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Customer process management: A framework for using customer-related data to create customer value

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Abstract

Purpose – The proliferation of customer-related data provides companies with numerous service opportunities to create customer value. The purpose of this study is to develop a framework to use this data to provide services.

Design/methodology/approach – This study conducted four action research projects on the use of customer-related data for service design with industry and government. Based on these projects, a practical framework was designed, applied, and validated, and was further refined by analyzing relevant service cases and incorporating the service and operations management literature.

Findings – The proposed customer process management (CPM) framework suggests steps a service provider can take when providing information to its customers to improve their processes and create more value-in-use by using data related to their processes. The applicability of this framework is illustrated using real examples from the action research projects and relevant literature.

Originality/value – "Using data to advance service" is a critical and timely research topic in the service literature. This study develops an original, specific framework for a company's use of customer-related data to advance its services and create customer value. Moreover, the four projects with industry and government are early CPM case studies with real data.

Keywords Value-in-use, Big data, Action research, Customer process, Customer process management

Paper type Research paper

1. Introduction

"Using data to advance service" is a critical research topic in this data-rich economy, but few studies have addressed it (Ostrom *et al.*, 2015; Lim, Kim, Kim, Kim and Maglio, 2018a). This broad topic spans a variety of data sources (e.g. customer behaviors and firm operations) and direct beneficiaries of data use (e.g. customers and firms). This study specifically focuses on using data on customers to create value for customers.

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The proliferation of data on customers and the objects they interact with has generated new types of services that create customer value using customer-related data. For example, smart band-based fitness tracking services record data on daily life, such as behavior data and bio-signals, to help customers achieve specific fitness-related outcomes, such as walking 10,000 steps (Takacs *et al.*, 2014). Golf training services use golf practice data to help users improve their stances and swing angles (Jung *et al.*, 2010), and vehicle fleet management services use truck driving data to help drivers (Volvo, 2009). Given the proliferation of (big) data related to customers, cases like these examples are emerging rapidly. However, little is known about how this data can be used for services. Accordingly, a service-oriented framework for using data to create value must be developed (Lim, Kim, Kim, Kim and Maglio, 2018b).

A common value creation mechanism in these examples is customers improving their performances using the data collected. Specifically, they can monitor their processes for performing a specific task (e.g. exercise, playing golf, and driving) and manage certain aspects of these processes (e.g. performance, consistency, and fuel efficiency). This study calls such processes, customer processes, which are similar to business processes. In these examples, data (e.g. exercise time, shot angle, and driving speed) are recorded during these processes, and value-in-use (Vargo *et al.*, 2008; Heinonen *et al.*, 2013) is created when customers successfully complete these processes (e.g. efficient exercise, high score play, and safe driving) using the feedback provided by their data. Thus, the use of customer-related data to create customer value can be improved by focusing on relevant customer processes.

This study highlights taking a customer process perspective in using customer-related data for service purposes and develops the customer process management (CPM) framework to implement this perspective. CPM can help customers monitor, measure, and manage their own specific processes using the related data. Developing this framework involved performing action research (Avison *et al.*, 1999) on four projects with industry and government and analyzing 67 relevant service cases. The CPM framework suggests different steps for a service provider to follow in providing customers with information to improve their processes and create more value-in-use using data related to these processes. CPM uniquely views individual customer processes as targets to be measured and improved, a perspective similar to those of studies on manufacturing and business processes (e.g. Linderman *et al.*, 2003; van der Aalst and Weijters, 2004). The term CPM is based on the existing term "business process management" (BPM), which refers to the use of business process data.

Figure 1 further illustrates this study. The study focuses on services with data recorded during a customer process (e.g. Jung *et al.*, 2010; Takacs *et al.*, 2014) and integrates studies

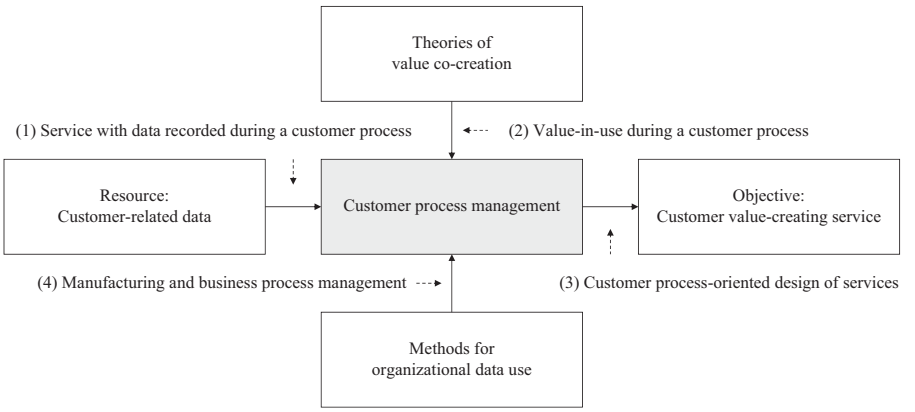


Figure 1.
Research overview

on value-in-use during a customer process (e.g. Payne *et al.*, 2008; Bettencourt *et al.*, 2014), the customer process-oriented design of services (e.g. Bitner *et al.*, 2008; Bettencourt, 2010), and the use of manufacturing and business process data (e.g. Linderman *et al.*, 2003; van der Aalst and Weijters, 2004). The topic of this study has emerged from practice. The action research method is useful for ensuring relevance to practice and designing a framework (Luftenegger *et al.*, 2017), whereas the case analysis method can effectively test a framework's ability to describe complex phenomena or systems (Ketokivi and Choi, 2014). This study develops an original service-oriented framework for customer value creation using customer-related data by empirically synthesizing the fields described above using action research projects and case analysis.

2. Literature review

Using data to advance service is an interdisciplinary research topic (Opresnik and Taisch, 2015; Ostrom *et al.*, 2015; Ng and Wakenshaw, 2017; Lim, Kim, Kim, Kim and Maglio, 2018a). As shown in Figure 1, the proposed CPM framework synthesizes different fields to fill the gap between customer-related data and services creating customer value, and previous studies in these fields provide foundations for the framework. This section describes the cases and prior research related to the numbered areas of Figure 1.

2.1 Services with data recorded during customer processes

Data are used to generate useful information in several ways. Existing studies on data use in services (e.g. Benitez *et al.*, 2007; Tsai and Chung, 2012; Kim *et al.*, 2013; Saarijärvi *et al.*, 2014; Opresnik and Taisch, 2015; Maglio and Lim, 2016; Lim, Kim, Kim, Kim and Maglio, 2018b) show that data may come from service providers (e.g. business transaction, human resource, and financial data) or customers (e.g. demographic, behavioral, and purchase history data) and may benefit either group. Thus, Figure 2 classifies data use in services based on the main data source (provider or customer) and direct beneficiary (provider or customer). This study focuses on using customer data to provide services for customers (upper right quadrant). The proliferation of customer-related data has provided companies with new opportunities to improve their existing services and design new services.

Figure 3 presents a detailed view of the upper right quadrant of Figure 2 and provides various examples of this service type. Existing studies on customer-related data use in services (e.g. Tsai and Chung, 2012; Porter and Heppelmann, 2014; Saarijärvi *et al.*, 2014;

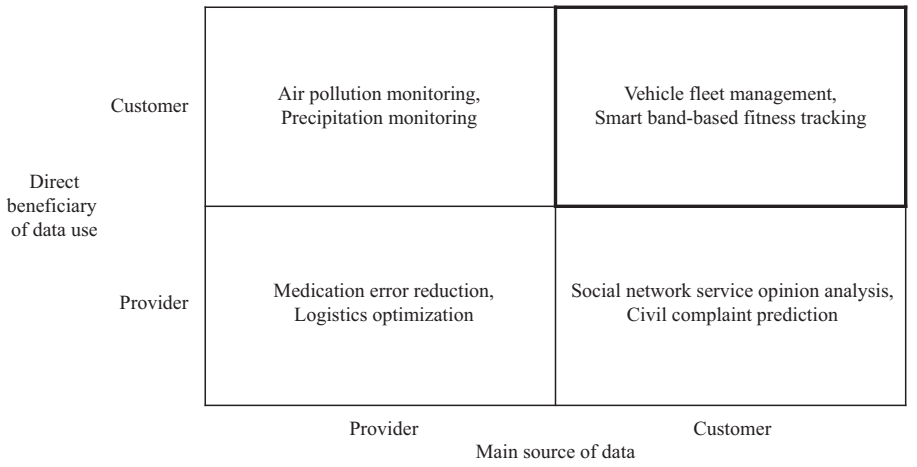


Figure 2. Classification of data use in services

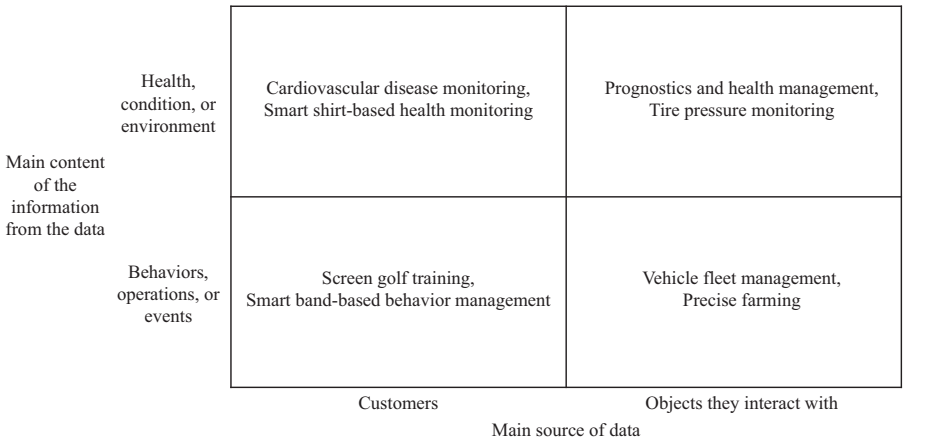


Figure 3.
Classification of service cases that use customer-related data to create customer value

Maglio and Lim, 2016; Hoffman and Novak, 2017; Lim, Kim, Heo and Kim, 2018a) show that data may come from customers (e.g. customer health, behavioral, and purchase history data) or objects that they interact with (e.g. product condition, environment, and event log data) and may be used to better understand certain aspects of the data sources. Thus, the main source of customer-related data is an important dimension in this analysis. Examples of objects as data sources include automobiles, equipment, livestock, and other people (see Table AI in the Appendix for more examples). Note that trackable fitness bands and smart shirts, for example, are means to collect data from customers rather than sources of data because the data collected reflect the customer rather than the object. In contrast, data about the condition of an object (e.g. heavy equipment condition data) are not customer data, but it may be highly relevant to a customer who uses the object. Another important dimension is the main content of the information from the data, which may relate to health, conditions, or the environment (i.e. about the "state" of the source) or to operations, behaviors, or events (i.e. about the "process" the source experiences). Note that similar/different devices can provide different/similar information, and as with any other service classifications, a service may be classified into multiple categories.

Each quadrant of Figure 3 shows representative cases. The upper right quadrant includes the use of heavy equipment data to handle potential product breakdowns and maximize availability for stakeholders (Lee *et al.*, 2014). Services in the upper left quadrant are based on smart products (e.g. bracelets, watches, shirts, and attachable devices; Porter and Heppelmann, 2014) and are used for health monitoring and management (e.g. analysis of heartbeat data to deliver diagnostic and prognostic information on cardiovascular diseases). The lower left quadrant includes screen golf training services to help customers improve their performance (Jung *et al.*, 2010). The lower right quadrant includes agricultural machine manufacturers providing precise farming services, such as the exact amount of fertilizer to be sprayed on crops, based on analyses of navigation signals and operations data from agricultural machines (Lim *et al.*, 2012).

As mentioned previously, these examples all allow customers to pay close attention to their specific processes (e.g. equipment operations, daily life, playing golf, and farming) and improve certain aspects of their processes (e.g. stability, consistency, performance, and accuracy for equipment operations, daily life, playing golf, and farming, respectively) using data recorded during these processes. Experiments show that such services are useful for adjusting behaviors and improving processes (e.g. Toledo *et al.*, 2008; Farah *et al.*, 2014). Athletes (e.g. baseball, golf, and soccer players) have used data related to poses, habits, and

active mass captured from play and exercises to improve performance, and advanced data collection technologies have enabled similar services for non-athletes. In what follows, such services are called "CPM services."

2.2 Value-in-use during a customer process

As shown in Figure 1, this study is based on theories of value co-creation because customers create value-in-use by using information from data about their processes in performing these processes (Figure 3). Some of the service marketing literature indicate that value is fundamentally derived and determined by the use of resources in a specific context (Vargo and Lusch, 2004; Vargo *et al.*, 2008). Providers facilitate value creation since they offer services to users. Users utilize the services to create value-in-use. Since both actors take part in value creation, "co-creation of value" occurs. To describe this mechanism, Payne *et al.* (2008) focused on the concept of a customer process, which they define as "a series of activities performed by the customer to achieve a particular goal." They found that customer value is co-created based on continuous interactions between the customer and supplier processes.

Other studies have highlighted the importance of the customer process concept in describing the customer value creation mechanism. Some of the service innovation literature state that customers have jobs, such as saving, farming, driving, dating, and business, and they hire services to get these jobs done (Ulwick, 2005; Christensen *et al.*, 2007). A job can be defined as "the fundamental problem that a customer needs to resolve in a given situation" (Christensen *et al.*, 2007). All jobs involve processes (Bettencourt and Ulwick, 2008), and understanding and managing the customer processes for accomplishing jobs is key to service innovation (Bettencourt, 2010). By combining the abovementioned studies, Bettencourt *et al.* (2014) describe value co-creation between customers and firms using the customer process concept.

These studies emphasize the importance of focusing on a customer process when creating customer value. Moving away from existing product or service concepts toward customer process-oriented thinking increases the freedom to find fresh and innovative solutions for customers. In this sense, Heinonen *et al.* (2010) discuss the importance of using a customer-focused lens that focuses on value-in-use and the customer's own context, which corresponds to the customer process in this study. Context is essential to theories of value co-creation, as it reflects the customer experience (Voss *et al.*, 2016). Value-in-context (Chandler and Vargo, 2011) also reflects the importance of focusing on a customer process through which the customer integrates resources in a unique context (process). With the recent advancements in sensing technologies, customer process-related data, which indicate the real behaviors and contexts of customers, are being increasingly recorded in many industries. This study views such data as a resource for implementing a customer process-oriented perspective to create value-in-use in practice.

Furthermore, operations management views a process as a transformation of inputs into outputs that adds value (Russell and Taylor, 2010). Here, value-adding components of service activities can be categorized into physical actions involving manipulation of physical objects (e.g. cooking and car repairing), information actions involving manipulation of symbols (e.g. data and decisions), and interpersonal actions involving dealing with human interactions (e.g. greeting and counseling) (Apte and Mason, 1995). Thus, a "service" involves one or more of the physical, information, and interpersonal interactions (Karmarkar and Apte, 2007; Glushko, 2010).

In summary, this study views a customer process as a series of activities performed by a customer to get a job done and create value. A customer process does not necessarily involve a service process. A service process should operationalize specific interactions and collaboration between the customer and provider for a specific customer process

(see Section 5.4 for related discussion). If a service provider intends to improve its competitiveness, then it must influence the focal customer processes such that the customer can use the available resources more efficiently and effectively (Payne *et al.*, 2008). In the CPM services introduced in Section 2.1, the service providers receive data from individual customers, turn the data into useful information for the customers, and provide the feedback information to the customers so that they can improve their processes, therefore creating value-in-use. Such information interaction is the core mechanism of value co-creation in CPM services. Thus, from the perspective of service operations management literature, the CPM services are categorized into the information-intensive service in which customer value is primarily created via information interactions, rather than physical and interpersonal interactions, between the customer and the provider (Karmarkar and Apte, 2007; Apte *et al.*, 2010; Lim, Kim, Kim, Kim and Maglio, 2018b).

2.3 Customer process-oriented design of services

Customer-related data are often analyzed to determine how customers behave (Porter and Heppelmann, 2014) to provide firms with multiple opportunities for value diversification and new market identification (Saarijärvi *et al.*, 2014) and design new information content and services for customers (Lim, Kim, Heo and Kim, 2018; Lim, Kim, Kim, Kim and Maglio, 2018b). In short, customer-related data can foster a mutually beneficial relationship between a firm and its customers (Kumar *et al.*, 2013). Service design, a multidisciplinary area that helps innovate services by bringing new ideas to customers (Ostrom *et al.*, 2015), is significantly related to these objectives and, thus, can serve as an effective approach to stimulate the use of customer-related data to create customer value.

The service design in this study focused on the concept or process design in the new service development (NSD) process (Johnson *et al.*, 2000). A generic NSD process consists of five steps, namely, opportunity identification, customer understanding, concept development, process design, and refinement and implementation (Kim and Meiren, 2010). A service concept includes the specific features of the service, which, in turn, indicate what to offer and how to offer it to customers (Edvardsson and Olsson, 1996). A service process is the process through which the service is produced (Kim and Meiren, 2010) and delivered to a target customer (Bitner *et al.*, 2008). Service process design determines the details associated with the process, such as customer actions, interactions between customers and employees, the sequence of operational tasks and their interactions, and the responsibilities of personnel and technology (Lim and Kim, 2014).

The customer process concept serves a key role in service design because customer process analysis is an effective way to enhance customer understanding and services are delivered according to customer processes (Bitner *et al.*, 2008). Bettencourt (2010) developed a method for establishing customer process-oriented service design. This method defines a detailed customer process, identifies the important outcomes of this process (e.g. time minimization and safety enhancement), and generates services for the outcomes. Other studies also highlight the importance of focusing on customer processes in service design. Service blueprinting (Bitner *et al.*, 2008; Lim and Kim, 2014) underscores the importance of analyzing and designing service delivery processes with respect to a series of customer actions (i.e. customer processes). Sampson (2012) describes the relationship between service operations management and the management of the customer's independent processes, the provider's independent processes, and their interactive processes. All these studies can be used for designing services that use customer-related data to create customer value. However, their applicability may be limited because they do not explicitly consider data use, so this study aims to address this gap.

Moreover, previous studies on service design (e.g. Bettencourt, 2010; Patrício *et al.*, 2011) mostly rely on survey or observation data, which are essentially research data that

involve a hypothesis before data collection, and they do not cover newly emerging natural records, such as behavioral records collected from consumer electronics sensors, which are collected chronologically and archived in a database independent of a specific research project. Given the expansion of usable data, the service design literature must be extended accordingly to enable effective service advancement. As described previously, this study focuses on the use of such data related to customer processes. These data provide digital traces of human activities or system operations that reflect customers' real behaviors and contexts without any cognitive transformation. In other words, these data reflect unbiased customer process characteristics (CPCs) rather than biased customer needs, and, thus, may contribute to understanding the unexplored space of service opportunities that create value-in-use for customers concerned about their processes, which is the focus of this study.

2.4 Manufacturing and business process improvement

Using data regarding individual customer processes to create value can be facilitated by the relevant operations and business process management methods. Six Sigma, a systematic process improvement method (Linderman *et al.*, 2003), is a typical example of using organizational data to improve processes, such as manufacturing (Henderson and Evans, 2000) and hospital processes (Benitez *et al.*, 2007). Six Sigma provides the following procedure for process improvement (Lynch and Cloutier, 2003): defining the process to be improved and improvement goals, defining and measuring key variables affecting process performance and quality, analyzing these variables with available data, improving the process, and controlling the process (DMAIC). Process mining, which aims to explicitly understand a complex business process based on event logs (van der Aalst and Weijters, 2004), is another example. Process mining has been intensively applied to understanding and managing complex processes in various domains, such as healthcare and urban management (Song and van der Aalst, 2008). Process mining entails several key activities, such as defining a theoretical process, collecting, and analyzing process event logs to determine the actual process, comparing the theoretical and actual processes, and identifying and eliminating bottlenecks to improve the process.

The above studies indicate that the use of available data for value creation can be improved by focusing on the relevant process. The development of the Six Sigma and process mining methods highlights the efforts and benefits of monitoring and improving manufacturing and business processes using process data. However, similar studies focused on individual customers are rare due to the relative lack of data for tracking, modeling, measuring, and analyzing individual customer processes. As shown in Figure 3, the amount and variety of data on individual customer processes have recently evolved considerably and will continue to increase in the future. However, few studies focus on creating customer value using data from customers and their concerned objects. The studies reviewed in Section 2 must be integrated to explore this interdisciplinary research area, and this work aims to examine this promising topic by developing a service-oriented framework for using customer-related data to create customer value.

3. Research method

3.1 Action research

Action research is "an orientation to knowledge creation that arises in a context of practice and requires researchers to work *with* practitioners" (Huang, 2010). Its two goals (Kullven and Mattsson, 1994) are to exploit an opportunity or solve a problem and to contribute to science (Coughlan and Coghlan, 2002). This research method "is unique in the way it associates research and practice, so research informs practice and practice informs research synergistically" (Avison *et al.*, 1999). In this study, "action" refers to the

actions involved in using data for service advancement and customer value creation, including data collection, data analytics, information creation, and information delivery service design. Action research on the four industry and government projects described in Table I was used to develop the CPM framework. These projects used data to create value (i.e. the first goal of action research) and to develop algorithms and frameworks for data use (i.e. the second goal). See Lim, Kim, Kim, Kim and Maglio (2018) for the detailed service design process in each project.

Action research is appropriate for this study because it focuses on organizational change (Avison *et al.*, 1999), and this study focuses on changes (i.e. creating or enhancing customer value) resulting from the emergence of customer-related data; it aims to achieve a holistic understanding (Coughlan and Coghlan, 2002), and this study explores a complete spectrum of the use of customer-related data to create customer value; research on data use fundamentally requires an understanding of rapidly evolving practices, and the close observation necessary for developing this understanding is only possible through action (i.e. the active participation of researchers) (Huang, 2010); and action research combined with design science research (Hevner *et al.*, 2004) or action design research (Sein *et al.*, 2011) is useful in designing a framework for a practical issue based on academic theory (Luftenegger *et al.*, 2017), as in this study. Although this study is based on both traditional action research and the recent action design research literature, for coherence, only the term "action research" is used (action design research is regarded as a subset of action research).

3.2 Contexts and processes of the action research projects

The industry and government clients of Projects 1–4 aimed to design services to support their customers using specific customer-related data that were already collected or yet to be collected. Thus, these projects fit the current study well. Projects 1 and 4 were requested by an automobile manufacturer and an IT company, respectively, to use driving and daily behavior data to design driving and wellness management services (Lim, Kim, Heo and Kim, 2018; Kim, Kim, Lim and Heo, 2018). Projects 2 and 3 were initiated by a government transportation safety institute to design services to help commercial drivers manage their driving, similar to driving assistant services for private drivers (Kim, Lim, Lee, Kim, Park and Choi, 2018; Kim, Lim and Kim, 2018; Lim, Kim and Maglio, 2018). Projects 1–3 mainly focused on the measurement and enhancement of driving processes, whereas Project 4 focused on wellness management. Each of these four projects targeted specific beneficiaries of data use for value creation, namely, private drivers (Project 1), commercial vehicle drivers (Projects 2 and 3), and students (Project 4). The diversity of these projects contributes theoretical and practical insights regarding the creation of customer value using customer-related data.

The multi-year action research process for these four projects is shown in Figure 4. The steps in Projects 2 and 4 are simplified because they are similar to those in Project 1. The action research process involves problem diagnosis (pre-step), data gathering, data analysis, action planning, action taking, action evaluation (main steps), and reflective learning (post-step) (Avison *et al.*, 1999; Coughlan and Coghlan, 2002). In each project, the service design process corresponded to the main action research steps and was planned based on the literature reviewed in Section 2.3 after the problems were diagnosed with practitioners. In Projects 1–3, the service design process involved data analytics, information design, service design, and action evaluation (i.e. evaluation of the previous steps). However, in Project 4, the design process started with an investigation of daily behavior data, and the information, and service design were conducted based on this investigation. Then, data to validate the designed service concept were collected from the students and analyzed.

In action research, actions should be planned and evaluated based on the literature (Mathiassen *et al.*, 2012). Given that the research on data use for service advancement is at a

Table I. Four action research projects conducted in this study

Subject	Project date	Service provider (project client) and customer	Data analyzed for service design	Summary of the service design based on the data
Project 1: Car infotainment service design (Lim, Kim, Heo and Kim, 2018)	October 2011–June 2012	Automobile manufacturer and private drivers	Passenger vehicle operations and conditions	Car infotainment services were designed for individual private drivers based on data analysis of 7.6 m trips by 18,943 vehicles (customer driving data) and 3,662 cases of warning code occurrences (vehicle condition data) for a major automobile manufacturer. The services add customer value by providing feedback information to help customers drive and manage their cars safely and economically
Project 2: Driving safety enhancement service design (Kim, Lim and Kim, 2018)	April 2013–May 2014	Transportation division of the government and commercial vehicle drivers	Vehicle operations and accident data for commercial vehicle drivers	In The Republic of Korea, all transportation companies must install data collection devices in each vehicle and regularly report the recorded vehicle operation data to the government for safety management. Driving safety enhancement services for commercial vehicle drivers were designed for a government transportation safety institute based on analyses of driving data from commercial vehicles (278 intra-buses, 46 taxis, and 931 trucks) and accident data from commercial vehicle drivers (4,289 intra-buses, 1,550 taxis, and 490 truck drivers). The services add customer value by providing feedback information to help customers drive the vehicles safely
Project 3: Eco-driving support service design (Kim, Lim, Lee, Kim, Park and Choi, 2018)	June 2014–October 2015	Transportation division of the government and commercial vehicle drivers	Vehicle operations and fuel consumption data of bus drivers	Eco-driving support services for bus drivers were designed based on an analysis of bus operations and fuel consumption data collected from 33 bus drivers. The services add customer value by providing feedback information to help customers drive the vehicles economically
Project 4: Smart wellness service design (Kim, Kim, Lim and Heo, 2018)	January 2015–December 2015	IT service company and college students	Daily behavior data	A smart wellness service for college students was designed with an IT service company and a student counseling center at a university. In this project, the daily behavior data, including activity and sleep data, of 47 students were analyzed. The service adds customer value by providing feedback information to help customers manage their daily life healthily

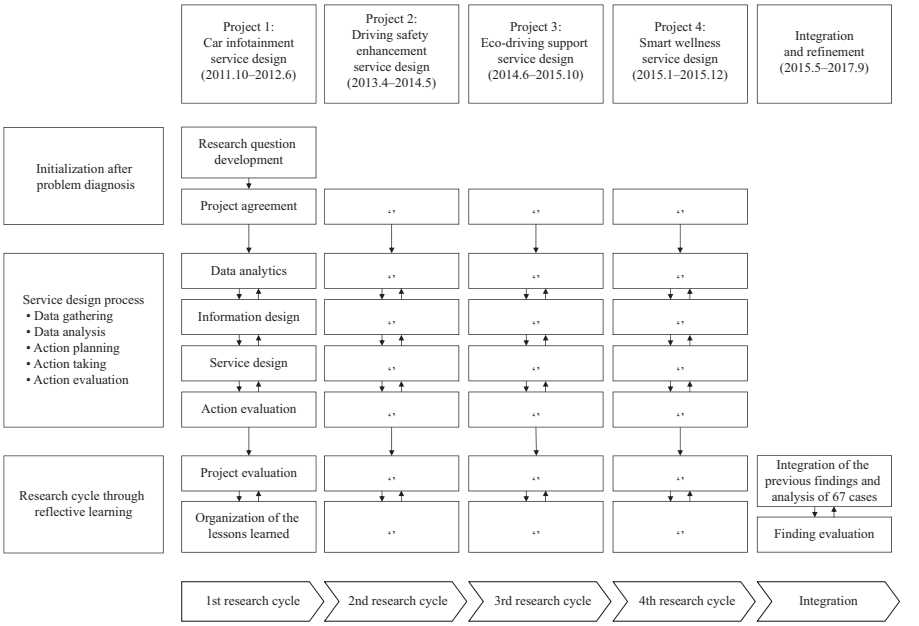


Figure 4.
Research process

nascent stage and the topic is truly interdisciplinary, no single concept in the literature can fully cover the relevant area. Thus, a wide range of studies were reviewed for these four projects, such as the studies reviewed in Section 2.

The main action research steps involved active participation of the authors in the four projects to examine customer-related data use in practice and to collect research data for this study, such as information obtained from the analysis of customer-related data to understand customer behavior, the design of information content for customer process improvement, information from experts and practitioners with extensive experience in data analytics and business, and the design and evaluation of new CPM service concepts. The research data for Projects 1–4 used in this study are distinct from the data considered within each project (i.e. natural records about customer processes). The interpretations of the research data correspond to the outcomes of reflective learning using this data. All projects involved monitoring, evaluating (by both researchers and practitioners), and repeating these steps to maintain the validity of action research (Avison *et al.*, 1999; Coughlan and Coghlan, 2002; Mathiassen *et al.*, 2012) (e.g. Project 2 involved analyzing sample driving process data, identifying data quality issues, requesting data from the client after specifying the data requirements, and analyzing the higher-quality data). This way, various practical and theoretical insights on the use of customer-related data to create customer value emerged.

3.3 Development of the CPM framework across the research process

As shown in Figure 4, the development of a preliminary framework for creating customer value with customer-related data began with Project 1, which was conducted in October 2011. An automobile manufacturer collected driving data and was motivated to develop customer services using this data. In the process of data analytics and service design, company managers and vehicle experts helped to identify certain issues and facilitate and enhance the use of driving process-related data. Based on this work, key factors of driving

process management, including devices for vehicle-related data collection, characteristics of driving process-related data, and information delivery channels for drivers, were identified. This knowledge was used to design car infotainment services for driving process management.

The Web Appendix[1] shows how the proposed framework was developed according to the research process. The preliminary version of the framework from Project 1 was generalized based on some of the studies mentioned in Section 2. The process-based framework for managing value co-creation (Payne *et al.*, 2008) served as the backbone of this work because it incorporates a comprehensive set of insights on how customers and service providers interact to create value. Building on this framework, the activities involved in the use of customer process-related data were identified based on previous studies that discuss such activities in the operations and business contexts. This process also involved the analysis of various practical cases of customer-related data use, such as the service cases in Section 2.1. As a result, the first general version of the CPM framework was developed (i.e. the alpha version, in action design research terms).

The first version of the CPM framework was used as a reference model in Project 2. This framework was used to plan the data collection, analyze the data, extract information from the data for the customers, and design information delivery services for safe driving. Through Project 2, the first version of the CPM framework was evaluated and refined into its second version (i.e. the beta version, in action design research terms), which was then used and refined into newer versions through Projects 3 and 4. Studies on data-based relationship management in services (e.g. Payne and Frow, 2005; Saarijärvi *et al.*, 2013) were incorporated in this refinement process. In response to the call for research on the use of big data for service advancement (Ostrom *et al.*, 2015) in the middle of Project 4, the findings of Projects 1–4 were reorganized, and the third version of the framework was refined.

The findings from each project are situationally grounded but may be difficult to generalize. Thus, after Project 4, a cross-project analysis was conducted to identify a sense of generality by looking for similarities and differences across the projects. The research data were re-integrated and re-analyzed to form theoretical generalizations and collate the knowledge gained throughout the four projects. This analysis also looked for synergies between customer process-oriented thinking for value creation, which is more related to marketing, and manufacturing and business process improvement methods, which are more related to operations management. The DMAIC procedure of Six Sigma (see Section 2.4) was integrated into this refinement process to define specific steps in the CPM framework. Ultimately, this process aimed to develop a comprehensive framework that best reflects the findings from action research, phenomenological observations, and the literature.

3.4 Cross-case analysis of 67 CPM service cases for generalization

To ensure the generalizability of the framework, for each project, the authors who did not initially participate in a project evaluated whether the framework covered that project and refined the framework when necessary. Nonetheless, the generality criterion in theory-generating research was not directly met because each project depended fundamentally on its specific context (Ketokivi and Choi, 2014). Thus, to enable generalizations, another phase of research was performed to refine the CPM framework using 67 CPM service cases. Table AI in the Appendix enumerates these cases according to the classification in Figure 3. The cases were collected from literature, reports, and books and cover various industries, including the automobile, energy, insurance, health, home, and transportation industries. A cross-case analysis of these 67 cases based on the CPM framework helped to assess the generality of the framework and

describe the use of customer-related data and the creation of value-in-use for various customer processes. Multiple iterations of this refinement process were performed (including the journal review process) to arrive at the final version of the CPM framework described in the next section.

4. Customer process management framework

In this section, the CPM framework (Figure 5) is described in terms of driving process management based on a large database of driving records (i.e. Project 1). The other project cases are introduced at the end of this section. Recall that a customer process is a series of activities performed by a customer to get a job done and create value, so the main agent of process management is the customer, not the provider. The service provider helps customers monitor and manage their processes.

Figure 5 presents the value creation activities (pentagons), resources for or outcomes from these activities (rectangles), and relationships (connections between diagrams) involved in CPM. As shown in the framework, value co-creation through CPM involves customer, interaction (encounter), and provider (supplier) processes (Payne *et al.*, 2008; Sampson, 2012). Customers engage in specific processes to get their jobs done (Bettencourt, 2010). Firms interact with customers, collect data, and deliver information (Lim and Kim, 2014). They transform data into useful information through analytics, and customers eventually use this information in their processes (Saarijärvi *et al.*, 2014). The analytics process is operated by the service provider and is often invisible to the customers. Value is not created until customers (i.e. information users) actually use the received information for a specific purpose. In other words, value is created in use (Vargo *et al.*, 2008; Heinonen *et al.*, 2010). For example, driving safety can be improved only when safe driving information is used by drivers, and health can only be improved when health-related advice is used for health management or care.

The terms "data" and "information" are often used interchangeably. However, in the CPM framework, these terms are distinct from a value perspective (Lim, Kim, Kim, Kim and Maglio, 2018b) based on the data–information–knowledge–wisdom hierarchy (Rowley, 2007). As Figure 5 indicates, data are the raw materials and ingredients of

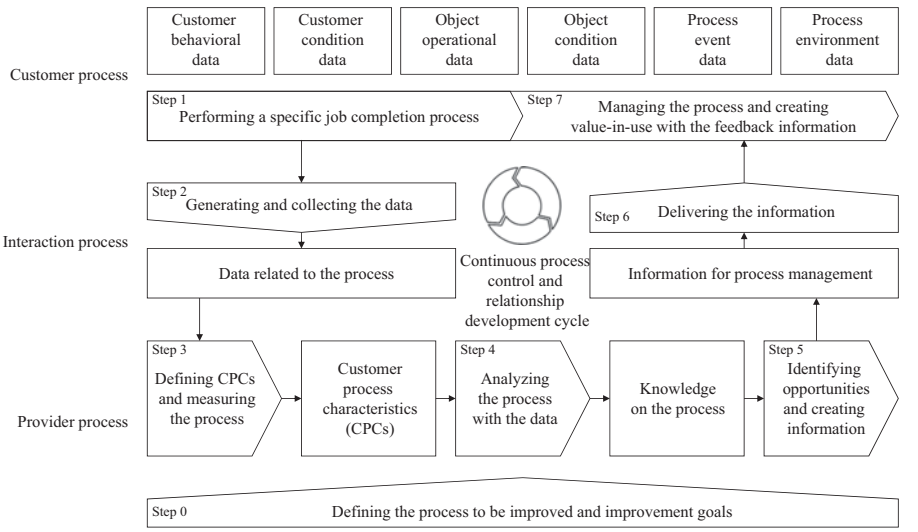


Figure 5.
Customer process management framework

information, whereas information is the outcome of data analysis that is delivered to customers for a specific purpose. Value-in-use is created when customers use this information as a resource. The circle at the center of Figure 5 represents continuous process control and relationship development, which are facilitated by iterative interactions between data and information. In sum, the framework suggests that firms can co-create value with customers and develop relationships through data and information exchanges. The remainder of this section illustrates the details of CPM using examples from Project 1.

4.1 Steps 0 and 1: defining the improvement goals of a specific job completion process

First, customers perform specific processes to get their jobs done. They create value by completing these processes successfully. In CPM, the unit of analysis is an individual customer process, and all distinct data collection, analysis, and information delivery activities must be coherently organized to improve the focal process. As such, the first step in implementing CPM is defining the process to be improved along with its improvement goals. In Figure 5, this step is called "Step 0" because it is a prerequisite to the cycle of Steps 1–7 but is not included in the cycle. If the set of available data is fixed, then Step 0 can be accomplished by considering the goals and processes that can be tracked, measured, and analyzed using this data.

The focal process in Project 1 was the driving process of private drivers, and process improvement goals were defined by analyzing customer complaints and requests, the existing services of competitors, and the available data and by holding discussions with automobile experts and managers at the manufacturer. JTBD theory (Ulwick, 2005) and the job mapping tool (Bettencourt and Ulwick, 2008) were also employed using the customer process as the unit of analysis. The defined goals included improving the fuel efficiency, safety, consumable use, availability, and entertainment aspects of private drivers' driving processes.

4.2 Step 2: generating and collecting the data

In the next step, the service provider or its partner collects data during customers' processes. As Figure 5 indicates, the data that can be collected from customer's processes include records on human behaviors, health, operations, conditions, process events, and the environment in the time or frequency domain. In Project 1, the automobile manufacturer collected driving process data directly from telecommunication networks (during driving) and indirectly from gas stations (when waiting or stopping). As such, "data collection" in Figure 5 includes the data transmitting action. Project 1 used the vehicle relationship management database (VRM DB) that included vehicle driving data (e.g. trip start/end time, average trip speed, average trip distance, and idle time) and vehicle condition data (e.g. warning codes, engine temperature, and revolutions per minute). Vehicle driving data were collected during each trip, and vehicle condition data were recorded for seven seconds whenever a warning code was triggered. This project used data on 7.6 million trips taken by 18,943 vehicles (19,063 drivers) in 2011. A total of 3,662 cases of warning codes and the associated conditions recorded from 2009 to 2012 were also used.

4.3 Step 3: defining customer process characteristics and measuring the process

Next, the service provider defines and measures the CPCs using the data. Defining the CPCs requires a specific equation for the indicators. In Project 1, the CPCs were defined and analyzed through multiple discussions with company managers and automobile engineers; some of them are shown in Table II. Some of these indicators are confidential and, thus, are simplified in this paper (e.g. engine oil deterioration indicator 1). The indicator values in Table II were calculated from analyses of 1,071,032 trips by 1,688 drivers in 2011.

A CPC is an indicator that quantitatively captures an important characteristic of a customer process, such as the average duration of daily processes, the ratio of behaviors in a process, or a specific indicator defined by domain experts. CPCs indicate certain aspects of customer behavior or health, the operations and conditions of products that customers use to perform their processes, and process events and the environment. The CPC values indicate variability in the processes by measuring and analyzing the CPC values of different customers, and understanding this variability is critical for process improvement (Montgomery, 2005) and, therefore, is a prerequisite for designing or improving a service (Frei, 2006). Moreover, customers can take actions that impact CPCs when performing their processes. In other words, customers can use CPCs to monitor and improve their processes. As such, CPCs are similar to the process variables in Six Sigma (Linderman *et al.*, 2003).

4.4 Step 4: analyzing the process

Fourth, after a basic understanding of CPCs is achieved, the process must be further analyzed to obtain advanced knowledge. Whereas CPC measurement aims to document existing processes quantitatively, CPC analysis focuses on specific CPCs and the relationship between these indicators and other variables. CPC analysis provides a deeper understanding of the process in question (e.g. the variability in different customers' processes and the sources of poor quality or performance) and formulates process improvement strategies. The analysis of the CPCs listed in Table II provided various insights on the drivers. For example, the distribution of annual mileage indicates that approximately 50 percent of the drivers have an annual mileage under 7,500 km. This percentage was well below company manager expectations, and the analysis implied that infrequent drivers could be offered different insurance services from those for frequent drivers. If drivers have poor driving patterns in terms of engine oil condition, then oil replacement should be performed earlier than the standard. The other CPCs listed in Table II were similarly used to cluster and categorize driving patterns based on an understanding of the variability of capabilities and efforts (Frei, 2006).

A systematic analysis of CPCs can help in discovering novel insights and identifying new service opportunities for improving customer processes. The CPC analysis model in Figure 6 illustrates the VRM DB analysis in Project 1. This figure was used with the automobile company as the conceptual basis for project participants (i.e. the authors, managers, and engineers). Figure 6 indicates the factors that determine or affect driving processes, and the arcs indicate the physical and statistical relationships between these factors. The analysis results revealed a wide variety of driving patterns according to the driving process improvement objectives, CPCs, and demographic and context variables. Consequently, 26 new service opportunities were identified, such as winter driving safety care, long distance travel safety care, mileage-based insurance, city driving care, and young

Driving characteristics (annual)	Driver 1	Driver 2	…	Driver 1,688
Number of trips	874	382	…	87
Mileage (km)	6,656	2,276	…	872
Average mileage per trip (km)	7.62	5.96	…	10.02
Ratio of short trips (< 18 km)	91.08	97.64	…	87.36
Average low speed (< 29 km/h) ratio per trip	73.18	72.87	…	68.15
Engine oil deterioration indicator 1	284	159	…	34
Engine oil deterioration indicator 2	32.49	41.62	…	39.08
Tire wear indicator 1	0.018	0.018	…	0.019
…	…	…	…	…

Table II.
Measurement of customer process characteristics in Project 1

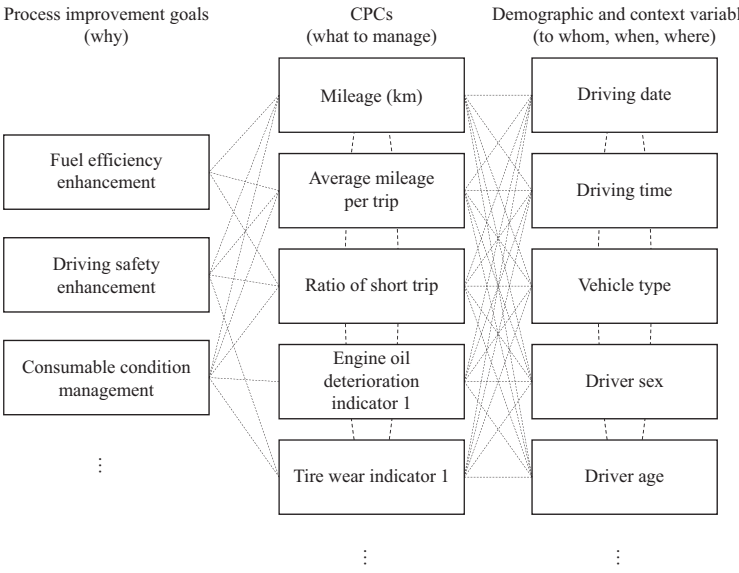


Figure 6.
Illustration of the driving process analyses in project 1

driver care services. Figure 6 shows the importance of CPCs in connecting process improvement goals and available data.

Within the CPM framework, CPCs can facilitate the use of customer data in services because CPCs provide lenses to understand customers. CPCs can enhance value creation by indicating the quality and performance of customer processes and helping customers control and improve their processes based on data. As shown in Figure 6, CPCs connect the data to the goal and are used to extract useful information from the data for customers. Aligning the goals, collected data, and delivered information is essential for CPM, and CPCs are useful in establishing this alignment. CPCs will continue to be defined and used in all industries to help customers improve their processes.

4.5 Step 5: identifying service opportunities and creating information for process management

Fifth, the service provider identifies service opportunities and creates information content for monitoring customer processes and improving process execution based on the data analysis. The results of CPC analysis provide cues for understanding customers and identifying service opportunities to address their variability. The service provider can, therefore, create information content for CPM to realize these opportunities and design an information delivery service. The information for process management can be classified according to the original process improvement goal (e.g. achieving desirable outcomes or preventing undesirable outcomes). For example, tire monitoring services mainly aim to prevent unexpected outcomes during driving, whereas fitness tracking services support customers in achieving desired fitness outcomes. This information can also be classified according to aspects of its focal process, such as cost, ease, time, resource, performance, flexibility, stability, and environmental aspects. The forms of information may include descriptive statistics regarding the CPCs, comparisons among different groups of customers, predictions of future process statuses, and prescriptions for process improvement. The information designed in Project 1 included daily/monthly driving process reviews, drivers' rankings, and the remaining lifetimes of consumables.

For example, Figure 7(a) presents a spider chart that reviews a driver's driving history and describes his driving capability based on normalized CPCs related to fuel efficiency. Figure 7(b) shows engine oil replacement recommendation. The solid line in the figure indicates the estimated mileage based on the real mileage since the previous replacement, and the dotted line indicates the same for the adjusted mileage. The future values for both lines were estimated using linear regression prediction models based on their advantages over autoregressive integrated moving average models. Adjustments were performed based on a penalty imposition developed by an expert in engine oils using the engine oil deterioration indicators listed in Table II. These examples show that CPCs can represent the variability either between customers or within a customer. Specifically, Figures 7(a)–(b) present information based on analyses between drivers and within a driver, respectively.

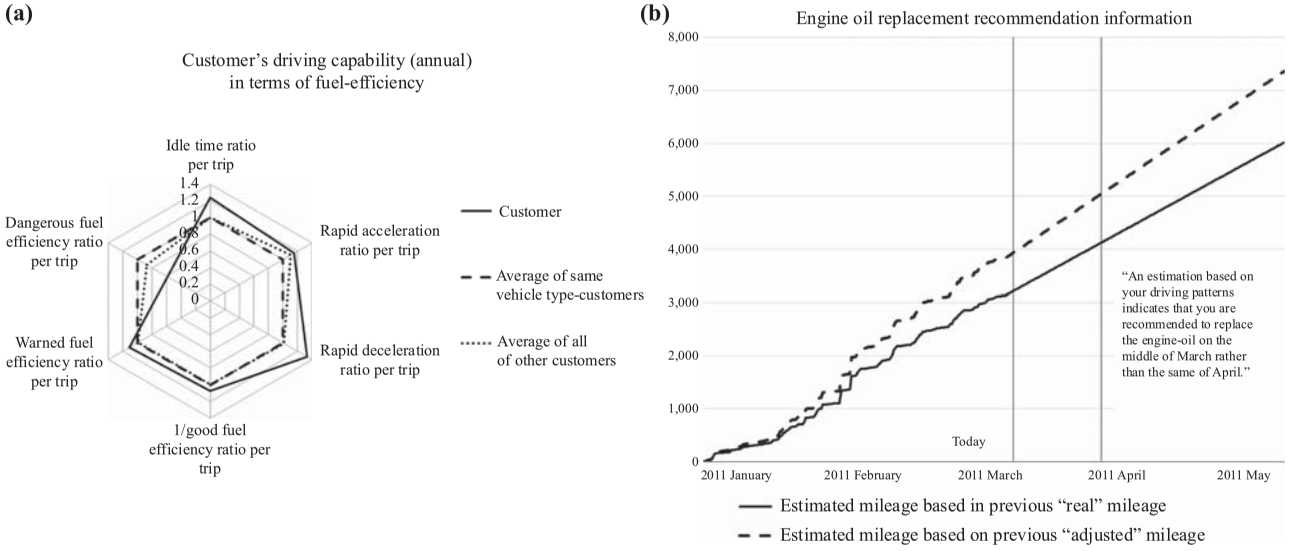
These examples show that CPCs are also useful in designing information content for customers based on available data because they can be controlled during the customer process execution. CPC measurement and analysis can enhance the understanding of the variability in different customers' processes (e.g. capability and effort variability), and information content design aims to identify how this variability should be addressed (e.g. reduced or controlled) to create value. Thus, the principle of CPM is to accurately define the customer process and the CPCs initially to help customers reach their goals.

4.6 Steps 6 and 7: delivering and using the information through a service

Finally, customers can use the feedback information received through a service to monitor, understand, and improve their processes, thereby creating value-in-use with the information. Project 1 designed services for fuel efficiency improvement, driving safety enhancement, consumable replacement support, and prognostic maintenance support. These services measure the CPCs listed in Table II and deliver the information illustrated in Figure 7 to drivers. Fuel efficiency improvement and driving safety enhancement services review patterns in driving processes and provide drivers with process improvement information related to mileage and driving safety, respectively. The consumable replacement support service manages the lifecycles of consumables, such as engine oil, tires, and batteries, according to the identified driving process patterns. The prognostic maintenance support service monitors driving processes and predicts the sudden breakdowns of vehicles. Preventive maintenance is suggested if a breakdown is predicted.

4.7 Continuous process control and relationship development

The activities involved in CPM form a cycle for improving and managing the focal customer process. The circle at the center of the CPM framework represents continuous process control and relationship development. While a CPM service with well-defined CPCs is used by customers, the service helps them improve their processes continuously. Furthermore, through iterative interactions between data and information, service providers can develop relationships with customers and sustain process improvements over the long term. For example, the information in Figure 7(b) suggests specific actions for drivers (i.e. replacing consumables) and contributes to the creation of touchpoints to foster customer relationships. Customer experiences develop over time, and designing a series of touchpoints for these experiences is critical to improving value co-creation (Payne *et al.*, 2008). Changing service providers is difficult for individual customers if their current providers are highly knowledgeable about their processes and characteristics. The knowledge accumulated through continuous interactions between data and information can provide a platform for identifying future marketing opportunities. For example, the managers of the automobile manufacturer in Project 1 wanted to promote the purchase or lease of cars using the new knowledge on how their customers drive and use their cars.



Notes: (a) Driver's driving capacity in terms of fuel efficiency-related CPCs; (b) engine oil replacement recommendation information

Figure 7.
Examples of information for better process execution designed in project 1

This section has illustrated the CPM framework using examples from Project 1. However, all four action research projects were used to develop the CPM framework, and Table III summarizes the CPM elements from these four research projects. See Lim, Kim, Kim, Kim and Maglio (2018a) for more information of the projects.

5. Discussion

5.1 Utility of the services designed in the projects

Each service designed in Projects 1–4 was evaluated by company managers, executives, or government employees. The practitioners appreciated the value of CPM services that operationalized (or institutionalized; Vargo and Lusch, 2016) value-creating activities using data from their customers. The smart wellness service designed in Project 4 was also evaluated by 47 potential customers (i.e. students). One of the factors they liked most about the service was that data from them were transformed into feedback to help them modify and improve their processes. This key factor distinguishes the use of data for CPM from traditional data use, such as in loyalty research, market investigation, and simulation. Existing studies also indicate the importance of the cycle of data and information exchange for value co-creation and relationship development between customers and modern service providers (Kumar *et al.*, 2013; Saarijärvi *et al.*, 2013; Opresnik and Taisch, 2015; Ng and Wakenshaw, 2017). The services designed in Projects 1–4 involve this cycle, and, in fact, the most important aspect of a CPM service is the knowledge accumulated through the service.

5.2 Comparison with related work

The CPM framework is highly related to the customer relationship management (CRM) (Payne and Frow, 2005), Six Sigma (Linderman *et al.*, 2003), and BPM (Burlton, 2001) frameworks. Table IV shows a comparison between the proposed framework and

Subject	Relevant customer process	Data used	CPCs	Information content
Project 1: Car infotainment service design	Driving processes of individual drivers	Driving data and vehicle condition data collected using an onboard device	Number of trips, average mileage per trip, engine oil deterioration indicator, etc.	Comparison of driving capabilities with other drivers, engine oil replacement recommendations, etc.
Project 2: Driving safety enhancement service design	Driving processes of commercial vehicle drivers	Driving data collected using a digital tachograph and accident records archived in the government database	Rapid accelerations, rapid left turns, rapid right turns, rapid U-turns, etc.	Distribution information on risky driving behaviors, driving safety comparisons with other drivers, etc.
Project 3: Eco-driving support service design	Driving processes of bus drivers	Driving data and fuel efficiency data collected using a digital tachograph	Speeding, ratio of idle time to total driving time, rapid decelerations, etc.	Fuel efficiency predictions, monthly fuel efficiency trends, driving efficiency comparison with other drivers, etc.
Project 4: Smart wellness service design	Health management processes of college students	Daily health behavior data collected from smart bracelets and manual recordings	Daily step achievement, daily golden time achievement for sleeping, overdrinking, etc.	Daily health behavior score, wellness comparison with other students, connections to the counseling center, etc.

Table III.
CPM elements in the four action research projects

	CRM (Payne and Frow, 2005) and value co-creation framework (Payne *et al.*, 2008)	Six Sigma (Linderman *et al.*, 2003)	BPM (Burlton, 2001) and process mining (van der Aalst and Weijters, 2004)
Similarities	Customer-oriented thinking Approach for relationship development with customers	Process-oriented thinking Statistical approach for a data-rich context Approach for process quality management	Process-oriented thinking Approach for process modeling and performance improvement
Differences	Whereas these existing works provide an approach for managing any type of interaction with any type of customer, CPM focuses on an individual customer process in the context of using customer process-related data	Whereas Six Sigma is an approach for improving and controlling the product or service production processes of organizations, CPM focuses on individual customer processes	Whereas BPM and process mining are approaches for improving the business processes of organizations, CPM focuses on individual customer processes

Table IV.
Comparison between customer process management and related work

these frameworks. Overall, CPM differs from the other frameworks in its focus on individual customer processes. For example, performance measures in CPM (i.e. CPCs) are customized to individual customers, whereas those in BPM (e.g. key performance indicators) are oriented toward the entire business. On the other hand, the similarity between CPM, Six Sigma, and BPM (i.e. process-oriented thinking) shows the area where existing process improvement techniques (e.g. statistical process control and process mining) can contribute to the service literature and practice through their application to customer processes.

5.3 Towards data-based value co-creation

Researchers have intensively discussed the notion of value co-creation (e.g. Vargo and Lusch, 2004; Payne *et al.*, 2008; Pinho *et al.*, 2014; Vargo and Lusch, 2016). However, our literature review revealed a surprising lack of work directed at providing frameworks to help organizations enable and manage data-based value co-creation, despite the significance of such frameworks in today's data-rich economy (Wünderlich *et al.*, 2015), with a few exceptions (Saarijärvi *et al.*, 2014; Hoffman and Novak, 2017; Kunz *et al.*, 2017; Lim and Maglio, 2018). These studies also lacked empirical evidence and actionable information for both researchers and practitioners. Value is co-created through "the application of competences (knowledge and skills) by one entity for the benefit of another" (Vargo and Lusch, 2004), and information is among the key resources of the value co-creation configurations, or the service systems (Vargo *et al.*, 2008). As such, value co-creation can be improved as useful knowledge about customers is developed and appropriate feedback information is delivered to improve their skills and create value-in-use. The proposed CPM framework may be useful to service providers to implement this data-driven value co-creation mechanism with emerging customer-related data.

5.4 Marketing operations interface for service management

CPM can be used as a bridge that connects marketing with operations to achieve effective service management. Payne *et al.* (2008) showed that the management of value co-creation in service requires an integrative approach considering the provider and customer sides. Traditionally, the former has been investigated mainly in the operations management field, whereas the latter is mainly addressed by marketing research. Integrating these two fields is difficult even though a high connectivity between them is essential in practice. The proposed CPM framework contributes to connecting these two fields by demonstrating the harmonization of customer and provider processes toward data-based

value co-creation, providing a basis for customer process-oriented operations management, and guiding analytics-based marketing with customer-related data. Despite the emergence of a broad range of marketing research on value co-creation over the last decade, surprisingly few studies have focused on providing frameworks to help organizations operate value co-creation with customers effectively and systematically (Payne *et al.*, 2008; Smith *et al.*, 2014). Operationalizing value co-creation has been difficult because of the lack of data required to track, measure, model, modify, control, and manage customer value-creating activities. The proposed framework addresses this difficulty by showing a way to operationalize value co-creation with data.

5.5 Issues in using the CPM framework

As with any large-scale initiative for change, shifting to effectively using customer-related data for service is not easy. This section describes some issues that arose in using the CPM framework. First, a good definition of the process in question is essential for effective analysis (Lynch and Cloutier, 2003). Thus, the customer process must be appropriately defined to effectively implement CPM. Although the job mapping tool (Bettencourt and Ulwick, 2008) and other project-sensitive information were used successfully in this study, future work on systematically defining and analyzing customer processes, particularly using process mining techniques, has a great potential. Second, defining CPCs is another core step in using the CPM framework. As demonstrated in Section 4, CPCs connect the service goal (process improvement goal) and used data. CPC measurement and analysis are essential in understanding customers with their process-related data and in designing information to be delivered to the customers. However, CPC identification is not straightforward and requires various types of expertise, such as knowledge on customers, data analytics, and services. As such, we believe generic models for defining and analyzing CPCs should be developed in the future. Figure 6 presents a sample model that can be further developed in future research.

Other issues include facilitating easy and spontaneous data collection from customers, integrating different data from different sources, and providing incentives for customers to accept the feedback information. For example, data collection by the automobile manufacturer in Project 1 was fully automated, whereas data collection in Project 2 required drivers and company managers to manually transmit the driving data to the government institute. In Project 2, a manager of the government institute had to remind or even visit drivers to collect the data. In addition, integrating the driver, driving, and accident data was a challenge in Project 2 because these data were separately archived in the databases of transportation companies, vehicles, and the government. Finally, from the evaluation of designed services (e.g. evaluation with the company managers in Project 1 and with the students in Project 4), we found that some customers do not listen to the feedback information and inducing them to accept the information is another challenge beyond the design of useful information for them. Thus, in Project 4, we designed and advertised the service with a university student counseling center to enhance the information acceptance of students by associating them to the professional care programs in the center through the service. We found that most students listen to the experts rather than to simple "Apps." We believe future works for the spontaneous collection of data from customers, integration of customer-related data into a database, and incentives for information use will improve greatly the service practice with customer-related data for customer value creation.

6. Concluding remarks

As more customer data are recorded, data-based services for customers are expected to become increasingly important (Hoffman and Novak, 2017; Ng and Wakenshaw, 2017; Lim and Maglio, 2018). Given this context, this empirical work proposes the CPM

framework showing the different steps a service provider can take to help customers manage their processes and create value. Using this framework, a service provider can collect data related to a customer's value creation process, analyze the data systematically with CPCs, create and offer useful feedback information to its customers through a new service, and create new touchpoints to develop a continuous value co-creation relationship. In short, the proposed framework can be used for service design or improvement starting from customer-related data.

Although "using data to advance service" has been highlighted as a critical and timely research topic in the service literature (Ostrom *et al.*, 2015; Kunz *et al.*, 2017; Lim, Kim, Kim, Kim and Maglio, 2018a), to the best of our knowledge, this study is the first to develop a specific framework for firms to use customer-related data to advance their services and create customer value. Moreover, this study provides novel case studies on four service design projects with industry and government. These projects were motivated by not only the authors but also the organizations, implying that there is a demand for this type of service in practice. Thus, the proposed framework and four CPM case studies can facilitate future related work in the service literature and practice. The CPM framework can help firms develop specific customer processes, as the DMAIC framework of Six Sigma has helped improve manufacturing and operations management (Linderman *et al.*, 2003; Lynch and Cloutier, 2003).

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Note

1. http://faculty.unist.ac.kr/service/wp-content/uploads/sites/380/2018/10/Evolution-of-the-framework-over-time-through-the-research-process.jpg

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Further reading

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Appendix

Note that the examples in Figures 2, 3, and Table AI represent only the specific cases we analyzed (e.g. the car infotainment services of several automobile manufacturers studied by the authors between 2011 and 2015); they may have different configurations in other contexts or in the future. Some of the names were translated to English or relabeled in a general term (i.e. from the term named by the company, such as "Hyundai Blue Link Service" to a general term, such as "car infotainment service").

Main source of data	Main content of the information from the data	Service cases for CPM
Customers	Behaviors, operations, or events	Car infotainment, driving record-based car insurance, screen golf training, smart band-based behavior management, smart belt-based orthotherapy, smart glasses-based driving safety management, smart bike-based transportation, real-time navigation, location-based advertisement, location-based security, skin sensing-based consulting, body sensing-based consulting, purchase record-based goods recommendation, credit card use data-based restaurant recommendation, demand-adaptive midnight bus routing, smart bed-based sleep management, educational content recommendation, disease monitoring, RFID-based patient monitoring and control, smart earphone-based music recommendation, smart remote control-based TV control, smart fork-based dietary habit consulting, smart shoes-based walking habit consulting, sensor-based hand cleaning monitoring, gambling stop timing assistance, smart racket-based tennis play assistance, sensor-based basketball play assistance, artificial intelligence soccer shoes, schedule management and alarm
Objects with which customers interact		Vehicle fleet management, precise farming, building energy usage consulting, community energy management, livestock raising management, insurance data-based hospital open consulting, credit card use data-based retail store open consulting, parcel delivery routing optimization, apple condition management, medicine administration monitoring, smart glove-based assistance for the blind, smart ankle bracelet-based baby monitoring, smart bed-based baby monitoring, smart feeding bottle-based dietary management for babies, smart necklace-based pet location monitoring, smart camera-based security, sensor-based fishing consulting, real-time adaptive traffic management
Customers	Health, conditions, or the environment	Sensor-based cardiovascular disease monitoring and prevention, smart shirt-based health monitoring, blood sugar monitoring, smart home telehealth, Home internet of Things (IoT) healthcare, smart necklace-based fitness coaching, smart cap-based stroke prevention, smart band-based blood pressure monitoring, remote patient condition monitoring, smart bra-based stress monitoring, smart socks-based fitness tracking, smart watch-based fitness tracking, insurance data-based preventive healthcare
Objects with which customers interact		Prognostics and health management, tire pressure monitoring, predictive engine oil management, smart necklace-based pet condition monitoring, smart flowerpot, smart gardening, IoT vinyl greenhouse

Table AI.
List of the 67 CPM service cases (see Section 3.4)

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