Towards Smart Customer Knowledge Management Systems

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Abstract. Nowadays, customer focus is one of the most important challenges of enterprises in identifying customer needs and providing suitable products and services to customers. Customer focus gives prominence to knowledge about, for, and from customers. Customer knowledge management and transfer – at the right time, in the right place, and with the right quality – enable enterprises to survive in today's business environment. This paper presents the concept of smart customer knowledge management and proposes a conceptual framework for studying and designing smart customer knowledge management systems based on the design science method.

Keywords: Customer knowledge management · Context-ware · Customer intelligence · Knowledge management system

1 Introduction

Nowadays, customer focus is one of the most important challenges of enterprises in identifying customer needs and providing suitable products and services to customers. Customer knowledge, which is defined as the knowledge about customers, knowledge for customers, and knowledge from customers, becomes crucial in offering customized products and services to customers [1]. Customer knowledge management and transfer, which should be available at the right time, in the right place, and with the right quality, enable enterprises to survive in today's business environment and to enhance their growth and competitiveness [2].

Enterprises are overwhelmed to take advantage of customer knowledge for smart services [3, 4]. However, designing a smart service system as a customer knowledge management system is a perplexing task [5, 6]. The challenges arise from identifying relevant types of customer data, sources, customer knowledge, and applications [4, 7, 8]. In this paper, we present the concept of smart customer knowledge management and then propose a conceptual framework for studying and designing smart customer knowledge management systems (SCKMS) based on the design science method.

The rest of the paper is organized as follows. Section 2 presents smart customer knowledge management. Section 3 proposes a conceptual framework for designing smart customer knowledge management systems. Section 4 illustrates the proposed framework

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with the specific case of the SCKMS for a cultural organization. Section 5 provides some conclusions and future research work.

2 Smart Customer Knowledge Management Systems

This section discusses customer knowledge management systems and then presents the concept of smart customer knowledge management systems.

Customer Knowledge Management Systems. Customer knowledge management system (CKMS) is the integration of customer relationship management systems (CRM) and knowledge management systems (KMS) [4, 9]. In CKMS, KMS is applied to manage and transform customer data into customer knowledge, which is then applied to operations of CRM [10, 11]. The purpose of CKMS is to capture, share, and apply customer knowledge [12]. CKMS steps further with the integration of the diverse sources of massive data such as webs, social media, and the Internet of Things [8]. The revolution of massive data also witnesses the convergence of traditional CKMS technologies with real-time, open-source technologies and machine learning [4, 13].

Customer knowledge management systems emphasize the role of absorptive capability to capture, share, and apply customer knowledge. Absorptive capability is defined as the ability to acquire and learn from, about, and with customer knowledge and then apply it to the decision-making process. Due to absorptive capability, enterprises will be able to absorb customer knowledge, merging it with the organizational process and knowledge, and transform it into a firm's knowledge [12].

Smart Customer Knowledge Management Systems. This paper seeks to answer the following research question: *"How to design a smart customer knowledge management system?"*. To respond to this question, the paper begins with the principles of customer knowledge management systems and then continues with the overall architecture of smart customer knowledge management systems.

Knowledge management systems (KMS) are defined as a class of IT-based information systems applied to manage organizational knowledge to support and enhance the organizational processes of knowledge creation, storage/retrieval, transfer, and application [14]. In the context of customer knowledge management systems (CKMS), organizational knowledge can be *knowledge for customers*, *knowledge from customers,* and *knowledge to customers* [15].

Inside CKMS, knowledge is considered as objects, which can be stored and manipulated [14, 16]. Thus, the system supports the process of knowledge development in order to transfer data into information and information into knowledge [16]. Indeed, the CKMS provides links among knowledge objects to create the breadth and depth of knowledge development [14].

Outside CKMS, knowledge is also a condition of access to information [14]. Therefore, the role of CKMS is to provide effective search and retrieval mechanisms for locating relevant information. In this case, CKMS can be considered a service system [17] that provides services relative to knowledge, information, and data to different stakeholders of the value creation network [18].

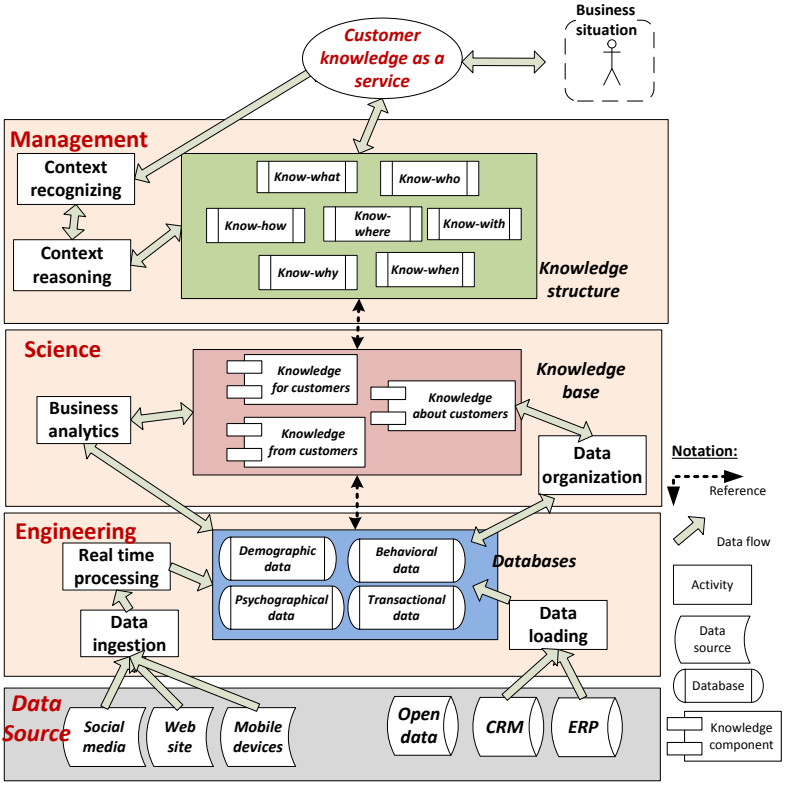

Fig. 1. Overall architecture of an SCKMS.

The purpose of this study is to propose an SCKMS that can provide smart services. In this paper, smart services are capable of actively adapting and responding based on the circumstance of interests [19, 20]. Moreover, the SCKMS becomes a smart service system, which is capable of learning, dynamic adaptation, and decision-making based upon data received, transmitted, and/or processed to improve its response to a future situation [21].

Figure 1 presents the overall architecture of a smart customer knowledge management system. To provide customer knowledge as a service, SCKMS includes the three levels of the service science perspective: Management, Science, and Engineering [17]. The *Engineering level* concerns the transformation of low-level data sources and unorganized data into purposed data. The *Science level* deals with the transformation of data

into useful information by organizing information in the knowledge structure and creating new insights based on different techniques of business analytics. The *Management level* focuses on the transformation of information into actionable knowledge, which is represented by different knowledge components [16]. The following section presents more detail about the three levels of SCKMS.

3 Conceptual Framework for Smart Customer Knowledge Management Systems

This section presents the framework for smart customer knowledge management systems, hereafter called the SCKMS framework. Based on the design science methodology, the SCKMS framework includes constructs, models, methods, and an illustrative example as an instantiation [16].

3.1 Constructs of the SCKMS Framework

Constructs of the SCKMS concern the key concepts of domain knowledge that constitute a conceptualization to describe the SCKMS [42] including different types of constructs such as data sources, customer data, knowledge components, and customer knowledge.

3.1.1 Data Source

The traditional customer data can be found in enterprise systems such as enterprise resource planning and customer relationship management systems. Thus, open public data becomes available to promote transparency. Recently, the advancement of the Internet of things, big data, and mobile computing leads to new customer data from social media, Web, and mobile devices.

Enterprise Resource Planning (ERP). ERP systems are in charge of managing and streamlining business resources [9]. ERP systems deal with back-end activities related to finance, manufacture, logistics, and human resources [22]. To put it differently, *knowledge for customers* is applied to these back-end activities to offer optimal products and services for customers. ERP systems also generate a significant amount of knowledge about customers through the business process of using, organizing, and sharing customer knowledge [23].

Customer Relationship Management (CRM). CRM the foremost source of customer data, particularly transactional data [5, 24]. CRMs provide all types of transactional data, including calls to customer support lines [25]. Nowadays, CRM systems can be integrated with social media to adapt to the rise of massive data [4, 13]. Social CRMs connect social media with operations of traditional CRM such as sales, marketing, and service [11]. As such, social CRM systems are also able to track the number of likes, tweets, retweets, views [4, 24].

Open Public Data. In order to promote transparency, several governments have made public data available for reuse [26]. Open public data are not only considered as an economic asset, which contributes to new products and services. They are also seen as a key driver in the increase in citizen participation in political and social life [26].

Social Media. The era of massive data is characterized by social media in which customers create a significant amount of data on digital platforms [13]. Social media contribute customer data related to socio-demography and behaviors of users and followers for CKMS is a great data source for *knowledge from customers,* which reflects in the number of likes, shares, and comments as well as the number of impressions and reaches on social media [4, 24]. Nowadays, executives put trust in content and sentiment analysis in interpreting dialogues or content of users to understand their attitude and satisfaction towards products or brands [4, 11].

Web Sites. Websites provide clickstream data through customer interactions [25]. Google Analytics can provide interesting insights on customer knowledge. Nowadays, interviews and questions are also conducted on web-based platforms to collect knowledge about customers towards experiences with the products and services [4, 24].

Mobile Devices. Along with websites, mobile devices such as cellphones or smart devices can provide spatial data that identifies the geographical locations of users [11, 27]. Spatial data release *knowledge from* and *about customers* with information on time, location, and activities of customers. Based on spatial data, service providers can offer location-based services in a real-time manner [23, 25].

3.1.2 Customer Data

Customer data can be imported and processed from different data sources and stored as databases in SCKMS. The era of massive data has acknowledged a significant amount of data created through interactions between enterprises and customers on digital platforms [28]. From the perspective of customer focus, customer data can be categorized into demographic, behavioral, transactional, and psychographic data.

Demographic Data. Demographic data identify customer profiles and segmentation [29]. Customers can be divided into different segments based on criteria such as age, gender, profession, location, income, and marital status [29, 30]. Enterprises rely on CRM systems, social media, and open public data (such as U.S. Census Bureau) as primary sources for this type of data.

Behavioral Data. Behavioral data examine customer behaviors through their interactions with enterprises and products on websites, social media, and mobile devices [31, 32]. Typical examples of behavioral data are clickstream data, add-to-favorites, add-to-cart data [33, 34]. The proliferation of social media contributes a large amount of behavioral data through customers' likes, shares, and comments.

Transactional Data. Transactional data demystify customer purchases [35, 36]. Examples of transactional data would be purchased items, amount, frequency, payment

methods [30, 34]. Transactional data come from diverse sources, including transaction records, sales reports, invoices, billing records, CRM systems [33, 37].

Psychographic Data. Psychographic data touch upon customer emotions, lifestyles, and preferences [36, 38]. Psychographic data are the integration of demographic, behavioral, and transactional data to uncover purchasing motivations and satisfaction [39]. Nowadays, data scientists apply text mining on social media to acquire psychographic data [13, 36].

3.1.3 Customer Knowledge

Customer data are organized to become useful information that is rich in relationship to represent customer knowledge. As mentioned above, customer knowledge can be classified into three types: knowledge about customers, knowledge for customers, and knowledge from customers [40].

Knowledge About Customers. Knowledge about customers is the understanding of customer behaviors and preferences [5, 24]. Knowledge about customers is derived from transactional data of customers (from ERP and CRM systems) such as purchasing activities [4, 13]. In other words, knowledge about customers involves customer satisfaction to gain insights on customer experience with products/services [12, 27]. Enterprises make use of knowledge about customers to learn about customer profiles by identifying similar patterns in transactional data [11, 41]. Then, knowledge about customers is applied to customer segmentation to define the most relevant customer segments due to knowledge on customer lifetime values [6, 7].

Knowledge for Customers. Knowledge for customers is developed by enterprises to satisfy the needs of customers [5, 12]. Knowledge for customers relates to knowledge on markets, products, or suppliers [13, 42]. Knowledge for customers aligns internal organizational information with external information; consequently, customers can position a product or a brand so that they understand the place of the product/brand in the market [15]. Enterprises rely on knowledge for customers to identify product benefits for customers [27]. From the marketing perspective, knowledge for customers is communicated to customers so that they can perceive values toward attributes and features of products/services [24].

Knowledge from Customers. Knowledge from customers is customers' knowledge on products, services, marketing, and supports of an enterprise and its competitors [5, 13]. Knowledge from customers is generated through customer interactions with enterprises [12]. Enterprises often neglect the role of customer co-creation in the innovation process even though this type of customer knowledge has significantly influence marketing results [7]. Interaction between customers and service providers creates a significant amount of knowledge for product development and service improvement. Knowledge from customers is believed to outperform knowledge about customers in capturing customer behaviors and preferences [25]. Organizational culture and incentives play an

important role in stimulating knowledge from customers [6]. Since customers are considered as knowledge development partners [43], this type of knowledge aims at facilitating interaction between customers and the enterprise to develop new knowledge such as new product/service developments [15]. The era of big data emphasizes the role of customers in co-creating knowledge with service providers [24].

3.1.4 Knowledge Components

In order to facilitate the interpretation and to support business decisions, customer knowledge is linked and organized based on knowledge components to construct the knowledge structure [14]. The proposed knowledge components for SCKMS are know-what, know-how, know-who, know-why, know-with, know-when, and know-where [14, 16, 44]. Table 1 presents the knowledge components and their characteristics.

Table 1. Knowledge components in an SCKMS.

Knowledge component	Description	Focus	Related customer knowledge
Know-what	Declarative knowledge that describes knowledge artefacts, which are known and related to a phenomenon of interest	Products and services	Knowledge for customer
Know-how	Procedural knowledge that describes the understanding of the generative processes constituting phenomena	Business activities	Knowledge about customer
Know-who	Know-who refers to individuals, groups, or organizations that participate in the value creation network	Customer	Knowledge about customer
Know-why	Causal knowledge that describes the understanding of principles of the underlying phenomena	Business rules	Knowledge about customer

(*continued*)

Table 1. (*continued*)

Knowledge component	Description	Focus	Related customer knowledge
Know-with	Relational knowledge that describes the understanding of how products and services relate to other products and services	Business activities	Knowledge from customer
Know-when	Conditional knowledge that describes when a product or service may be purchased	Business activities	Knowledge from customer
Know-where	Situational knowledge that describes where a product or service may be purchased	Business activities	Knowledge from customer

3.2 Model of the SCKMS Framework

The model of the SCKMS framework aims at expressing the relationships between the constructs [45], which are represented based on the simplified UML notation [46].

As presented in Fig. 2, each class represents a construct. There are different types of relationships between classes such as specialization, dependency, composition, and reference. Four key constructs of this framework include Data source, Database, Knowledge base, and Knowledge components. Databases are created from different data sources; knowledge bases are organized from databases; and knowledge components are used to represent knowledge from knowledge bases. As one can observe in Fig. 2, there are different specializations of key constructs. Each construct can be referenced to constructs at higher and lower levels.

Furthermore, there are relations between constructs at the same level. For instance, a *know-how* is an activity performed on a set of *know-what* for a *know-who* at (time) a *know-when in (a location) know-where.* A *know-why* is a business rule that is defined on a set of *know-what* and a set of conditions on a *know-how*.

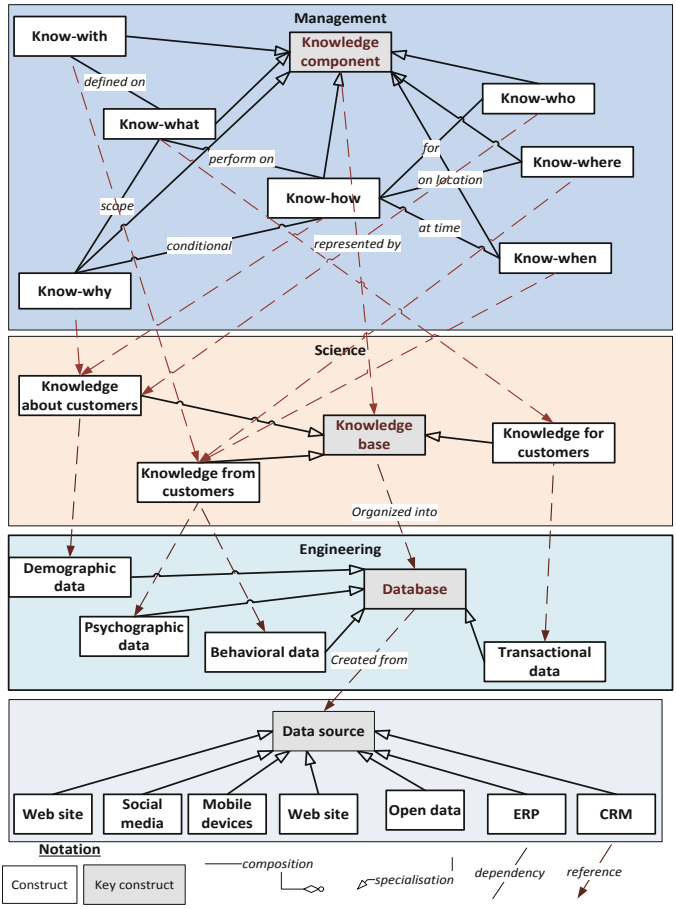

Fig. 2. Model of the SCKMS framework.

3.3 Method of the SCKMS Framework

The method covers a set of interrelated activities of the knowledge development process to develop constructs and establish relationships among constructs [45].

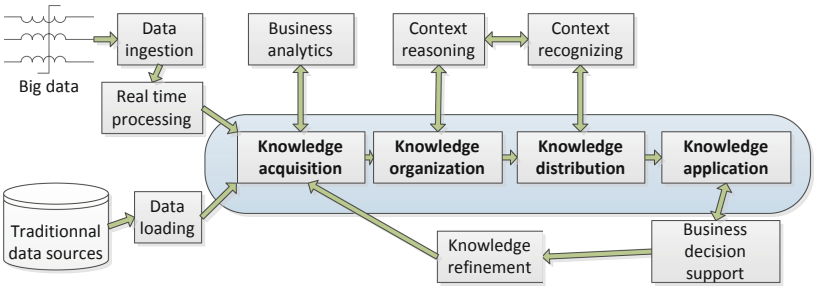

Fig. 3. Method of the SCKMS framework.

As presented in Fig. 3, the method outlines the knowledge development process over the three levels of SCKMS. The key activities of the knowledge development process include *knowledge acquisition*, *knowledge organization*, *knowledge distribution,* and *knowledge application* [14, 47].

Customer data can be captured from the traditional data sources such as ERP, CRM, and public open data by the *data loading* activity [47]. These data can also be captured and processed from big data sources by using the *data digestion* and *real-time processing* activities to make big data available to higher-level layers [47]. Business analytics techniques, which are descriptive, diagnostic, predictive, and prescriptive analytics, can be used to create new knowledge thanks to the *business analytics* activity.

In order to apply customer knowledge as a (smart) service, the context needs to be identified by *context recognizing* activity based on the business situation of the requested service [48]. In some specific cases, the *context recognizing* activity may determine the similar context of knowledge usage in the knowledge base by using the *context reasoning* activity [48].

Finally, the *business decision support* activity can be used to support a decision based on a particular context. The evaluation of the decision made can be used to refine the knowledge in the knowledge base by the *knowledge refinement* activity.

4 Illustrative Example

This part of the article continues with an example to illustrate the application of the SCKMS framework for cultural organizations, hereafter called SCKMS-CO, which is currently developed with an organization in the cultural sector in Québec, Canada.

The constructs of SCKMS-CO consist of customer data from CRM systems, social media, and company websites. CRM systems contribute a significant amount of demographic and transactional data. Social media is a great source of demographic, behavioral, and psychographic data. Websites of cultural organizations record transactional data along with behavioral data through user interactions. The most common data are transactional. In the cultural sector, demographic data comes from customer profiles. As the nature of the cultural sector depends on funding, cultural customers can be donors and other stakeholders. Many cultural organizations tend to use social media, particularly Facebook, Twitter, and Instagram to acquire demographic and behavioral data (the numbers of likes, shares, retweets, comments). Text mining through comments is still a challenging task for cultural organizations to acquire psychographic data.

Concerning the model of SCKMS-CO, the engineering level takes advantage of different types of customer data and transforms them into customer knowledge through different analytic techniques. Applying customer knowledge helps cultural organizations develop cultural products/services (know-what) that meet the need and preferences of customers. At the management level, SCKMS-CO leverages the value of customer knowledge by recommending the right service (know-what) to the right customers (know-who) at the right time (know-when) in the right context (know-where). On the other hand, behavioral and psychographic data generate knowledge from customers. SCKMS-CO can predict similar purchasing preferences among customer segments. Accordingly, business rules among similar products/services and customers (know-why)

can be found. Based on the know-why component, SCKMS-CO can function as a recommender system that makes recommendations based on related cultural contents or users with similar preferences. Transactional data give prominence to knowledge for customers. Purchasing behaviors that reflect through customer transactions help cultural organizations determine products/services (know-what) that customers are interested in. At the science level, knowledge about customers, from customers, and for customers can facilitate business rules or business models that support the internal decision-making processes. In the current situation of the COVID-19 pandemic, cultural organizations in Québec, particularly ones in the performing arts domain, have shown a great interest in applying and visualizing customer knowledge towards digital dashboards for data-driven decisions.

In terms of the method of SCKMS-CO, customer data are acquired from different data sources. Through descriptive, diagnostic, predictive, prescriptive analytics, customer knowledge is acquired and organized by *context reasoning* activities. Descriptive analytics is relevant to explore historical data and transforms them into knowledge through different techniques such as business reporting, descriptive statistics, and visualization [29]. Diagnostic analytics explains why something happened. As the characteristics of predictive analytics are to forecast future possibilities, it would make customer knowledge more actionable [32]. On the other hand, prescriptive analytics proposes the most optimal solutions for specific practical scenarios through simulations and optimization [30]. Once customer data are converted into customer knowledge through analytics, it is visualized through digital dashboards or reports that can be accessed by employees and managers. Therefore, customer knowledge is distributed and applied to support the decision-making process across cultural organizations.

5 Conclusion

The great potential of customer knowledge as a smart service has stimulated the research motivation of the paper. This study aims at proposing a framework for smart customer knowledge management systems through the lens of design science, called the SCKMS framework. Through the paper, the authors have clarified the detailed artefacts relevant to the SCKMS framework, including constructs, model, method, and an example as an instantiation. The validation of the SCKMS has been conducted through an ongoing project with organizations in the cultural sector in Québec, Canada. According to our knowledge, this study is one of the first that addresses smart customer knowledge management as smart service systems.

In terms of research contributions, this study has leveraged the value of customer knowledge as a smart service corresponding to the circumstance of interests. Giving the matrix of customer knowledge applications, the SCKMS would assist enterprises to stay on track in developing and optimizing smart services. Furthermore, customer knowledge, including knowledge about customers, from customers, and for customers can stimulate customer insights such as business rules, models, or dashboards to support the decision-making process. From the perspective of customers, the SCKMS would facilitate the process of supporting customers to find the right products/services at the right time in the right context. To put it another way, the SCKMS supports customers to filter out misleading information and efficiently search for the right information.

For future work, a customer intelligence framework for customer journey management will be developed. This framework can be considered as a part of the SCKMS and will be experienced with a case study, whose objective is to map and optimize customer journeys for cultural organizations in Québec, Canada.

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