an interaction. Based on the CKM model proposed by Garcia-

Murillo and Annabi (2002) a sales person is in charge of interaction with the customers. In AMCKM model, sales persons can be substituted with agents. The agents have the same behaviour against the customers, while the sales person performance and behaviour usually is dependent on the conditions of the interaction, the mental conditions of the persons and so many other environmental conditions.

The agents or MAS used instead of the humans need to be quite reliable and independent. Especially in the case of acquiring the knowledge from the customers, there is not any specific framework or routine question to discover this knowledge; while in providing knowledge for the customers usually specific question is required to be replied. Table 2 shows the abilities of the agents in KM and the requirements of the CKM which can be covered by the agents. The agents need to be rational in providing services for the customers. In many cases customers may enter wrong data into the CKM model. The agents need to be wise enough to identify such cases and prevent providing wrong knowledge for the wrong data. On the other hand, the agents have to customize the knowledge for the customers. Providing routine knowledge packages for defined customers is not the basic intended application of agents in CKM.

Table 2- The abilities of agents in CKM

No.	Ability of agents	Requirement of CKM
1	Autonomy	Provide the quick response to the customers' orders.
2	Reactivity	Agents need to interact with customers and respond to their actions.
3	Pro-activeness	Predict the requirements of customers prior to explain them.
4	Social ability	Usually MAS are needed in KM systems, communication with other agents and human supervisor is required.
5	Veracity	All the knowledge provided for the customers should be reliable and precise.
6	Compatibility	The agents should be customizable with ever changing preferences of the customers
7	Rationalism	The agents should follow the final goal of CKM which is to provide knowledge for customers and collect knowledge from and about customers.

Figure 1 provides a schematic view of the proposed AMCKM model. This is to show the basic application of agents in CKM, not to provide a practical model for the AMCKM, which is beyond the scope of this paper. In this model only three types of agents are considered (interface, knowledge-based, and reactive). Other kinds of agents can be considered based on the requirements of the CKM environment. In figure 1 the agents are shown by the circles, the rectangular shapes show the organization processes (not the departments). The knowledge repositories are shown by cylinders.
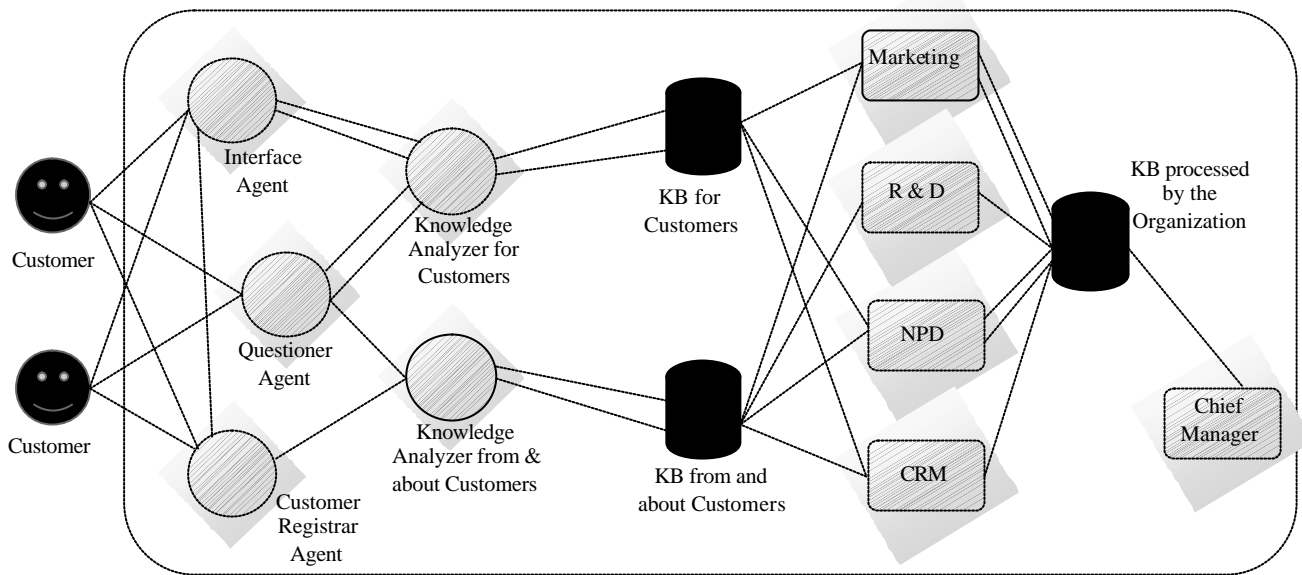
Figure 1: Proposed Model for AMCKM

As it is shown in figure 1, the interface agents are in charge of direct interaction with the customers. Each of the interface agents is supported by a knowledge-based agent. The knowledge-based system provides the required knowledge for the interface agents, and gathers, classify and deposit the knowledge from, for and about the customers. Agent number 3 is the most important interface agent to interact with the customers. Knowledge for the customers is gathered through this agent and is analyzed by agent number 1. The required knowledge for the customers is provided by the agent 1 and if such kind of knowledge does not exist, a request to provide this knowledge is issued by this agent.

Interface agent can refer an unidentified customer to the customer registrar agent (agent 5). This is to create a knowledge base for information about the existed and potential customers, and speed up the customization process for the customers. The registration process should be as easy as possible to encourage the customers to register at the CKM system. However the basic information should be available for all of the customers, even if they do not prefer to register at the system. The registrar agent can obtain the main parts of knowledge about customers.

Knowledge about customers is used by the second agent that is in charge of clustering and classification the knowledge from and about customers. Identifying repeated purchases, special purchases, identifying potential customers for specific purchases, and etc, can be analyzed by this agent. Agent 4 interacts with the customer in case of special questions or requests. Usually customers who did not receive their required knowledge from agent 3 are referred to this agent. Determining the missed parts of customers' knowledge is the main responsibility of this agent. In the proposed model for AMCKM the agents are substituting human sales persons for acquiring the knowledge from customers.

After obtaining the knowledge from and about customers, a mechanism is required to provide proper channels between knowledge repositories and the organizational processes that need this knowledge. In fact these processes are known as the main users of knowledge from and about customers. Furthermore the knowledge for the customers is provided by the organizational processes. The knowledge for customers which is provided by the organization is deposited in KB number 1.

KB number 3 is the storage for the knowledge processed by the organizational processes and can be used by other processes and departments. Generally it can be deducted that the requirements of the CKM system can be covered by the capabilities of the agents. Development of AMCKM system may results a meaningful reduction in the amount of human resources required for the CKM systems. By means of AMCKM the agents are responsible to interact with the customers and the expert human staffs are responsible to provide more reliable and precise knowledge for the customers and to analyze the knowledge from and about customers. On the other hand developing AMCKM system needs high skilled experts which may increase the costs of such systems' development.

5.0 DISCUSSION AND CONCLUSION

Customer knowledge management was used to acquire the knowledge from and about the customers and to provide the required knowledge for the customers. Customers gain the knowledge while using the products or services, which is so important for the enterprises. The agent-based systems were proposed to be used in knowledge management to improve the performance of such systems. Furthermore the interconnection between various knowledge resources and

several customers of the knowledge is provided by this methodology. Independent and autonomous agents facilitate the search, acquisition, analysis, and integrating the knowledge from the heterogeneous knowledge resources and the customization of knowledge for various users.

This paper proposed to use the agents in customer knowledge management. The introductory model for AMCKM is proposed in this paper. The applicability of agents in CKM is illustrated. Furthermore the benefits of using agents in practical CKM models are shown by this model. Agents' reactivity gives aid to AMCKM to respond the behavior of customers and to show the proper reaction. Generally agents provide an effective, reactive and autonomous interaction between customers and the company. More studies on the application of agents in CKM can be considered for future works.

REFERENCES

Ahn, J.Y., Kim, S.K. and Han, K.S., (2003) On the design concepts for CRM system, *Industrial Management & Data Systems*, Vol.103, No.5, 2003, pp. 324-331.

Bose, R., and Sugumaran, V., Application of knowledge management technology in customer relationship management, *Journal of Knowledge and Process Management*, Vol.10, No.1, 2003, pp. 3-17.

Chira, O., Chira, C., Roche, T. and Tormey, D. An agent-based approach to knowledge management in distributed design. *Journal of Intelligent Manufacturing*. Vol.17, 2006, pp. 737-750.

Dignum, V., An overview of agents in knowledge management. In Umeda, M., Wolf, A. Bartenstein, O., Geske, U., Seipel, D., and Takata, O. (Eds): *Declarative Programming for Knowledge Management*, Springer-Verlag Berlin Heidelberg, 2006, pp.175-189.

Dignum, V., Dignum, F., and Meyer, J.J., An agent-mediated approach to the support of knowledge sharing in organizations, *The Knowledge Engineering Review*, Vol.19, No.2, 2004, pp. 147-174.

Eppler, M Glossary definition knowledge management, NetAcadem, 2002, http://www.knowledgemedia.org/modules/glossary/viewdef.php?id=mediamanagement-20

Froelich, W., Dorohinicki, M.K., and Nawarecki, E., Agent-based evolutionary model for knowledge acquisition in dynamical environments, In: Alexandrov V.N. et al. (Eds.): ICCS-2006 Part III, LNCS 3993, 2006, pp. 839–846.

Garcia-Murillo, M. and Annabi, H., Customer knowledge management. *Journal of the Operational Research Society*, Vol.53, No.8, 2002, pp. 875-884.

Gebert, H., Geib, M., Kolbe, L. and Brenner, M., Knowledge-enabled customer relationship management. *Journal of Knowledge Management*, Vol.7, No.5, 2003, pp. 107-123.

Huang, C.C., and Lai G.H., Knowledge management system: an agent-based approach. *Knowledge Management Research & Practice*, Vol. 2, No.2, 2004, pp. 80–94.

Lin, Y., Su, H.Y. and Chien, S., A knowledge-enabled procedure for customer relationship management. *Industrial Marketing Management*, Vol.35, 2006, pp. 446 – 456.

Luck, M , McBurney, P and Preist, C , *Agent technology: enabling next generation computing: a roadmap for agent based computing. AgentLink II*, 2001.

Monostori, L., Vancza, J. and Kumara, S.R.T., Agent-based systems for manufacturing. *Annals of the CIRP*, Vol.55, No.2, 2006, pp. 697-720.

Rowly, J., Eight of question for customer knowledge management in e-business, *Journal of knowledge management*, Vol. 6, No. 5, 2002, pp. 500-511.

Salomann, H., Dous, M., Kolbe, L. and Brenner, W., Rejuvenating customer management: how to make knowledge for, from and about customers work. *European Management Journal*, Vol.23, No.4, 2005, pp. 392–403.

Su, C.T., Chen, Y.H. and Sh, D.Y., Linking innovative product development with customer knowledge: a data-mining approach, *Technovation*, Vol. 26, 2006, pp. 784–795.

van Elst, L., Dignum, V and Abecker, A , Towards agent-mediated knowledge management, In van Elst, L., Dignum, V. and Abecker, A. (Eds) *Agent-Mediated Knowledge Management: Selected Papers (Lecture Notes in Artificial Intelligence, 2926)*, 2004, Springer, Berlin.

Wooldridge, M. and Ciancarini, P., Agent-oriented software engineering: the state of the art, In: Ciancarini P. and Wooldridge M.J. (Eds.): *AOSE-2000, LNCS 1957*, 2001, pp. 1-28. Springer-Verlag Berlin Heidelberg.

Xu, M. and Walton, J., Gaining customer knowledge through analytical CRM. *Industrial Management & Data Systems*, Vol.105, No.7, 2005, pp. 955-971.