



Towards a Conceptual Framework for Customer Intelligence in the Era of Big Data


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ABSTRACT

The dominance of services and service-based products in today's economy highlights the significance of customer intelligence for service offerings. Furthermore, the revolution of big data has generated a vast amount of customer data and reshaped the dimensions of organization, management, and technology within enterprises. The big data era also acknowledges the role of customers for value co-creation. Therefore, the objective of this paper is to propose a service-based framework for customer intelligence in the age of big data, hereafter called the SBCI framework, from the design science and service science approach. It laid the groundwork upon design science; the SBCI framework is proposed with the detailed artefacts, including construct, model, method, and instantiation. The framework also reflects service science through the three levels: 1) the network of service systems level for service proposal, 2) the service system level for service creation, and 3) the service level for service operation.

KEYWORDS

Big Data, Conceptual Framework, Customer Co-Creation, Customer Insights, Customer Intelligence, Design Science, Digital Transformation, Service Science

INTRODUCTION

The dominance of the service sector in today's economy gives prominence to customer intelligence as a means for enterprises to provide optimal services and service-based products (France & Ghose, 2019; Ramaswamy & Ozcan, 2019). The age of big data defines customer intelligence as knowledge or insights on customers extracted from the data mining process by integrating, analyzing, and interpreting various sources of customer data (Dam et al., 2020b; Davenport & Spanyi, 2019). Accordingly, customer intelligence enables enterprises to develop service offerings, understanding customer behaviors, and improving marketing strategies in the service-based economy (Anshari et al., 2019; Yan et al., 2020; Zerbino et al., 2018). Nowadays, the service sector occupies the majority of the Gross Domestic Product (GDP), particularly in developed countries with over two-thirds (Szirmai & Verspagen, 2015). The proliferation of the service sector in the age of big data highlights the role of customers as co-creators for business value. Customer interactions on various digital platforms

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have created a vast amount of customer data, which is considered as a great source for customer intelligence (Cooke & Zubcsek, 2017; Crandell, 2016).

However, most enterprises find it challenging to overcome the three major obstacles related to customer intelligence. The first challenge arises from customer co-creation concerning engagement forms (Crandell, 2016; Frow et al., 2016; Xie et al., 2016), which leads to a burdensome task to figure out the roles of customers in the process of co-creating with enterprises for customer intelligence. The second challenge happens within the organizational, management, and technological dimensions of enterprises (Davenport & Spanyi, 2019; Tabrizi et al., 2019). As a matter of fact, the majority of enterprises tend to overemphasize the importance of technological changes while lacking the mindset of restructuring the organizational and management viewpoints to better offer service for customers (Anshari et al., 2019; Tabrizi et al., 2019; Yohn, 2018). The last challenge involves how enterprises apply customer intelligence for service development and innovation (Amado et al., 2018; Anshari et al., 2019). Accordingly, optimal service offerings require the congruence in the dimensions of organization, management, and technology which enables enterprises to acquire customer intelligence and turns it into optimal applications for service (Lafrenière, 2020; McGrath & McManus, 2020).

To address this challenge, the objective of the paper is to propose a *service-based framework for customer intelligence* in the age of big data - hereafter called the **SBCI** framework. Considering the significance of service in the era of big data, the framework is developed through the lens of design science and service science. On the one hand, the design science approach deals with the development and validation of designed artefacts or concepts related to customer intelligence (Hevner et al., 2004; Peffers et al., 2007). On the other hand, the service science approach focuses on science, management, and engineering dimensions in the transformation to the service-based economy (Maglio & Spohrer, 2013; Spohrer et al., 2007). The science dimension focuses on the organizational viewpoint, the management dimension covers the strategic viewpoint, and the engineering dimension touches upon the technological viewpoint.

The remaining structure of the paper continues with the theoretical background relevant to the service science approach. Then this paper applies the design science approach to examine the research objectives. Based on the design science, different artefacts are constructed. The SBCI framework is further discussed with validation. The last section of this paper indicates an in-depth discussion of contributions and future directions as a conclusion.

THEORETICAL BACKGROUND

This paper relies on the service science approach as it covers the three principal dimensions within an enterprise: science, management, and engineering (Maglio & Spohrer, 2013; Spohrer et al., 2007). It is argued that the service science approach can be used to fortify the significance of customer intelligence. In light of the *science dimension*, customer intelligence deals with the organizational structure and the process to create, communicate, and deliver values to customers, clients, partners, and society. Regarding the *management dimension*, customer intelligence is applied to marketing decisions and strategies. The final dimension of the service science approach: the *engineering dimension* clarifies how to transform customer data into information, knowledge, and wisdom to offer innovation and service (Le Dinh et al., 2014).

Laid the foundation upon the service science approach, customer intelligence may be implemented as services or service-based products. The study of Vargo and Lusch (2004) defined a *service* as the “application of competencies such as knowledge as skills to offer values to other entities and the entity itself”. Accordingly, customer intelligence is the application of knowledge and skills relative to customers and enterprises for mutual benefits. The science, management, and engineering dimensions set a robust foundation for the service system (Maglio & Spohrer, 2013). A *service system* is defined as the “value-co-creation configurations of people, technology, value propositions connecting internal

and external service systems, and shared information” (Spohrer et al., 2007). A service system is facilitated by a *network of the service system*, also called a value-creation network, which emphasizes the role of customers as the resource for knowledge and skills (Vargo & Lusch, 2004).

RESEARCH DESIGN

In terms of the research design, the design science approach is applied to develop and measure artefacts for customer intelligence (Hevner et al., 2004; Peffers et al., 2007). Design science is defined as designing and evaluating a process or artefacts to solve the problem, discussing its contribution, and communicating what has been found to researchers and other audiences (Hevner et al., 2004). An important aspect of design science that stands it out from other research methodologies is the emphasis on the demonstration and evaluation of artefacts (Peffers et al., 2007). Integrated from different views on design science methodology (Hevner et al., 2004; Peffers et al., 2007), the research design of this paper is divided into two phases: i) the construction of the research artefacts and ii) the validation and experimentation of the framework.

The first phase of the research design focuses on building the artefacts of the design science methodology involving constructs, methods, models, and instantiations (Hevner et al., 2004). The constructs are concepts describing or responding to problems. In this paper, the constructs will be associated with customer intelligence. The models are statements describing the relationships among constructs. The method is a set of activities performing a specific task. The instantiations are empirical disciplines or algorithms operationalizing constructs, models, and methods. In other words, the instantiations are the best practices for implementing the SBCI framework.

In the second phase, the artefacts are demonstrated and evaluated to ensure their validation and applicability (Hevner et al., 2004; Peffers et al., 2007). The second phase continues with the validation through the application of the SBCI framework in the recommender system for the cultural sector. After the second phase, we iterate back to the first phase - the construction of the research artefacts - to adjust artefacts for further improvement and recommend future research directions (Peffers et al., 2007). The following part explores the first phase of the design science methodology on developing artefacts for the SBCI framework.

A SERVICE-BASED CUSTOMER INTELLIGENCE FRAMEWORK

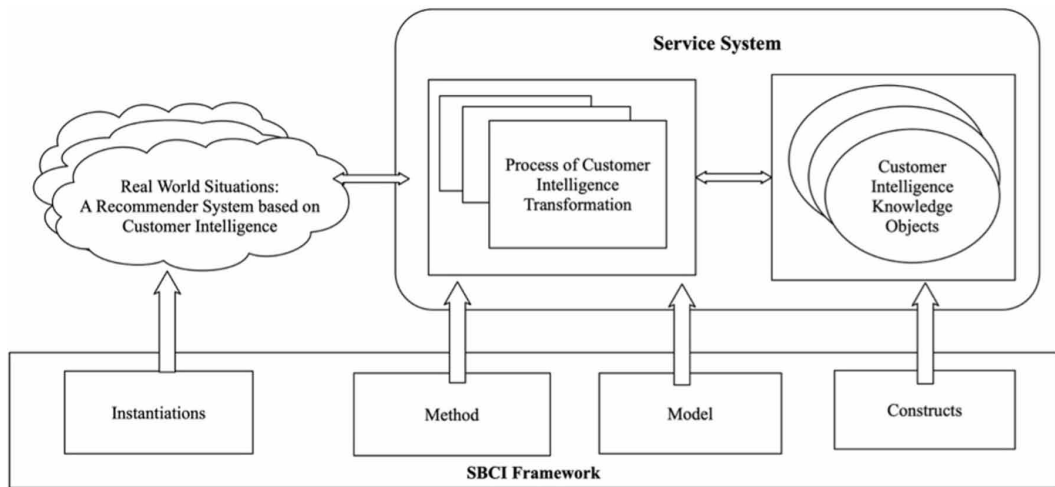
This part of the article starts with the first phase of the design science approach. It will discuss the design and development of the artefacts of the framework consisting of constructs, methods, and models. The component of instantiation will be built after the SBCI framework is tested and validated with enterprises.

In accordance with this view, a service system can be a customer, an enterprise, or an economy (Bartolini et al., 2016; Le Dinh & Thi, 2016). Service systems manage different levels and types of knowledge acquired from knowledge objects – for example: data, information, wisdom, experiences, evaluations, and initiatives – and make the best use of knowledge. Laid the foundation upon design science, the service-based customer intelligence management framework consists of a set of constructs, methods, models, and instantiations (Hevner et al., 2004). Figure 1 demonstrates the components of the framework, including the constructs referring to the knowledge objects, the method referring to the process of customer intelligence transformation, the model referring to the relationship between constructs and methods, and the installation as the lesson and experience learned from validation of real-world situations of the framework.

Constructs of the SBCI Framework

As mentioned above, the constructs of the SBCI framework are different concepts related to knowledge objects for customer intelligence. As knowledge is constituted from knowledge objects, a knowledge

Figure 1. Components of the SBCI framework



object contributes to the development of structured sets of data, information, insights, or intelligence (Bellenger, 2004; Rowley, 2007) that is related to a specific business area. The knowledge development process starts with data, evolving into information and insights, then reaching the highest level as intelligence. *Data* are defined as raw and unprocessed numbers or text (Erevelles et al., 2016; Hu et al., 2014). Once data are processed, aggregated, and organized, they become *information*. *Insights* are the presentation of information used in an organization, through the reflection of business rules, models, dashboards with relevance to a particular context or phenomena (Holmlund et al., 2020; Yohn, 2018). In this paper, *intelligence* is considered as the highest hierarchy of data transformation. *Intelligence* is the ability to perceive and apply *insights* to the decision-making process in order to overcome a business situation (Dam et al., 2020a).

This research inherits the definition of customer intelligence that the authors have developed and published in the previous study. As such, customer intelligence is defined as “*the ability to acquire knowledge and skills from big data and business analytics and to apply to the process of creating, communicating, delivering, and co-creating in order to offer more values to actual or prospective customers of smart service-based products or service*” (Dam et al., 2020a).

In order to identify knowledge objects for customer intelligence, the paper begins with the value co-creation between customers and enterprises, which is defined as the interaction between customers or between customers and service providers to achieve their individual goals as well as collective goals (Le Dinh & Thi, 2016; Provan & Kenis, 2008). Accordingly, customers can play various roles in this co-creation, including co-partners, co-ideators, co-designers, co-marketers, and co-experiencers (Frow et al., 2015; Ramaswamy & Ozcan, 2018).

Co-partners. Customers can become co-partners in the network of service systems by offering their knowledge and intelligence and receiving benefits from enterprises. As customers develop skills and knowledge through experiencing products and service, their partnership yields positive outcomes for enterprises. For example, customers of a customer relationship management (CRM) software can become experts, who can create and sell add-on apps for the user community (Libert et al., 2015). Therefore, other customers can enjoy additional service offered by enterprises’ customers. When customers can prove that they can offer values to enterprises as co-partners, they do not only receive profits but also have a chance to be recruited as experts or become business partners for the service system.

Co-ideators. As co-ideators, customers with product/service interests and passions often participate in the process of idea generation for the product/service conceptualization and improvement (Russo-Spena & Mele, 2012). The interaction between an enterprise and customers facilitates improvement for existing products/service and gradually stimulates ideas for innovation. Besides, customers can evaluate ideas of others. For example, M&Ms customers can personalize their candies with different colors, text, and images (Libert et al., 2015). Starbucks launched the project called “My Starbucks Idea” allowing customers to express their ideas and discuss ideas from other customers (Russo-Spena & Mele, 2012).

Co-designers. At a higher level, customers can involve more as co-designers in product/service development (Ramaswamy & Ozcan, 2019). For the co-designing practice, customers are required to have a certain level of knowledge and skills (Russo-Spena & Mele, 2012). To facilitate the customer co-designing process, enterprises provide engagement platforms, which can be a website, user design tool kits, virtual prototyping tools, or a joint process (Frow et al., 2015; Nambisan, 2010). Nikes exploits customers as co-designers by allowing them to design their running shoes through the website (Libert et al., 2015).

Co-marketers. Customers can involve as co-marketers in participating in activities related to testing and sharing experience with products/service (Frow et al., 2015). The primary goal of the co-marketing practice is to evaluate products/service and optimize customer experience (Russo-Spena & Mele, 2012). Customers can also discover new ways or shortcuts for consumption; thus, product/service values can be leveraged (Nambisan, 2010). Microsoft has created different online communities in which users share their experiences and support other users (Gibbert et al., 2002). From this co-creation approach, each Microsoft customer becomes a marketer through their participation in the online customer support service.

Co-experiencers. Customer co-experience aims at improving customer experiences and knowledge with products/services (Verleye, 2015). Accordingly, customers are stimulated to share their experience and knowledge with each other (Oertzen et al., 2018; Xie et al., 2016). To stimulate customer co-experience, extrinsic values such as bonus points, promotions, or discounts are offered (Fernandes & Remelhe, 2016; Rashid et al., 2019). On the other hand, some customers might be interested in achieving intrinsic values by making friends or having followers to gain their social status on social media (Ranjan & Read, 2019; Zhang et al., 2015).

Customer co-creation creates a significant amount of data that is a valuable source for creating knowledge relative to customers or customer knowledge. Customer intelligence sets the foundation on customer knowledge, including knowledge about customers, knowledge for customers, and knowledge from customers (Gibbert et al., 2002). Knowledge about customers is the understanding of customer behaviors and preferences whereas knowledge for customers is developed by enterprises to satisfy the needs of customers purchases (Holmlund et al., 2020; Rawson et al., 2013). On the other hand, knowledge from customers is customers’ knowledge and experience (Gibbert et al., 2002). Built on these reflections, this study has identified three corresponding generic knowledge objects (KO): products/services (knowledge for customers), activities (knowledge from customers), and customers (knowledge about customers). Table 1 presents types of customer co-creation corresponding with knowledge objects and customer knowledge through the lens of Service Science.

Products/services KO covers features and characteristics that a product or service can satisfy customers’ needs (Holmlund et al., 2020). This KO contains knowledge for customers with regards to what to offer customers. It supports customer intelligence in product/service development, improvement, and innovation (Erevelles et al., 2016; France & Ghose, 2018). Enterprises can rely on this KO to keep track of changes in customer needs and preferences to deliver value for customers (Davenport & Spanyi, 2019; Erevelles et al., 2016). With an aim to offer products/services for customers, this KO responds to the service level of Service Science.

Activities KO focuses on customer interactions on websites or social media with enterprises, products, and other customers (Holmlund et al., 2020; Ramaswamy & Ozcan, 2019). Customer interactions on websites and mobile devices release customer information related to clickstream behaviors, add-to-favorites, add-to-cart data (Chen et al., 2012; Fan et al., 2015). This KO explores knowledge from customers through their experience with the products/services and enterprises. Therefore, the activities KO supports the network level of Service Science.

Customers KO provides demographic data of customers, including age, gender, profession, location, income, and marital status (Erevelles et al., 2016; France & Ghose, 2018). This KO deals with knowledge about customers. Based on these data, enterprises can carry out customer segmentation to divide customers into similar groups and develop customer profiles (Anshari et al., 2019; Rygielski et al., 2002; Yan et al., 2020). Therefore, the customers KO support the service system level in choosing relevant customer segments to help enterprises better develop marketing strategies for target audiences (Fan et al., 2015). The customers KO also reveals customer behaviors and preferences through customer profiles. This KO touches upon the service systems level of Service Science.

Table 1. Constructs of the SBCI framework

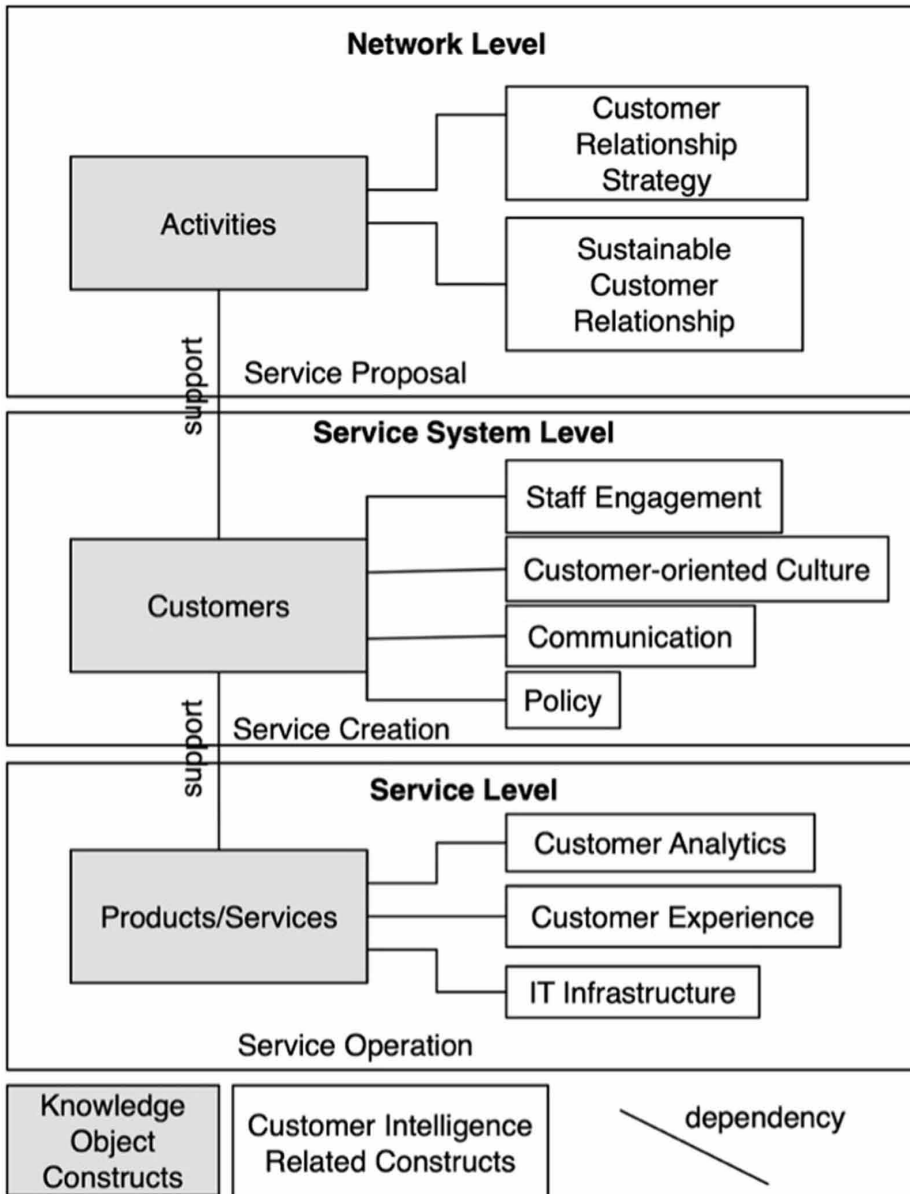
Types of Customer Co-creation	Generic Knowledge Object Constructs	Related Customer Knowledge	Service Science	Specific Functionality
Co-partners	Activities	Knowledge from customers	Network Level	Customers exchange values with enterprises.
Co-ideators	Products/Services	Knowledge for customers	Service Level	Customers generate ideas, improving products, and proposing innovation.
Co-designers	Products/Services	Knowledge for customers	Service Level	Customers design and develop products/services.
Co-marketers	Activities	Knowledge from customers	Network Level	Customers test and share experiences with products/services
Co-experencers	Customers	Knowledge about customers	Service System Level	Customers share experience with each other.

Model of the SBCI Framework

Based on the construct development in the previous part, this part presents the model of the SBCI framework, which is defined as a set of statements expressing the relationships among key concepts (Hevner et al., 2004). As illustrated in Figure 2, the model consists of three levels, including the Network of service systems for service proposal, the service system level for service creation, and the Service level for service operation.

The network of service systems level. From the service science perspective, the service proposal covers the management dimension which aims at creating value from services offered to customers (Maglio & Spohrer, 2013; Spohrer et al., 2007). To better deliver services to the right customers, the Activities knowledge object supports the service level in the reflection of customer intelligence applications, including customer relationship strategy and sustainable customer relationships (France & Ghose, 2019; Siggelkow & Terwiesch, 2019). Customer intelligence is

Figure 2. Model of the SBCI framework



applied to the process of *customer relationship management* (CRM) to understand customers and maximize their values for enterprises (Anshari et al., 2019; Dam et al., 2019a). On the other hand, *sustainable customer relationship* is defined as connected strategies in which enterprises are interconnected with customers 24/7 due to the application of technologies in the age of big data (Siggelkow & Terwiesch, 2019). Maintaining a continuous connection with customers helps enterprises improve service quality as well as customer experience. Instead of waiting for customers to come, enterprises applied customer intelligence in simulating customer experience to anticipate customer concerns (Anshari et al., 2019).

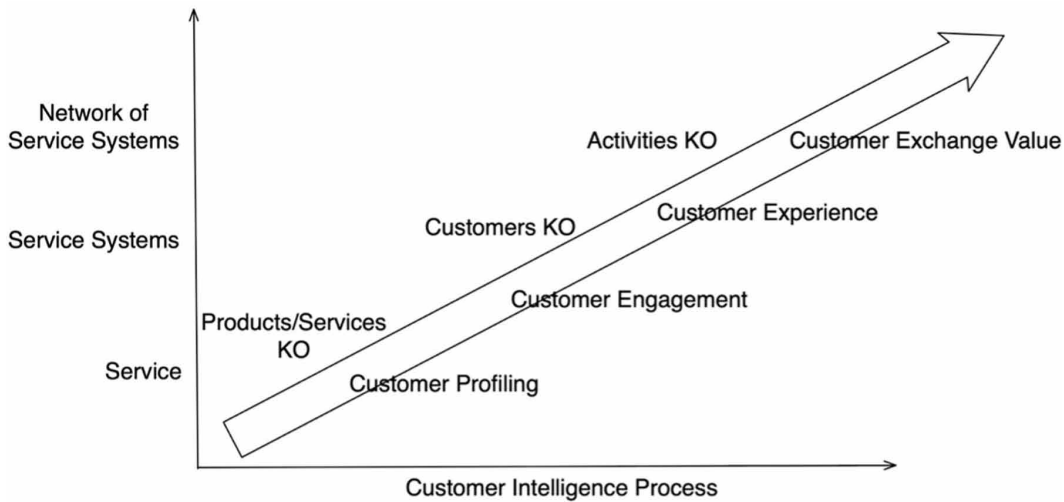
The service system level. Service creation touches upon the science dimension, which deals with the process of generating, communicating, delivering, and co-creating values to customers (Maglio & Spohrer, 2013; Spohrer et al., 2007). Therefore, the Customers knowledge object highlights the importance of customer-oriented culture, staff engagement, communication, and policies. *Customer-oriented culture* is considered as the most significant factor in the science dimension as it has such a significant impact on the business process, functions, people, leadership, and strategies (Dam et al., 2019b; Yohn, 2018). To support the customer-oriented culture, enterprises should consider developing *policies* such as an appropriate incentive system (Rawson et al., 2013). In terms of *staff engagement*, it is important to align leaders and employees with a customer-oriented mindset, especially employees who interact directly with customers (Tabrizi et al., 2019). Without a customer-oriented mindset, it is challenging for employees to understand customer needs, identifying the motive behind their needs, and providing advantageous solutions (Holmlund et al., 2020; Lu et al., 2020). Concerning *communication*, enterprises should allow every employee to access customer intelligence. Sharing customer intelligence across departments helps employees understand customers and get updated on customer experience (Yohn, 2018). Therefore, a flat hierarchy will facilitate the communication process as it eliminates the power distance among employees (Tabrizi et al., 2019).

The service level. Service operation focuses on the engineering dimension resources and information technology (IT) to provide service solutions. Accordingly, the engineering dimension discusses the role of technologies concerning data analytics and IT infrastructures in the age of big data. *Business analytics* involves descriptive, predictive, and prescriptive (Lu et al., 2020; Yan et al., 2020). Descriptive analytics is ideal to explore historical data and transforms them into insights (Sivarajah et al., 2017). As the characteristics of predictive analytics are to forecast future possibilities, it would make information more actionable (Sivarajah et al., 2017). Prescriptive analytics proposes the most optimal solutions for specific practical scenarios (Wedel & Kannan, 2016). Furthermore, *IT infrastructure* plays an important role in the engineering dimension. A repository supported by a data warehouse may be required to store customer data from different databases or servers. MySQL – an open-source relational database – is a popular choice for many enterprises to store customer data for executing SQL queries with low latency (Rao et al., 2018). In the age of big data, NoSQL or non-relational databases provide a great mechanism for handling extremely large data sets in volume, velocity, variety, and veracity (Chen et al., 2012). Other database infrastructures may include intranets, software, or cloud-based platforms (Akter & Wamba, 2019; Chen et al., 2012).

Method of the SBCI Framework

Based on the design science methodology (Hevner et al., 2004; Peffers et al., 2007), the method of the SBCI framework focuses on the activities which support the process of customer intelligence development. As seen in Figure 3, the SBCI operates based on the four key activities of the customer intelligence process: customer profiling, customer engagement, customer experience, and customer exchange value (Holmlund et al., 2020; Vila et al., 2020; Zhang et al., 2018). At the service level, customer profiling relies on the products/services KO in identifying the most relevant customer segments. At the service systems level, customer engagement and customer experience count on the customers KO and activities KO to build customer relationships and improve customer satisfaction. Finally, customer exchange value highlights the importance of the activities KO in co-creating values with customers.

Figure 3. Method of the SBCI framework



Customer profiling collects data on demography (age, gender), buying behaviors (needs, purchasing power, preferences, lifestyle), and purchasing attributes (recency, frequency, size) (Lu et al., 2020; Yan et al., 2020). Therefore, enterprises will be able to build customer profiles and choose the most profitable segment. In this spirit, customer intelligence is applied to identify customer segments with similar interests and profitability (France & Ghose, 2018; Ngai et al., 2009). Various demographic, psychographic, behavioral, or geographic criteria are used for customer segmentation (France & Ghose, 2019; Rygielski et al., 2002).

Customer engagement focuses on building the relationship and brand perception with customers (Chen et al., 2012; Tu et al., 2018). The more enterprises interact with customers, the more customers involve with service as they can feel the devotion and embracement (Ranjan & Read, 2019; Zhang et al., 2018). Therefore, customer engagement is improved. Enterprises can take advantage of traditional marketing tools such as storytelling and public relations to deliver real-time messages shaping customer perceptions on brands (Vila et al., 2020). In the age of big data, another useful technique is to develop an online community (Tuan et al., 2019; Xie et al., 2016). It is important to take into consideration the purpose, missions, benefits, and stories to nurture customer engagement in these communities (Ramaswamy & Ozcan, 2018; Yan et al., 2020).

Customer experience focuses on customer satisfaction by improving value, design, and journey orchestration through constant innovation from pre-purchases to post-purchases (Holmlund et al., 2020; Rawson et al., 2013). Value augmentation consists of product/service improvement, product sustainability and innovation, and direct-to-customer services and delivery. Many enterprises upgrade technology (i.e.: mobile application) and infrastructures to augment customer satisfaction with the core products and services as well as the delivery process (Ramaswamy & Ozcan, 2019; Verleye, 2015). On the other hand, customer experience improves the design of communication and distribution channels to eliminate hassles and smooth service experience. Some enterprises also offer information or guidance for customers across customer journeys (France & Ghose, 2019; Sivarajah et al., 2017). Finally, journey orchestration touches upon the experience strategy and journey management so that customers can have an optimal and consistent experience from omni-channels (Vila et al., 2020).

Customer exchange value emphasizes the significance of customer value co-creation (Saarijärvi et al., 2013; Tuan et al., 2019). Accordingly, enterprises can achieve full customer value when their offerings can match customer needs. Specifically, enterprises should recognize what customers

are looking for and when to deliver their offerings in real-time (Ranjan & Read, 2019; Xie et al., 2016). In fact, enterprises need to develop conversion, personalization, and prediction capabilities to maximize exchange value. Conversion capability spotlights the application of marketing automation to boost marketing performance whereas personalization aims at offering personalized products/services to improve customer relationship management (Crandell, 2016; Ramaswamy & Ozcan, 2018). Prediction is the application of fine-tuned algorithms to forecast trends, needs, location, and life-cycle of customers (Sivarajah et al., 2017; Xie et al., 2016). For example, recommender systems are developed to deliver personalized recommendations based on forecasting customer needs and trends.

INSTANTIATION OF THE SBCI FRAMEWORK

This part of the article continues with the second phase of the design science methodology. The component of instantiation will be built after the SBCI framework is tested and validated with real-world situations. In terms of validation, an illustrative example of the SBCI framework is extracted from an ongoing project for the development of a recommender system, hereafter called DIMARecSys. DIMARecSys is specifically developed for organizations in the cultural sector in Québec, Canada. Figure 4 illustrates the recommendation process. Firstly, (1) Cultural organizations request different types of recommendations for an input document that is currently browsed by users on their website. Subsequently, (2) DIMARecSys generates a list of recommendations and returns the metadata of cultural products/events in XML format. (3) The service providers of cultural organizations display the relevant recommendations on their websites. Finally, (4) once users click a recommendation, the service providers of cultural organizations send a notification to DIMARecSys. This example illustrates recommendations as a service, the recommender system as a service system, and customers in the cultural sector as stakeholders of the network.

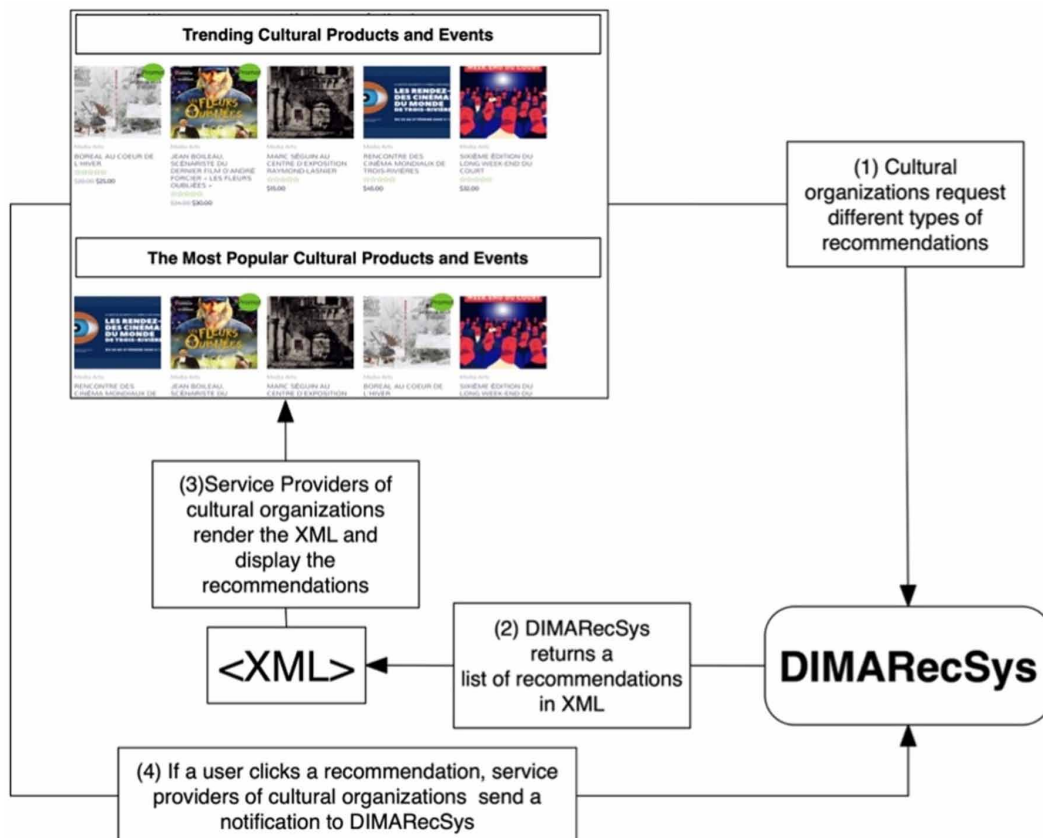
At the Network Level

There are four significant stakeholders in the network: content partners, service partners, users, and operators of DIMARecSys. Each stakeholder has a different role as follows:

- **Content partners** are responsible for the content of cultural products/events as input for DIMARecSys. The most significant content partners are cultural organizations. Considering the nature of the cultural sector, other content partners can be theatres, cultural agencies, or independent artists.
- **Service partners** are web service providers of cultural organizations. The role of service partners is to receive recommendations from DIMARecSys and display them on their website.
- **Users** can be potential or existing customers of cultural organizations. They receive recommendations from the website of service partners. Users also create clickstream data which are considered a significant source for customer intelligence.
- **The operators of DIMARecSys** are in charge of the development and maintenance of the recommender system.

Concerning the Activities KO, the network of DIMARecSys makes a point of **customer exchange value** in maximizing value acquired from customers. Users play a key role in co-creating customer intelligence. Specifically, users are co-experiencers and co-marketers for DIMARecSys. As co-experiencers, cultural users experience the system and contribute a significant amount of data through their comments, ratings, and interactions. At the same time, users can be co-marketers in shaping the public taste and recommending their choices to new users. On the other hand, content partners function as co-ideators and co-designers for cultural content generation and design prototypes.

Figure 4. Demonstration of DIMARecSys



At the Service System Level

DIMARecSys functions as a service system that is in charge of creating recommendation services. The key component of DIMARecSys is its master data storage, namely a MySQL or PostgreSQL database (Chen et al., 2012). This database contains all relevant data including metadata of cultural products/events and statistics of delivered recommendations. Concerning service creation, DIMARecSys uses Django, a Python-based and open-source web framework, to generate embedding-based recommendations. DIMARecSys relies on RESTful APIs, which use HTTP requests to GET, PUT, POST, and DELETE data. RESTful APIs allow DIMARecSys to communicate with other web platforms (e.g.: WordPress). Accordingly, cultural organizations interact with DIMARecSys via HTTP requests (typically GET requests). To retrieve recommendations, cultural organizations call HTTP requests and retrieves an XML response containing a list of relevant recommendations.

At the service system level, the Customers KO accelerates service creation. DIMARecSys puts trust in **customer engagement** to develop customer relationships and brand perception. DIMARecSys also pay attention to **customer experience** by evaluating the precision and accuracy of recommendations to improve customer satisfaction and loyalty. Accordingly, cultural organizations can be aware of the suitability of recommended products or services for users. Customer satisfaction sets the strong foundation for developing customer relationships. Therefore, cultural consumers are more likely to embrace and engage with cultural organizations.

At the Service Level

At the service level, DIMARecSys aims at providing different types of recommendations for cultural products and events as a service. The system accounts on the application program interface (API) to allow cultural organizations to easily integrate a recommender system into their website. Correspondingly, DIMARecSys generates recommendations for cultural products and events. Cultural organizations can request recommendations from DIMARecSys and display these recommendations to their users.

The Products/Services KO supports service operation at the service level. DIMARecSys gives prominences to **customer profiling** in facilitating the service operation of recommendation as it takes into consideration behavioral changes of customers in pre-purchase, purchase, and post-purchase stages. In terms of service recommendations, DIMARecSys optimizes service operation with five types of recommendations, including recommendations for upcoming events, location-based events, most popular events/products, trending events/products, and similar events/products. These types of recommendations are divided into three levels: general level, domain level, and item level. The general level is displayed on the homepage with two types of recommendations (most popular and trending events/products). The domain level consists of recommendations in six domains of the cultural sector such as heritage and libraries, live performance, visual and applied arts, written and published works, audio-visual and interactive media, and sound recording. In each domain, users can find recommendations of upcoming events, location-based events, most popular events/products, trending events/products. Finally, the item level proposes recommendations for similar events/products on individual pages of cultural offerings.

CONCLUSION

Customer intelligence in the age of big data has emerged as a means for enterprises to gain competitive advantages. Customer intelligence creates values by transforming customer data into customer insights for robust business decisions. In accordance with this view, the article has developed the service-based customer intelligence framework considering changes from the revolution of big data. The SBCI framework laid its foundation on design science, including construct, model, method, and instantiation. Through the paper, the authors have clarified the detailed artefacts relevant to the generic knowledge objects, which can be customized and adapted to meet specific business objectives of each organization for applying customer intelligence. The validation of the framework has been conducted through the ongoing project of developing the recommender system - which is called DIMARecSys - for enterprises in the cultural sector in Québec, Canada. An illustrative example of DIMARecSys was presented as the demonstrative validation of the SBCI framework. To conclude, major theoretical and practical contributions are outlined as follows.

Compared to previous works, the original contribution of the SBCI framework lies in the focus on customers, particularly customer co-creation for customer intelligence, instead of technological changes. Digital transformation should start with customers and for customers, not just the technological revolution. In the era of big data, most enterprises aim at technological upgrades in acquiring customer intelligence. They lack the mindset of restructuring the organizational and strategic viewpoints for customer intelligence (Davenport & Spanyi, 2019). Considering this reflection, this study examines different dimensions, including technology, management, organization. Through the SBCI framework, customer intelligence from the network will recur into the dimensions of science, management, and engineering instead of producing one-off products/services (Libert et al., 2015). This originality would extinguish the paper from previous studies with a significant contribution.

Bearing in mind the relatively sparse literature on customer intelligence (Liang & Liu, 2018), the article makes significant theoretical contributions by revealing interesting findings. This is one of the first integrated frameworks, which comprehensively covers the service science approach coupled

with the profound groundwork on design science. In the matrix of customer intelligence research stream, the paper clearly defines the most relevant constructs related to customer intelligence. These constructs are also aligned with the knowledge objects to assist enterprises to stay on track in acquiring and applying customer intelligence. Subsequently, the model of the SBCI framework serves as a roadmap for enterprises to create, managing, and amplifying values of customer intelligence in terms of service creation, service operation, and service proposal. Lastly, the method of the SBCI framework demystifies the process of transforming customer data into customer intelligence. Compared to other customer intelligence process, the method of SBCI catches attention by spotlighting customer exchange value through the customer co-creation as co-partners, co-ideators, co-designers, co-marketers, and co-experiencers.

Regarding practical implications, the SBCI framework can make critical contributions for enterprises as customer intelligence equips them with competitive advantages to overcome challenges in the age of big data. Customer intelligence from the SBCI framework is fine-tuned with changes from the revolution of big data. Therefore, it will help enterprises make better data-driven decisions based on customer intelligence. Enterprises can also rely on the SBCI framework to modify the dimensions of science, management, and engineering to promote customer intelligence in a coherent manner. Furthermore, the result of this study sheds light on the process of customer intelligence transformation, including customer profiling, customer engagement, customer experience, and customer value exchange. Considering the clarification on the process of customer intelligence transformation, the SBCI framework would assist enterprises to stay on track in reaching strategic goals.

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