Data-driven Approach to New Service Concept Design

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Abstract. Various types and massive amounts of data are collected in multiple industries. The proliferation of data provides numerous opportunities to improve existing services and develop new ones. Although data utilization contributes to advancing service, studies on the design of new service concepts using data are rare. The present study proposes a data-driven approach to designing new service concepts. The proposed approach is aimed at helping service designers to understand customer behaviors and contexts through data analysis and then generate new service concepts efficiently on the basis of such understanding. A case using bus driving data is introduced to illustrate the process of the proposed approach. The proposed approach provides a basis for the systematic design of new service concepts by enabling efficient data analysis. It also holds the potential to create a synergetic effect if incorporated into existing approaches to designing new service concepts.

Keywords: Big data · Data utilization · Service concept design · Customer understanding

1 Introduction

We live in an information economy in which data are increasingly exchanged globally [1]. With the advancement of information and communication technologies, various types and massive amounts of data are collected in multiple industries [2]. Such data proliferation provides new opportunities for companies to improve existing services and to develop new ones. Automobile manufacturers analyzed driving records collected from inboard devices to develop various services (e.g., safety, entertainment, and consumable replacement information) for enhancing the experience of the drivers [3]. Heavy equipment manufacturers analyzed equipment condition data to provide services that cope with unexpected product breakdowns and maximize product availability for stakeholders [4]. In building system, many kinds of data, such as energy resource consumption (e.g., electricity, gas, and water) and external situation (e.g., external temperature, amount of rainfall, and solar insolation) were collected and analyzed to

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extract energy consumption patterns of building; then the analysis results were used to reduce energy cost and improve energy utilization efficiency [5]. Insurance companies analyzed patient data to understand their health-related behaviors and to develop services for high-risk patients to improve their healthcare safety [6]. Companies producing wearable fitness tracking devices, such as Fitbit, collected and analyzed people's fitness activity data (e.g., step achievement, active minutes, and awaken or restless time) to support them achieve specific fitness-related outcomes, such as walking 10,000 steps [7]. Such cases are becoming increasingly relevant in the current data-rich economy [8, 9].

Existing studies have demonstrated that using data is key to improving the design activities including a customer understanding and designing service concepts [10]. The design of adequate and innovative service concepts is the core of successful new service development [11]. A service concept indicates what to offer to customers and how to offer it and mediates between customer needs and the strategic intent of a company [12]. Several studies have explored the approaches to designing new service concepts, including a computer-based tool to design the functions of a service concept [13], a morphological approach to designing new smart service concepts [14], and a knowledge-based method for designing product service system concepts [11]. However, studies on the design of service concepts starting from data are rare despite the expected contribution of this topic to data-rich economies. Therefore, developing a systematic and efficient aid for new service concept design starting from data is obviously necessary.

This study proposes a data-driven approach to designing new service concepts that integrates insights from the literature related to big data and service concept design. The proposed approach aims to enhance the effectiveness and efficiency of new service concept design starting from the data. The proposed approach consists of five steps: (1) collecting available data and integrating the collected data for analysis, (2) developing an analysis model that aids in efficient data analysis, (3) analyzing data to understand customer behaviors and contexts, (4) identifying service ideas on the basis of insights gained from the data analysis, and (5) designing new service concepts. The proposed approach is illustrated using bus driving data to show its working process.

The proposed approach contributes to the systematic design of new service concepts by enabling efficient data analysis and further creating a synergetic effect when incorporated into existing approaches to service concept design.

2 Research Background

2.1 Data Utilization to Advance Service

Massive amounts of data in various formats are collected consistently and non-intrusively with the advancement of technologies of data collection and storage, such as the Internet of Things. In particular, data that indicate customer behaviors and contexts are recorded and tracked [15]. For example, automobile manufacturers collect drivers' driving records to monitor their driving behaviors [3]. Companies that produce wearable fitness tracking devices collect people's fitness activity data to help them attain specific fitness-related outcomes [7].

Customer data provide service companies with new opportunities to design new service concepts. In particular, such data help companies in understanding their customers and generating various service contents for customers. Ostrom et al. [9] indicated that companies today can easily get to know their customers in terms of what they did, when they did it, and where they did it through a constant flow of data from multiple sources. Lim et al. [10] indicated that data can be used to understand customer behaviors and produce the information contents required by customers. Opresnik and Taisch [16] similarly noted that the utilization of data from customers can facilitate the development of services in manufacturing industries. Huang and Rust [15] indicated that service companies can leverage and transform customer data into useful information about customers for strategic marketing planning.

The aforementioned studies demonstrate that data utilization contributes to the design of service concepts for customers. Although data utilization is a key for designing new service concepts, studies on service concept design starting from data are rare, and the understanding of the mechanism behind such design is limited. The current research addresses this limitation.

2.2 Existing Approaches to New Service Concept Design

In developing new services, designing service concepts is the first and foremost issue [11]. A service concept is defined as a bridge between the "what" and the "how" of a new service [17], which mediates between customer needs and the strategic intent of a company [12]. The importance of designing new service concepts has gradually increased because of various customer demands, competitive environment, and globalization of services.

Service concepts are commonly designed through intuitive, investigative, and analytic approaches [14]. In the intuitive approach, service concepts are designed on the basis of the intuitions of service designers, which are gleaned from activities such as brainstorming. The investigative approach designs new service concepts by asking for customers' ideas directly, for example, through customer surveys or interviews. The analytic approach uses engineering methodologies and tools for designing new service concepts. For example, Sakao and Shimomura [13] proposed a computer-based tool to design the functions of a service concept for satisfying customer needs. Kim et al. [11] established a methodology for product service system (PSS) concept generation that includes a list of general customer needs, a list of PSS models, a PSS concept generation support matrix, and a PSS case book. Geum et al. [14] proposed an approach to designing new smart service concepts using morphological analysis.

The aforementioned studies can support the design of new service concepts using data. However, the applicability of the results is limited because these studies do not focus on the use of data to design service concepts. By contrast, the present study focuses on service concept design starting from the data, which is a significant issue in data-rich economies. The approach suggested in this work is aimed at providing a systematic procedure that links data analysis to service concept design. Therefore, the approach will assist service designers in efficiently generating new service concepts.

3 Data-Driven Approach to New Service Concept Design

This study proposes a data-driven approach to designing new service concepts. The approach involves (1) collecting available data and integrating the data for efficient analysis, (2) defining variables related to customers and services and estimating the physical or statistical relationship among the variables, (3) analyzing data to understand customer behaviors and contexts, (4) identifying target customers and producing various service contents based on the results of the data analysis, and (5) designing new service concepts by considering the delivery process of service contents (Fig. 1). The following subsections describe each step in detail.

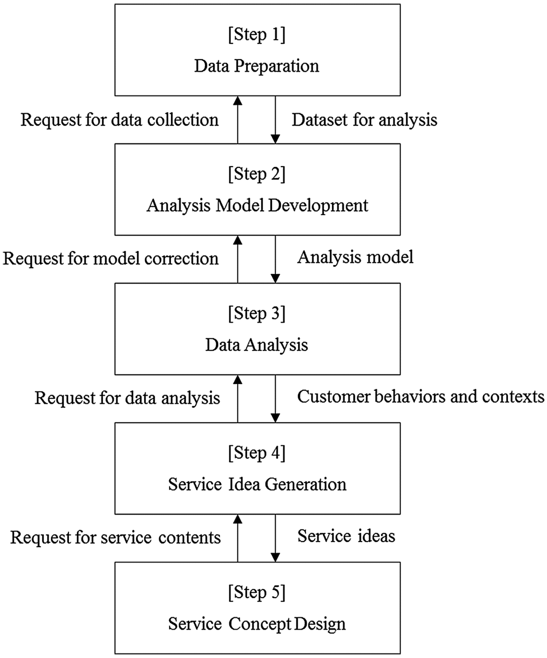

Fig. 1. Procedure for data-driven service concept design

3.1 Step 1. Data Preparation

Step 1 aims to collect proper data from multiple sources, such as the Internet, sensors, and social network activities. Although various types of data exist, this study uses data generated by customers, which include information on customer behaviors and contexts. Driver's driving data, fitness activity data, and patient behavior data are the examples of data used in this study. Moreover, the collected data also feature different formats and structures because of various data sources. Thus, the first step also aims to transform various types of data into a format that can be used to analyze data efficiently.

3.2 Step 2. Analysis Model Development

A prerequisite for customer understanding using data is defining the variables related to the customers and services in question, which indicate customer behaviors and contexts. Therefore, Step 2 aims to define three types of variables that can be measured using the collected data. If the collected data are not sufficient to define the variables, then Step 1 should be repeated to collect the data required to define such variables. To facilitate the understanding of such variables, we briefly describe three types of variables used in each type by using a driving safety enhancement service as an example.

The first type is a service objective variable that includes the goals of both service designers and customers. For example, minimizing accident rates is a goal of service designers for enhancing driving safety. In this case, accident rate is defined as the objective variable. The second type is the customer behavior variable, which indicates people's behaviors or the operation of objects, such as driving while drowsy or engine speed, respectively. Considering this type of variable, service designers can analyze customer behaviors and then identify "the behaviors that should be managed through the service." The third type is the customer context variable, which indicates customers' characteristics (i.e., demographic information) and situations (i.e., time and location), such as gender and driving time, respectively. By analyzing the variables, service designers can identify "when and where to offer the service and to whom it should be offered."

This step also aims to develop an analysis model for customer understanding, which is defined as a model that represents the relationship among the three types of variables. It aids in the analysis of data for identifying customer behaviors and contexts. The relationship among the variables may exist statistically or physically, and this relationship is estimated in this step. For example, a physical or statistical relationship between customer behavior variables and customer context variables may exist. The customer behavior variables are highly relevant to the customer context variables because customer behavior changes depending on customer types (e.g., gender and age) and situations (e.g., weather and time). Thus, analyzing the two types of variables enable service designers to understand customer behaviors and contexts comprehensively. Moreover, changes in customer behaviors under various contexts and differences in customer behaviors across diverse customer types can be analyzed.

3.3 Step 3. Data Analysis

Step 3 aims to analyze data to identify customer behaviors and contexts on the basis of the analysis model. For the data analysis, some variables in the analysis model are selected because of their potential to influence the results of the data analysis. Variable selection is conducted with several domain experts and through a literature review. If undefined variables are needed for the data analysis, then Step 2 should be repeated to define the variables. The statistical or physical relationship among the variables estimated in Step 2 is identified by analyzing the data with respect to the selected variables. The distribution of each selected variable or the relationship among the variables can be analyzed. Figure 2 shows the example of variable selection for analyzing risky driving behaviors that can be used to gain insights for designing driving safety enhancement services. Figure 3 shows analysis results considering selected customer behavior variables and customer context variable in Fig. 2.

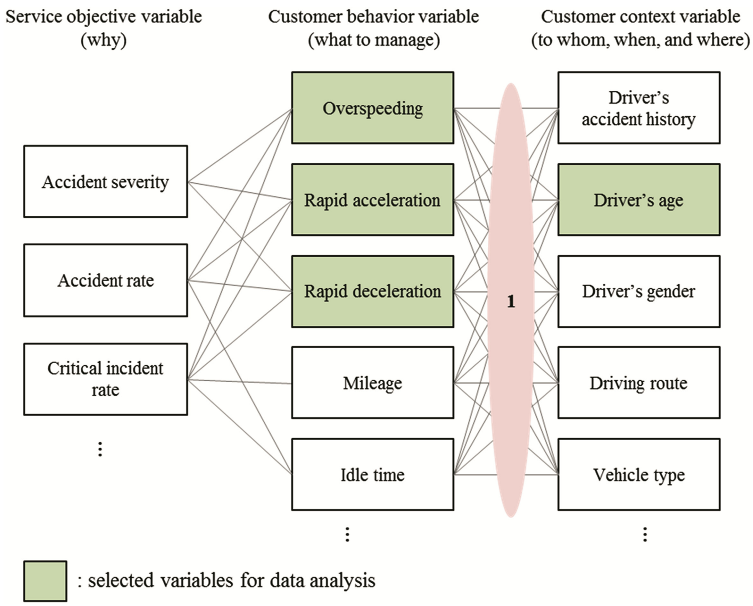

Fig. 2. Example of variable selection for analyzing risky driving behaviors

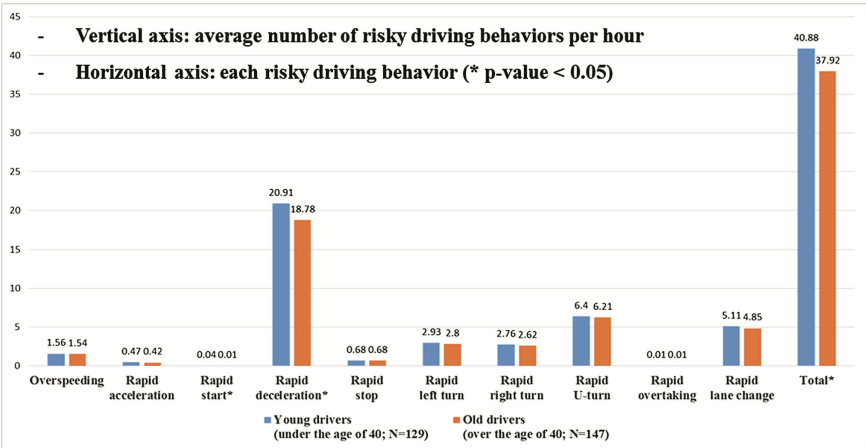

Fig. 3. Comparison of risky driving behaviors of young drivers and old drivers

3.4 Step 4. Service Idea Generation

Various studies explained that defining target customers should be the first stage of designing a service concept because different target customers require different service concepts [18]. Moreover, existing studies emphasized the understanding of target customers' behaviors and requirements in designing customized service concepts for them [19, 20]. Therefore, Step 4 aims to define the target customers of a service (to whom) and the motivations for such a service (why) on the basis of the insights gained from the data analysis in Step 3. For example, identifying the relationship between customer behaviors and customer context variables, which shows the change in customer behaviors considering various contexts, helps to define when and where to offer a service and to whom it should be offered.

This step also aims to produce various service contents because identifying appropriate information in terms of its contents and form is a key factor in improving service value creation [15, 21]. A service content is defined as a function or information that can be provided to target customers. Such function or information is derived from the results of the data analysis in Step 3. For example, the relationship between customer behaviors and context variables can be used to provide information on the comparison or classification of customers because it indicates changes in behaviors in different contexts. If data analysis results are needed to produce a service content, then Step 3 should be repeated to analyze the data.

3.5 Step 5. Service Concept Design

Building on existing studies on the definition of service concepts (see Sect. 2.2), the present study defines a service concept by indicating which contents (what) to offer to target customers (to whom) so as to enhance their experience (why) based on which data (how) and by which delivery process to employ (when, where, and how). The service concept is designed sequentially from Step 4 to Step 5. Step 4 indicates why to offer a service concept to whom (i.e., motivation and target customers) as well as what to offer through the service concept (i.e., service contents). Step 5 aims to define the primary components of the service content delivery, namely, when, where, and how to offer the service contents. In case a service content not produced in Step 4 is needed to design the delivery process, Step 4 should be repeated to produce the service content.

"When" represents the timing of the provision of a service content (i.e., before, during, and after customer process). Using the define, prepare, execute, monitor, and conclude steps of the universal job map [22], the customer process can be identified. This process helps identify the timing of the provision of a service content. "Where" indicates the delivery channels of the service content (i.e., machine and human). Smart devices and managers are examples of delivery channels. Finally, "how" indicates the delivery types of the service content (i.e., push and pull). The push type describes a communication in which the request for a given service content is initiated by service providers. By contrast, the pull type means that the initial request for a content originates from customers.

4 Illustrative Example: The Use of Bus Driving Data

Using the proposed approach, the authors designed service concepts for enhancing the driving safety of bus drivers with the Korea Transportation Safety Authority (TS) of the South Korean government. TS collects operational data of buses through digital tachograph (DTG) to manage the driving behaviors of bus drivers. All bus companies must install DTG on their buses and regularly upload the recorded operational data to TS. As a result, TS now maintains a database called DTG DB. TS uses this database to provide new services that will enhance the driving safety of bus drivers.

The three types of data prepared in Step 1 include DTG (e.g., speed and mileage), accident (e.g., accident type, time, and place), and driver (e.g., driver's age, driving date, and car plate number) data. DTG data are collected every second and then archived in TS. Accident data are collected and managed by the National Police Agency. Driver data are collected and managed by transportation companies. With assistance from TS, this study collected DTG data, accident data, and driver data related to 276 bus drivers of one transportation company covering the periods of April to May 2013, 2004 to 2013, and 2013, respectively. The collected data were then integrated. Through the data integration, we were able to analyze the differences in the driving behaviors of the 276 drivers. Moreover, we were able to analyze the changes in their driving behaviors by considering various driving contexts, such as driving route.

The three types of variables used to understand the driving behaviors of the bus drivers were defined in Step 2. First, we defined the service objective variables, which indicate driving performance such as the accident rate of a driver. Second, we defined the customer behavior variables, which explain driving behavior such as overspeeding and rapid acceleration. Third, we defined the customer context variables, which indicate drivers' characteristics and driving environment. After the variables were defined, an analysis model was developed. Figure 2 indicates an example of the analysis model.

On the basis of the opinions of transportation experts, 10 types of risky driving behaviors defined by the Korean government were selected as customer behavior variables. Driver's age, accident history, and driving routes were selected as customer context variables. The data analysis results in Step 3 include the correlations among risky driving behaviors, the frequency of risky driving behaviors in specific routes, and the comparison of different driver groups according to their risky driving behaviors. Figure 3 shows an example of data analysis results. Specifically, the figure indicates the results of the analysis of the differences between the driving behaviors of young drivers (i.e., under the age of 40) and old drivers (i.e., over the age of 40).

The data analysis results exemplified in Fig. 3 provided insights for defining the target customers of a service and the motivation for such service in Step 4. As shown in Fig. 3, the total number of risky driving behaviors per hour in the young driver group is higher than that in the old driver group (p-value < 0.05). Moreover, the average numbers of rapid start and deceleration per hour in the young driver group are higher than those in the old driver group (p-value < 0.05). These results indicate that driving safety enhancement services should be provided to the young driver group instead of the old driver group. In particular, the services for reducing rapid start and deceleration should be presented intensively relative to other risky driving behaviors.

The service contents for young drivers were also produced in Step 4. Examples of service contents include a service content that indicates the distribution of the risky driving behaviors of a young driver (Fig. 4) and a service content that indicates the ability of a young driver to drive safely (Fig. 5).

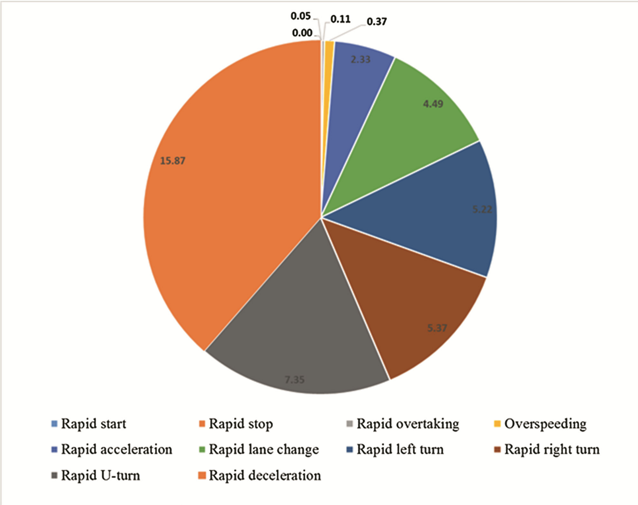

Fig. 4. Distribution of the risky driving behaviors of Driver A (young driver) on a given day

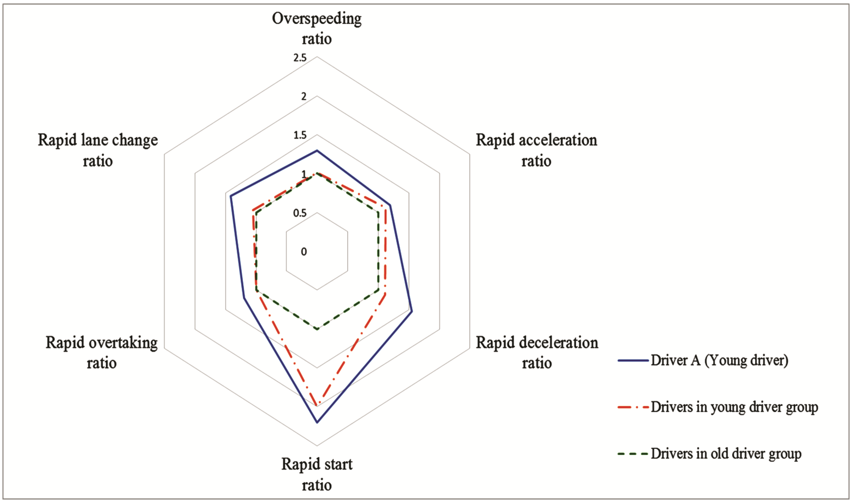

Fig. 5. Distribution of the driving performance of Driver A (young driver) in terms of driving safety

The concept of a driving safety enhancement service that delivers such service contents to young drivers was designed in Step 5 (Fig. 6). Through the service, drivers can receive an educational content about the necessity of safe driving and a feedback content describing their previous driving behaviors through a manager when they check their driving schedules before departure. If drivers rapidly decelerate while driving, an alarm is sent to their in-vehicle devices. At the end of the day, a report describing their driving behavior during that day is relayed to them through their smart devices.

	Driving safety enhancement service concept for young drivers						
Driver actions (when)	Check driving schedules	Review previous driving	Drive to the destination	Adjust driving based on the guide, alarm	Arrive at the destination	Review today's driving	Take a rest
Service contents (what)	Education for safe driving	Feedback on previous driving	Interventions for driving safety (especially rapid start and deceleration)		Reports about today's driving behavior		Training for safe driving
Service channel (where)	Smart devices	Manager (strictly)	In-vehicle devices (e.g., navigation and radio)			Smart devices	Manager (strictly)
Delivery types (how)	Push				Push or pull		Push
	Before driving		**During driving**			**After driving**	

Fig. 6. Driving safety enhancement service concept for young drivers

5 Conclusion and Future Work

The main contribution of this study is to provide an aid for designing service concepts starting from data. Most studies related to big data indicated that the use of data can be a key to designing service concepts, but existing studies do not focus on the use of data for designing service concepts. The present study focuses on the process that encompasses the use of data to design new service concepts. To facilitate such process, we applied the proposed approach to bus driving data. Our results revealed the possible application of the proposed approach to new service concept design. The proposed approach does not replace the existing approaches for service concept design, but it has the potential to create a synergetic effect if incorporated into the existing approaches to designing new service concepts.

Despite such important contribution, challenges for future work remain. First, although the proposed approach provides insights for generating service ideas, the generation of service ideas depends on the creativity of service designers. In particular, the production of service contents is an important issue because suitable information in terms of contents and form significantly influences services [15, 21]. Therefore, future research should develop a tool for supporting service content production. Second, the proposed approach can be applied to various data in multiple industries. Thus, additional case studies on new service concept design using various data should be conducted.

Finally, our approach could be advanced further by incorporating it into the existing approaches to designing service concepts.

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