PROVIDING DATA-DRIVEN SERVICES

QUALITATIVE STUDY ON DYNAMIC CAPABILITIES NEEDED FOR THE PROVISION OF DATA-DRIVEN SERVICES BY AUTOMOBILE MANUFACTURERS

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Abstract:
Automobile manufacturers are increasingly facing increased competition from industry leaders as well as new entrants, which are leading to stagnating revenues and dwindling profits. This makes it imperative for them to increase their portfolio beyond just the core products. In order to continue competing and maintaining their advantageous positions in the market, incumbents are developing their data-driven services by leveraging the growing development of sensors and data collecting mechanisms. The study aims to identify how automobile manufacturers can leverage vehicle data for data driven service propositions. The authors draw on data-driven services literature and dynamic capabilities literature and through an in-depth case study on a leading automobile manufacturer, explicate the processes (i.e., data collection, information creation and service delivery and use) involved in data-driven service provision by automobile manufacturers and identified dynamic capabilities required for each process.

Keywords: Vehicle Data, Information, Data Analysis, Services, Dynamic Capabilities

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Glossary

Telematics: An interdisciplinary field that encompasses telecommunications, vehicular technologies (road transport, road safety, etc.), electrical engineering (sensors, instrumentation, wireless communications, etc.), and computer science (multimedia, Internet, etc.).

Drive Train: Group of components of a motor vehicle that deliver power to the driving wheels. This excludes the engine or motor that generates the power. In contrast, the powertrain is considered to include both the engine and/or motor(s), as well as the drive train.

Rotations per minute: The number of turns in one minute. It is a unit of rotational speed or the frequency of rotation around a fixed axis.

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1 Introduction

Traditionally, automotive manufacturers have a product-oriented focus on selling the manufactured vehicles with services as pure add-ons to the products, for example, providing spare parts and conducting repairs and maintenance (Swan, 2013, 2015). However, the advent of new digital technologies and its integration with the vehicles, have increased the functionality of the vehicles (Llopis-Albert et al., 2021). Today, such technologies represent half of the total vehicle value of a vehicle (CCOO, 2018). The digital technologies can be software or hardware and allow the vehicles to capture data about themselves and their environment (Swan, 2013, 2015). This captured vehicle data allows the development of new types of data-driven services (Bridgelall et al., 2018; De Winter et al., 2019; Pillmann et al., 2017; Pütz et al., 2019), such as remote vehicle diagnostics or interactive trip analytics (Kuschel, 2008; Papatheocharous et al., 2018). Schüritz et al. (2019) describe data-driven services as services that "support customers' decision-making processes by providing data and analytics to create value for the customer". Such services are able to improve the driving experience of customers, for example, by monitoring fuel consumption. Data-driven services help in creating a pipeline of customer-centric services, for example, vehicle data can enable real-time emergency calls, road hazard warnings that allow drivers to be informed and respond immediately (McKinsey, 2016). Data can reduce the breakdown of vehicles to increase uptime by providing predictive maintenance services and allow real-time monitoring of the technical status of critical components such as oil temperature, airbag deployment, fault code generation, and analysis (McKinsey, 2016).

Although digital transformation in the automotive industry is underway (Kuhnert et al., 2018; McKinsey, 2016), it remains a challenge for the manufacturers to embrace this digital innovation (Svahn et al., 2017). First, vehicles collect a large amount of data that needs to be stored, transferred, and analyzed (IHS, 2015). It is a challenge not to drown in the sea of unstructured data, but to gain insights from the big data to develop new services (IHS, 2015). Second, automotive companies need extensive planning and cross-channel integration to provide data-driven services (IHS, 2015). With increased technological integration, complexity pertaining to data protection and consumer safety increase (Global Market Insights, 2019). To be successful to provide data-driven services, companies need to integrate data analytics into their long-term strategic planning (Global Market Insights, 2019). As data-driven services are sold in a different way from more traditional automobile products, companies would require knowledge and competencies in the cloud and data-connected services, digital content, and big data (IHS, 2015). Hence new capabilities would be needed to integrate and respond to the vast amount of data collected from vehicles to produce services that could drive profitability in the long-term (IHS, 2015).

Dynamic capabilities need to be developed by incumbent companies to achieve a sustainable competitive advantage (Lusch & Nambisan, 2015). Dynamic capabilities refer to a companies' ability to develop and apply knowledge and competencies to address rapidly changing business environments (Teece et al., 1997). The dynamic capabilities framework is one of the most used approaches to study how companies respond to the market changes and rapid technological developments (Eisenhardt & Martin, 2000; Helfat et al., 2007; Teece, 2007; Teece et al., 1997). In today's digital economy, new sets of capabilities are needed, i.e., sensing and seizing of value creation opportunities from data and reconfiguring existing resources, processes, and other rigid organizational set-ups to become more innovative and agile (Opresnik & Taisch, 2015; Teece, 2018, Helfat et al., 2007). Given the disruptive nature of digital technologies, the dynamic capabilities framework becomes a powerful lens for studying the value creation from data (Schymanietz, 2020) in incumbent industries. Being successful in the development of such capabilities enables organizations to outperform their competitors (Teece, 2017). In the automotive domain, there is a lack of detailed studies about companies' capabilities to deliver data-driven services based on utilizing the vehicle data (Kuhnert et al., 2018). Literature on such services is limited, and especially what dynamic capabilities are required to develop data-driven services is nearly unknown (Lim et al., 2018).

1.1 Research Gap

Data-driven services use data to create value for the customers through data and analytics (Schüritz et al., 2019). Extant studies have been done on such services from different aspects such as effects on the business model, managerial implications in business management, engineering design, and information systems (Boehm & Thomas, 2013). Scholars have studied the designing of processes, including data collection, data analysis, value creation, information delivery (Opresnik & Taisch, 2015; Raghupati & Raghupathi, 2014; Lim & Kim, 2015). In manufacturing, the strategy framework in data-driven services has been studied to help companies identify and create new revenue streams (Opresnik & Taisch, 2015). Managerial implications have also been studied in providing such services in the automobile, transportation, healthcare, wellness, telecommunications, and information technology (IT) industries (Lim et al., 2017). In automobile manufacturing, scholars have analyzed the vehicle data to provide information related to safety and entertainment to provide a superior customer experience (Lim & Kim 2015). Lim et al., 2018 studied the value creation process from data to information, highlighting how the process can be used for identifying opportunities for new services or improving the existing ones, understanding customer requirements, and needs, and providing information required by the customers. However, studies of such services using real cases in automobile manufacturing are limited and lack an in-depth understanding of the mechanism behind such service design (Lim et al., 2018). These processes provide new opportunities to the companies to create a sustainable competitive advantage with long-term profits (Opresnik & Taisch, 2015). Companies need to build dynamic capabilities to sense and seize the opportunities and reconfigure their existing competencies (Teece, 2007). For instance, new sets of capabilities related to ensuring data privacy and securing access of data for collaboration are required (Schymanietz, 2020). Organizations also need to develop IT-related capabilities to collect and analyze the data (Schymanietz, 2020). Scholars have been called for rich in-depth accounts for what dynamic capabilities are required to provide such services (Schymanietz, 2020). Therefore, a study is needed to understand what dynamic capabilities are required to provide data-driven services.

1.2 Purpose & Research Question

Based on the identified research gap, the purpose of the study is what dynamic capabilities organizations need to provide data-driven services. This is investigated through a single case study on a world-leading provider of transport solutions. The identity of the case company has been withheld for the purpose of confidentiality. Using data-driven service and dynamic capabilities literature as theoretical lenses, this study investigates the processes that are involved in data-driven service provision by automobile manufacturers and then identifies the required dynamic capabilities for each process.

This is accomplished by examining the following main research question:

"How can automobile manufacturers leverage vehicle data for data-driven service provision?"

Sub question 1: What are the processes involved in data-driven service provision for automobile manufacturers?

Sub question 2: What are the dynamic capabilities needed by automobile manufacturers for data-driven service provision?

First, an understanding of what processes are involved in data-driven services is important, i.e., gaining in-depth knowledge from storing, analyzing to producing information from data. Second, to develop services an organization needs to implement a change or transition within itself. Dynamic capabilities are required to sense and seize opportunities and also to reconfigure internal competencies to address and bring about, changes in the business environment (Teece et al., 1997; Teece, 2007). The study focuses on various opportunities that the collected data provide, how to take advantage of the opportunities and how to align existing capabilities or develop new capabilities within the organization to gain a potential competitive advantage. An analysis of what kind of dynamic capabilities are required for data-driven service provision is needed. The study, therefore, intends to fill the research gap by identifying the missing dynamic capabilities.

Figure 1 : Research Gap

1.3 Delimitations

Data-driven services in the automobile industry lend many interesting topics of investigation. This study focuses on the dynamic capabilities required for data-driven service provision. Hence, the study is conducted within the following limits. First, a wide variety of data such as vehicle data, traffic data, social media data, data from different actors such as customers, suppliers are available for the automobile manufacturers to use for data-driven service provision. This study chose to focus on the service provision by automobile manufacturers based on vehicle data, which helps to gain useful insights on matters of vehicle health and operation in order to provide improved service provision. Also, an automobile manufacturer can produce cars, trucks, or buses. The data obtained vary depending on if it's derived from the car, bus, or truck. The study focuses on data from buses. Secondly, different companies have varied software and hardware to collect vehicle data. The data also vary according to the objective the company is trying to achieve. Hence, the authors focused on a single case study, as the research gap required an in-depth understanding. Thirdly, this study intends to know the different processes involved in vehicle data-driven service provision. Hence, this study does not focus on the process of developing new data-driven services in an organization. Thus, the authors focus solely on the dynamic capabilities that are required by automobile manufacturers to use vehicle data and analyze it to offer data-driven service provision for customers. For the purpose of the study, the authors disregard all external contingencies such as political and legal factors beyond the control of the firm or the vehicle that influence the ability of a company to derive value from the data and convert it into service offerings.

2 Literature Review

To understand what dynamic capabilities are required for data-driven service provision, this section will review the relevant literature for the framework and the context of the study.

2.1 Data-driven Services

In the pre-digital era, data were stored in the physical products preventing extraction of the data from the products (Schymanietz, 2020). Digitization allows decoupling of the device and data, and enables to store, access, transmit or display data from any device (Yoo et al., 2010). Hence, digitization allows faster generation of data and information for real-time use (Marinakis et al., 2018; Pullmann et al., 2017) and also enables recombining of data from different sources for companies to provide new services (Troilo et al., 2017; Yoo et al., 2010). These data provide industries with ample of new opportunities to create value for their customers through services where data is the key resource (Hartmann et al., 2016).

The rise of internet and fast development of new digital technologies has supported new services in many different industries through IT-enabled service systems (Lusch & Nambisan, 2015; Yoo, 2010; Rust & Huang, 2014). Service systems are dynamic network structures of people, technology allowing value creation through the connection of external and internal systems (Maglio & Spohrer 2008). Such service systems allow exchange and integration of resources and knowledge (Lusch & Nambisan, 2015; Yoo, 2010; Rust & Huang, 2014). IT allows the exchange of resources to digitize information interactions within the service, thus enabling value creation among involved actors (Karmarkar & Apte, 2007; Barrett et al., 2015). Data-driven services are defined as services that" support customers' decision- making processes by providing data and analytics to create value for the customer" (Schüritz et al., 2019). Such services focus on creating customer value through information that helps in achieving customer goals (Lim et al.,2015). Hence, these services are expected to grow in manufacturing companies with the advancement of technologies as it allows the collection of data from customers and products (Lim et al.,2015). Digitization in manufacturing industries is done through smart and connected products that produce large amounts of data (Tountopoulos et al., 2018). Faced with cost reductions, companies are increasingly adopting a services-based strategy with the aim to create a differentiated identity among competitors to maintain a sustainable competitive advantage (Lim et al., 2015). Existing literature has many studies on such services from different aspects in areas such as business management, engineering design, and information systems (Boehm & Thomas, 2013).

Data produced by customers are helpful in understanding their behavior (Boyd & Crawford, 2011) and help in ascertaining the reasons for their decisions (Lim et al.,2015). Customer data enable companies to create new and improved service offerings that can fulfill unmet needs of customers (Lim et al., 2018), thereby strengthening customer and firm relationship (Kumar et al., 2013). Earlier literature discusses the ways in which services are developed by leveraging customer data in areas of manufacturing and healthcare (Opresnik & Taisch, 2015, Raghupati & Raghupathi, 2014). For example, data reuse and resell can create new revenue streams in manufacturing companies that have transformed from a product to a service-oriented focus (Opresnik & Taisch, 2015). Data are also collected from clinical trials and other depositories to provide critical and timely information to treat complications (Raghupati & Raghupathi, 2014). Such studies lack the information about the dynamic capabilities that organizations need to develop to create value from the data.

Automobile manufacturers analyze vehicle health by collecting data from inboard sensors and provide data-driven services to enhance the experience of passengers and drivers (Lim & Kim 2015). As more vehicles are getting connected through hardware and software systems, there is a large amount of data that is collected through sensors such as vehicle acceleration, speed at a certain time (Dhungana et al., 2016; Venkataram, 2019). These data are sent to the manufacturer servers and can be used to obtain insights, for example, the estimated time of arrival (Dhungana et al., 2016; Venkataram, 2019). Hence, data collected from vehicles allow the manufacturers to provide new and innovative services (Stocker et al., 2017). In general, vehicle manufacturers seek to leverage the value of the data collected through their vehicles to better meet customer needs (Kaiser et al., 2018; Stocker et al., 2017). Such services rely on value creation based on data (Lim et al., 2018). One should take into account the data value chain as well as key factors (Lim et al., 2018). Lim et al. (2018) introduce a comprehensive nine-factor framework that describes the factors critical for data-driven service provision, i.e., the data, the data source, data collection, data analysis, information delivery, information on the user, the value in information use, and the provider network, for data-based value creation. The factors are useful in describing how usable information can be obtained from vehicle data and how it can be leveraged to provide unique service proposition (Lim et al., 2018). Hence, the nine-factors work as a lens to assess as well as help in identifying the key design areas in the context of data-driven services (Lim et al., 2018). For a data-driven service provision, companies need to further transition and build capabilities to provide such service and reach a broad customer base (Kowalkowski et al., 2015).

2.2 Dynamic Capabilities

In the fast-changing business world filled with competition, organizations need to implement a value creating strategy that cannot be copied or implemented by its competitors in order to maintain a sustainable competitive advantage (Barney, 1991). Resource-based view of firm considers that an organization can obtain such an advantage if its resources have four attributes that are resources are valuable, rare, inimitable and non-substitutable (Barney, 1991). But resource-based view of the firm is static in nature and does not take into account firm’s fast moving business environment to explain how such resources can be developed and integrated successfully (Teece et al., 1997; Eisenhardt & Martin 2000; Winter 2003). Teece et al. (1997) introduced the concept of dynamic capabilities to explain how firms can develop the competitive advantage in an uncertain and rapidly changing market. Dynamic capabilities are defined as “the firm’s ability to integrate, build, and reconfigure internal and external competences to address a rapidly changing environment. Dynamic capabilities thus reflect an organization’s ability to achieve new and innovative forms of the competitive advantage given path dependencies and market positions” (Teece et al., 1997). They not only emphasize the capacity to renew competences to develop an innovative solution but also adapt, integrate and reconfigure internal and external organizational skills, resources and functional competences when faced with a changing environment (Teece et al., 1997). Teece (2007) builds on this definition to use processes of sense, seize and reconfigure opportunities to build a competitive advantage. The development of internal dynamic capabilities lies at the core of the organization's success or failure rather than the external business environment (Teece, 2007). However, some scholars today still see dynamic capabilities as an extension of the resource-based view (Helfat & Peteraf, 2003). Other known definition of dynamic capabilities (Schilke et al., 2018) is by Eisenhardt and Martin (2000): "The firm's processes that use resources—specifically the processes to integrate, reconfigure, gain and release resources—to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die" . Eisenhardt and Martin (2000) consider the dynamic capabilities to be homogenous and substitutable. Additionally, Helfat et al. (2007) define dynamic capabilities as "the capacity of an organization to purposefully create, extend, or modify its resource base." Helfat and Winter (2011) modified this definition to include an organization's capacity to influence its external environment. The three definitions hold different views on the extent to which the dynamic capabilities are the source of a competitive advantage and their emphasis or deemphasis on external resources or environment (Jakovina, 2019). Teece's (2007) definition of dynamic capabilities is adopted for the study as the authors aim to study what dynamic capabilities are needed by companies to develop data-driven services to create a long-term sustainable advantage, excluding the influence of external environment.

Existing literature has studies of dynamic capabilities in many areas such as "management of R&D, product, and process development, technology transfer, intellectual property, manufacturing, human resources, and organizational learning" (Schilke et al., 2018), highlighted the relevance of the concept for strategic change and organization performance. Hence, dynamic capabilities are a widely applicable framework relevant to domains such as innovation, acquisitions, diversification, market entry, alliances (Helfat et al., 2007, Jakovina, 2019), making the framework topic of interest for many scholars.

2.2.1 Dimensions of Dynamic Capabilities

Dynamic capabilities are a complex phenomenon and have different forms in the literature (Teece et al., 1997; Eisenhardt & Martin, 2000; Helfat et al., 2007; Schilke et al., 2018). Different scholars have developed ways to dimensionalize the capabilities construct. Some scholars dimensionalize the dynamic capabilities by the degree of routinization from spontaneous problem-solving to highly patterned and routinized processes (Winter, 2003). Wohlgemuth and Wenzel (2016) ask for research to study the interplay between the two types of dynamic capabilities and how they can be put to practical use (Heimeriks et al., 2012; Peteraf et al., 2013)

Others emphasize the different functional domains in which dynamic capabilities are applied such as new product development (Eisenhardt & Martin, 2000). Further studies are, however, required in aspects such as business model adaptation capability and implementation of dynamic capabilities within the organization (Mezger, 2014; Wirtz et al., 2010).

Also, dynamic capabilities can be segregated into, zero, first, second, and higher-order capabilities (Collis, 1994, Winter 2003). Scholars are looking to explore more about the relationship between different levels of hierarchy (Schilke et al., 2018).

Additionally, the dynamic capabilities can exist at different units of analysis such as individual, team, organizational, and extra-organizational (Adner & Helfat, 2003; Felin et al., 2012). Dynamic capabilities can be analyzed by studying it from different hierarchical levels but Adner & Helfat, 2003; Augier & Teece, 2009; Felin & Foss, 2005 and Helfat & Martin, 2015 also argue that these can also be seen from an organizational or individual lens.

Finally, the differentiation is based on how the process in the dynamic capability engaged (Schilke et al., 2018). Teece et al. (1997) describe the processes of coordinating, learning, and reconfiguring, while Teece (2007) uses the dimensions of sensing, seizing, and reconfiguring, which builds on the former one. Sensing is the "identification, development, co-development, and assessment of technological opportunities in relation to customer needs," seizing is the "mobilization of resources to address needs and opportunities, and to capture value from doing so"; and reconfiguring is the "continued renewal" of the firm as its resources are reconfigured to strategically seize opportunities and respond to threats" (Teece, 2007). Hence, an incumbent organization first needs to spot an opportunity, make decisions to execute the opportunity and then stay agile to continuously reconfigure the processes and procedures responsible for its early success to generate long-term profits (Teece, 2007).

The authors are studying the dynamic capabilities required for automobile manufacturers to provide data-driven services, hence the dimensions of sense, seize and reconfigure (Teece, 2007) are appropriate. These dimensions will help the authors identify specific dynamic capabilities required for each process involved in data-driven service provision.

However, there appears to be no single and specific list of dynamic capabilities that can be generalizable across different types of contexts and organizations (Jakovina, 2019). Schilke et al. (2018) call for more research to use concrete approaches to investigate and understand dynamic capabilities as opposed to generic ones.

2.3 Literature Synthesis

A recent focus on dynamic capabilities research has been to reflect the characteristics of service (Kindström et al., 2013; den Hertog et al., 2010) and can also be divided into Teece's (2007) categories sensing, seizing and reconfiguring. When developing services, firms can sense opportunities and threats to establish new roles, resources and processes to identify user needs (Kindström et al., 2013; den Hertog et al., 2010; Kowalkowski et al., 2012) that might include setting up processes that support creation and development activities with suppliers, customers and other actors in the service system (Kindström et al., 2013; den Hertog et al., 2010). After sensing, seizing the potential service opportunities is the next step. Firms should be able to deliver service propositions to their customers that are based on mutual interactions and creation activities within the service system (Alam, 2006; Sundbo, 1997; Kindström et al., 2013). To ensure a profitable growth, it is important to reconfigure or transform organizational structures and assets (Teece, 2007) and analyze the whole service system that contains customers, suppliers and partners (Kindström et al., 2013; den Hertog et al., 2010). Finally, for a long-term success, development of service-oriented mindset is needed within the organization (Matthyssens et al., 2006; Kindström et al., 2013).

In the data rich economy, services developed using data from connected devices are the key resource for delivering high value solutions to customers (Schymanietz,2020). Organizations can develop data-driven services such as predictive or preventive maintenance (Schüritz et al., 2017). To offer such services, companies need to take into account issues of data privacy and access to data for collaboration with other actors within the business ecosystem (Schymanietz, 2020). In this regard, new capabilities of customer relations need to be developed (Story et al., 2017). Organizations need to develop dynamic capabilities related to IT to analyze and interpret large amounts of data (Schymanietz, 2020). To be able to transform the organization to obtain a competitive advantage based on data-driven services, the service system needs to be effectively reconfigured (Schymanietz, 2020). However, when developing data-based services, sensing the opportunities and threats, seizing and reconfiguring them is challenging (Coreynen et al., 2017; Ostrom et al., 2015; Barret et al., 2015). Scholars call for a detailed understanding of the dynamic capabilities required to develop service in the digital era (Coreynen et al., 2017; Ostrom et al., 2015; Barret et al., 2015).

3 Theoretical framework

The following chapter describes the fundamental notions of the relevant concepts. Combined, these concepts present the theoretical framework that will be used to analyze the empirics of this study.

3.1 Data–value chain: Nine-factor framework characterizing different processes in Data-driven Services

Lim et al. (2018) describe a nine-factor framework for understanding the data-driven services (Appendix 1). The framework describes four key processes involved in providing data-driven services as a data value chain. It is one of the first studies to elaborate those processes (i.e., data collection, information creation, value creation) in detail, including required activities, resources and network members. Based on this framework, it is possible for the authors to identify dynamic capabilities specifically to each process involved in data-driven service provision. It is made up of the various activities, resources, and the network members involved in creating value through the use of data in an industry. The entire data value chain is divided into four distinct processes based on their utility, namely, (i) “data collection,” (ii) “information creation,” (iii) “value creation” and (iv) “distribution through the provider network.”

The authors noted that the term value creation for the third process is a vague term as all the other three processes namely data collection, information creation and distribution can be seen as part of value creation. Also, Lim et al. (2018) do not clearly mention for whom the process of value creation is aimed at. The process can be aimed at customers, service providers and partners or the company providing the services. Therefore, in this study, the third process is renamed from “value creation” to “service delivery and use” and is aimed to create value for the customers.”

These four areas than further talk about nine key factors that characterize data-based value creation (Appendix 1), which can be broadly grouped according to their utility: (1) data source, (2) data collection, (3) data, (4) data analysis, (5) information on the data source, (6) information delivery, (7) customer (information user), (8) value in information use, and (9) provider network.

<u>(1) Data Sources</u>: This includes specific objects, such as vehicles; facilities, management activities, and customers. This is classified according to the main source of data, which can be people or objects. The main distinction between traditional and recent data use, is the source

of data (i.e., engineering and human systems) and are useful for analyzing and designing data-based value creation, which is directly connected to the purpose of the service.

(2) Data Collection: This is done using sensors and recording logs of systems. This is classified according to the level of human involvement, which may be physical sensing enabled by or conducted through physical sensors or social sensing, which are any type of sensing enabled by or conducted through people without using physical sensors. This is useful for the analysis and design of data-based value creation, which is related to service efficiency.

(3) Data: These deal with the conditions of engineering systems, event logs of business systems, health and behavioral records of people. This factor can be classified according to the focus of the data, which may be conditions or operations important for determining scope and potential of the service.

(4) Data Analysis: This involves using pre-installed programs and server algorithms again classified based on human involvement, fully automated or involving human intervention is useful to analyze the influence of the collected data and service quality.

(5) Information: These are the interesting facts created from data analysis revealed about the original data source. The obtained information can be descriptive statistics, comparisons with other customers, and guidelines for a specific task improvement. This factor helps in analysis and design of data-driven value creation, which influences the value and attractiveness of the service.

(6) Information delivery: Methods include e-mail, smartphone applications, and on-board displays in vehicles. This is an important factor in analyzing and designing data-based value creation for selecting appropriate methods for delivering relevant information efficiently and enhancing the acceptability of the service.

(7) Information users: They are the main users, individual (B2C) or organizational (B2B) who represent the main target of the service.

(8) Value in information use: These include evidence-based health management, improvement of the operational processes of certain service systems, and prevention of potential user problems by creating value through the dedicated use of information.

(9) Network of providers: They are the main service partners, which include the companies engaged in sensor manufacturing, data management, and analytics.

Although Lim et al. 2018 use the term 'information', it actually denotes the services, for example, fitness management service and energy management service. Therefore, the "information delivery" factor of the process is renamed as "service delivery." Lim et al. 2018 names the factor "information delivery" in the framework as they describe a value chain process for the creation and delivery of information from data. Since the authors are studying the key factors involved in data-driven services and the focus of the study is delivering services from the information created from data, the factor "information delivery" is renamed as "service delivery" for the study. Additionally, the factor "information users" is renamed "service users" and "value in information use" is renamed "value in service use".

The fourth aspect, namely the provider network, which mainly consists of value chain partners like companies engaged in sensor manufacturing, data management, and analytics have been ignored as the authors are concerned only with the dynamic capabilities within the firm that is required to transform vehicle data to create value and leverage it to provide a service proposition to customers.

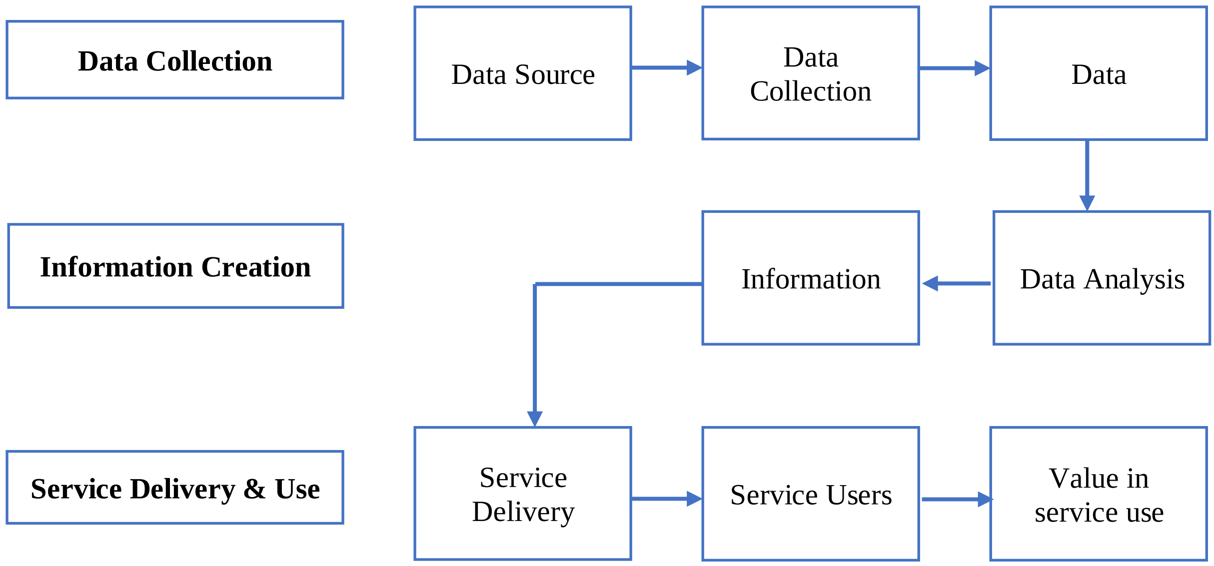

Figure 2 Modified Nine-factor framework for data-based value creation

3.2 Dynamic Capabilities framework

In addition to the ownership of proprietary assets, businesses in the fast-moving environment as today also need some unique and difficult to replicate dynamic capabilities to have a sustained competitive advantage. These are the capabilities required to adapt to changing customer and technological opportunities, shape the ecosystem it occupies, develop new products and processes, and design and implement a viable business model. This framework has been used to help understand how the different elements of dynamic capability, namely, sensing, seizing, and reconfiguring can help firms in collecting vehicle data and use them to provide data-driven service offerings to customers. The dynamic capabilities framework states that companies need to ensure that resources are aligned with the relevant customer requirements and market trends. This is done through a series of activities which broadly can be grouped under three steps, sensing, seizing, and reconfiguring (Teece, 2007).

1. Sensing

The firm needs to start with the sensing activities to find new opportunities like examining the surrounding trends, analyzing competitor behavior, and approaching customers or suppliers to find out about unaddressed requirements. This can be done by individuals through analyzing, learning, and interpreting from existing information and new data to discover existing opportunities and creating new opportunities (Teece, 2007). This must be done systematically to find ways to gain insight from large quantities of information and identify relevant information on which to focus their resources and capabilities. (Teece, 2007)

2. Seizing

After sensing, the opportunity should be appropriately seized. This requires determining the key aspects of the business model, understanding needs for resources and investments and decisions related to technology, and other changes (Teece, 2007). However, organizational decision-making processes are complex due to multiple functional areas being involved with a significant amount of coordination and management required (Teece, 2007). These demands that cross-functional activities and investments occur concurrently, rather than sequentially to cut time-to-market for new products and services (Teece, 2007).

3. Reconfiguring

This is followed by the reconfiguring of necessary resources through realignment aimed at arriving at combinations that increase value to the firm. This results in the firm gaining the ability to adapt to changing circumstances and break out of outmoded routines to allow for sustaining profitable growth (Teece, 2007). This can be achieved by realigning incentives, developing or acquiring new assets, and reallocating resources (Teece, 2007).

3.3 Synthesis and visualisation of theoretical framework

The preceding theoretical concepts were selected to answer the main research question - ***"How can automobile manufacturers leverage vehicle data for data-driven service provision?"***

Most of the studies on developing dynamic capabilities in organizations deal with the dynamic capabilities required for a complete overhaul or a transformation of the business model of the firm. The authors devised the following framework to support the authors' inquiry into the dynamic capabilities needed for data-driven service provision by automobile manufacturers.

The nine-factor framework for data-based value creation is used as a reference. As the study aims to understand different processes in data-driven services, the authors will analyze the three processes, namely (i) "data collection," (ii) "information creation," (iii) "service delivery and use" to answer the Sub question 1: What are the processes involved in data-driven service provision for automobile manufacturers?

The three overarching processes involved in data-driven service provision, namely, "data collection," "information creation" and "service delivery and use'' are individually analyzed through the lens of the dynamic framework, to pinpoint how opportunity can be sensed and seized in order to collect data from the vehicle and analyze to create value for customers to provide services. This helps us answer Sub question 2: What are the dynamic capabilities needed by automobile manufacturers for data-driven service provision?

Hence, the proposed theoretical framework will guide the authors in the data collection and data analysis.

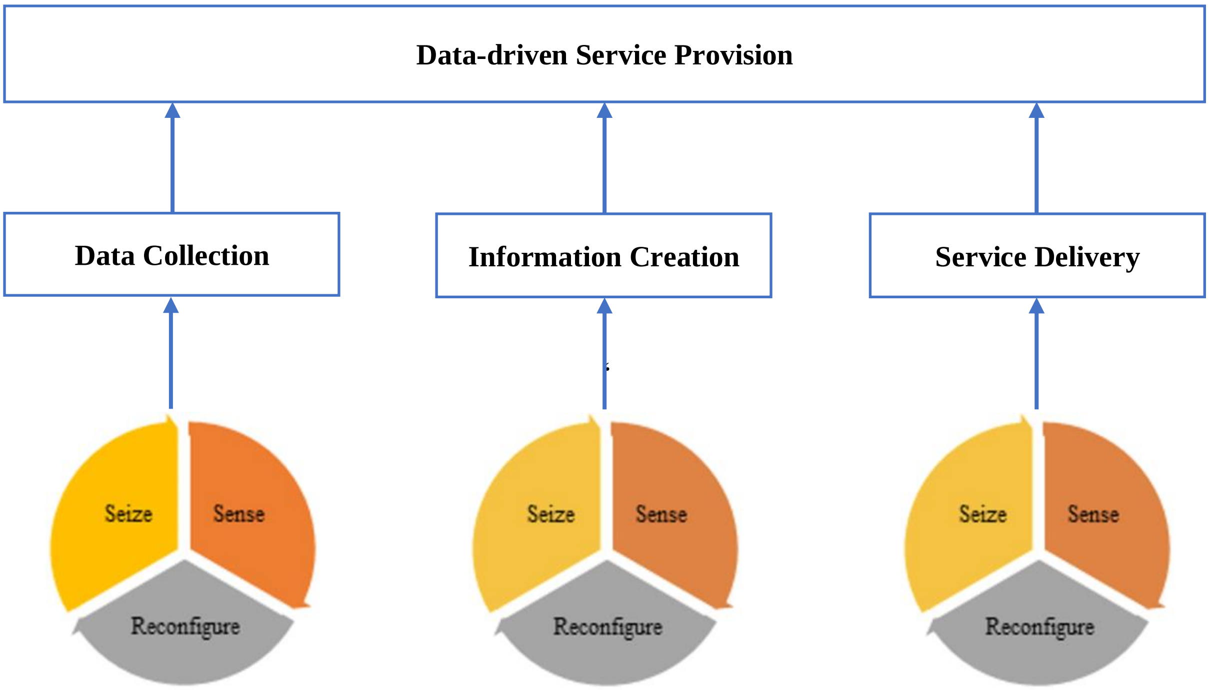

Figure 3: Visualization of theoretical framework

4 Methodology

This section outlines the methodological approach used to answer the research question. First, the research design is discussed, second, the research process is described, and third, the quality of the study is evaluated.

4.1 Research Design

Research design is based on the ‘Research Onion’ developed by Sanders et al. (2007), which covers all the important and necessary stages of developing a research design (Appendix 2). As working from outside to the inside of the onion, each layer corresponds to a more detailed stage of the research design and process.

4.1.1 Research Philosophy

The study employs interpretivism as a research philosophy that is used to formulate the author’s research strategy and data interpretation and analysis. This research philosophy allows the authors to interpret elements of the study, integrating human interest (Flick, 2014). Following this approach, the authors believe in the view that “management can only be understood from the point of view of the people who are directly involved in it” (Bell and Thorpe, 2013).

The philosophy is chosen for the following reasons. First, the study focuses on exploring the experiences and perspectives shared by different stakeholders on the same issue interest, namely, the dynamic capabilities required for data-driven service provision (Flick, 2014). Second, through the interpretivist approach, an in-depth investigation can be done through a detailed description of stakeholder's experiences instead of abstract generalizations (Mathison, 2005).

4.1.2 Research Approach

The study follows an abductive approach that allows the authors to elaborate on the dynamic capabilities required for data-driven services. This approach put emphasis on theoretical developments rather than theory generation, as it aims to build upon existing theory rather than creating something entirely new (Dubois & Gadde, 2002). This approach allows the authors to go back and forth between developing a theoretical framework and related empirical findings as they can influence each other.

The study started with a literature review to know what has been conducted on data-driven services. Extant studies on such services have been conducted in manufacturing, health care, especially on the design and value creation processes from the data (Opresnik & Taisch, 2015, Raghupati & Raghupathi, 2014). The literature review gave us a fairly clear idea about the studies that have already been done in the sphere of data-driven services based on vehicle data. However, the literature review also helped us identify definite research gaps, for example, about the lack of studies in how dynamic capabilities in organizations can help in service provisions based on vehicle data. From the two preliminary interviews, the authors gained knowledge about the different sources from which data can be obtained in the company, namely, (i) vehicles, (ii) marketing and sales, (iii) customers. Additionally, value can be created from the data for the company, customers, or network providers and partners. The study focuses on data obtained from the vehicle for service provision to customers. As the exploration of the theory and construction of the theoretical framework started before the data collection, this research approach allowed for adjustments in the framework as well as go back and find new theories as new insights surfaced in the empirics. In-depth interviews of people at different business verticals as well as different hierarchical levels helped the authors identify potential areas of opportunities that accompany this transition to vehicle data collection and value creation. The abductive nature of the research helped in this iterative process of going back and forth between data collection and data analysis based on the theoretical framework.

4.1.3 Research Choice

Multimethod qualitative research uses multiple forms of qualitative data. This method was selected as it allows for an in-depth answers to the research questions by combining multiple data collection techniques. A combination of primary and secondary data has been used in the study. It provides an in-depth study and allows for methodological triangulation (Yin, 2014). Primary data were collected through semi-structured interviews with the case company's employees. Secondary data were gathered from journals, the website of the case company, industry reports, and online articles.

4.1.4 Research Strategy and Time Horizon

Research strategy helps the author to plan how to conduct the research to systematically reach an answer to the research questions (Saunders et al., 2007). This qualitative study was based on the case study method. It allows the authors to explore and conduct an in-depth investigation of complex topics like issues like providing services based on vehicle data and linking dynamic capabilities to the transition. Additionally, the method allows the authors to ask how and why questions to get an invaluable understanding of the dynamic capabilities required for the provision of data-driven services by automobile manufacturers (Yin, 2014). The qualitative data in a case study help explain both the process and outcome of a phenomenon through complete observation, reconstruction, and analysis of the cases under investigation (Tellis, 1997). This allows the findings to be generalizable with the aim to establish knowledge and contribute to the existing literature (Yin, 1994) of data-driven services.

Fine-grained narratives are required in the form of cases to understand the businesses and process of their transformation (Hedman & Kalling, 2003; Harrison & Freeman, 1999). Hence, a single case study method was deemed appropriate for the study as it allows to go deeper into one case rather than increasing the number of cases when analyzing a complex problem (Dubois and Gadde, 2002). A single case study also allows investigating in-depth as to how and why a phenomenon happens and under what circumstances, and to enter the crux of the issue (Yin, 2011).

The case company was chosen for a couple of reasons. First, the case company is a leader in the data-driven services in an industry that is facing big changes and challenges related to such service provision. The case company also aims to get the majority of its revenue from services in the coming years. Therefore, gaining an understanding of how the company internally deals with these changes was particularly interesting. Second, the company is a market leader in the automobile industry and has a huge customer base. Hence, it was easier to find participants for interviews that are in constant interaction with the customers. This allowed the authors to gain an in-depth understanding of different processes involved in data-driven service provision.

Conducting semi-structured interviews with employees allowed the authors to get an in-depth understanding of the different processes involved in providing services as well as the dynamic capabilities required, while the review of the secondary data provided knowledge about the kind of data obtained from the vehicles, the existing data-driven services provided to the customers who helped to supplement and triangulate the interview data.

The time horizon is the time frame within which the research study is intended for completion (Saunders et al., 2007). This study was conducted under a cross-sectional or short-term time horizon, i.e., the data were collected at one specific point in time rather than over a long period of time (Flick, 2014).

4.1.5 Data Collection & Data Analysis

Qualitative research is done by having a detailed understanding of the relationship between issue and method (Flick, 2014). Data collection and analysis at this stage of a study influence the consistency and credibility of the study (Saunders et al., 2007). Therefore, both primary and secondary data were collected. This was done through semi-structured interviews conducted with the case company and experts, with additional secondary sources used to validate and strengthen the arguments.

4.1.5.1 Pre-Study

To gain an improved knowledge about the context and field of study, two preliminary background interviews were held within the case company. One interview was conducted with the Director of Services and Connectivity, and an additional one with a person within the Business Unit team. Both interviewees are involved in the process of vehicle data collection and value creation from the data. All the pre-study interviews were held online through video calls and lasted for approximately 60 minutes. The authors before the preliminary interviews had basic knowledge about the data needed from vehicles and had limited knowledge about the data-driven services. The interviews provided in-depth knowledge about vehicle data, the process of extracting data from the source to creating value from data and the company's offerings related to data-driven services. The relevant insights helped in creating questions for the interview guide as well. Through the interviews, the authors got to know that the knowledge about data-driven services varies among employees at different hierarchical levels. It was through these pre-interviews that we became aware that employees facing the customers have in-depth knowledge about the data, the processes involved in data-driven service provision and customer requirements. On the other hand, executives at the corporate strategy level have knowledge about the company's current data-driven service offerings to the customer.

4.1.5.2 Secondary Data

The secondary data collected for the study was based on journals, website of the case company, industry reports, and online articles. The purpose of assembling the secondary data was to determine the various market factors that contribute to increasing demand for data-driven services for customers. It was also instrumental in knowing the kind of data that are needed from the vehicles and what data-driven services are demanded by the customers.

4.1.5.3 Interview Sample

The interview sample consisted of 24 interviews (Appendix 3). All the interviews were conducted on Microsoft Teams due to the ongoing pandemic COVID-19 and the consequent recommendations of working remotely (Folkhälsomyndigheten, 2020). Each interview lasted for approximately 60 minutes. The interview sample was selected using a generic purposive sampling method. The interviewees were thus strategically chosen in accordance with the research question and purpose of the study (Bryman & Bell, 2015). The aim was to obtain a heterogeneous group of interviewees to explore different perspectives and experiences regarding the research topic (Yin, 2011). Because the focus of the study was to identify dynamic capabilities needed for the data-driven service provision, the employees interviewed have all worked on developing and providing these services to the customers. From the preliminary interviews, the authors learned that employees at different hierarchical levels have different levels of knowledge about the data and the processes related to data-driven service provision. Therefore, the sample involved employees from different hierarchical levels including sales and key account managers to directors of the markets in order to get a complete picture of what went into developing and implementing these services.

The number of interviews was deemed sufficient for the following reasons. First, the number of interviewees was sufficient to identify the dynamic capabilities required to develop data-driven services and achieve saturation in data (Brinkmann, 2013). Second, as the number of interviews was manageable, it allowed a more detailed and in-depth analysis of the data collected (Brinkmann, 2013).

4.1.5.4 Interview Design

A semi-structured interview approach was applied which is more consistent with an explorative approach. This method simultaneously allows for flexibility in terms of making follow-up questions (Bryman & Bell, 2015). Furthermore, a semi-structured approach was appropriate considering that the interviewed people differ in terms of their expertise, responsibility and the customers handled. For instance, some interviewees were working in a market that showed significant maturity with respect to data-driven service. Thus, they had a very clear idea about the dynamic capabilities required to gain a competitive advantage by providing such services, while others were far from the target.

Flexibility is an important requirement of qualitative interviewing (King et al., 2018) as it allows the interviewees to talk more about the topics closely related to their area of expertise (Merriam, 2009; Yin, 2011). The interview guide can help in making sure all the essential topics are covered (Bryman & Bell, 2015). The interview guide was based on dynamic capabilities framework (Appendix 4), which is used as a theoretical lens to analyze the processes to develop data-driven services. The interview guide was structured according to themes that fit the research questions, and insights from the literature review, theoretical framework, and pre-study were used to generate a broad range of relevant questions. However, the interviewers were flexible in rephrasing and reordering the questions. This allowed the authors to lead the interaction in the way they wanted (King et al., 2018).

The coordination of the interviews happened with the help of a point of contact in the case company. All participants received an e-mail with the description of the study. Before the start of the study, the authors signed a contract and a confidentiality agreement to ensure the protection of the company’s sensitive data. Due to the ongoing pandemic COVID-19 and the consequent recommendations of working remotely (Folkhälsomyndigheten, 2020), the interviews were conducted through video-calls rather than face-to-face. Conducting the interviews by video enabled us to observe body language and build rapport as in a face-to-face interview, which is otherwise seen as a potential limitation of telephone interviews (Bryman & Bell, 2015). Both researchers were present in all interviews, which, were conducted in English, to enable all parties to talk as freely as possible and limit misunderstandings. The interviews lasted for approximately 45-60 minutes and were transcribed within a week from the date they occurred.

Each interview began by asking for permission to record it and assuring the interviewee of anonymity in the study. A potential drawback of recording the interviews is that the interviewees may feel less comfortable disclosing certain information. However, this was likely mitigated by informing the interviewees at the beginning of the interview that everything they said would remain anonymous and that the recordings would be deleted upon completion of the study. The weakness of recording is also further outweighed by its benefits such as greater capture of details in information and the ability to be more responsive during the interviews. (Bryman & Bell, 2015). In every interview, one of the authors was the primary interviewer and the other was responsible for recording the interview and taking notes in order to ensure they can ask follow-up and probing questions. After starting the interview, the participants were given a brief introduction of the authors and the study purpose. Each participant was asked to introduce themselves and their role in the case company.

4.1.5.5 Data Processing

All interviews were audio-recorded and transcribed within one week after they were conducted. The transcription software used was ‘otter.ai’, which allowed the authors to easily slow down, pause or play, and rewind or forward the audio recordings. Secondary sources were read, and relevant quotes were highlighted to be later used for reference.

After transcribing the interviews, all the transcripts were read again to gain in-depth understanding of the collected data. The transcript of the interviews makes up the main source of the empirical part of this study. Coding and categorizing of the unstructured data were conducted to facilitate the presentation of the empirical data. First-order themes followed a scheme suggested by Strauss & Corbin (1990) and reconceptualized in Gioia et al. (2013) aimed at identifying concepts and then extracted into Excel tool for easy overview. Second-order themes using research and literature-centric concepts were then generated by grouping similar first-order themes together (Brinkmann, 2013). This allowed the authors to use terminology that is more consistent with those in existing theories related to data, data-driven service provision and dynamic capabilities.

4.2 Research Quality

Traditionally, quality of a study is determined by its degree of reliability and validity across industry, context, and time. However, it is recommended that credibility, transferability, dependability, and confirmability are used as alternative measures of a qualitative study (Bryman & Bell, 2015).

4.2.1 Credibility

A study is treated as credible when it addresses the internal validity and researcher’s perception, and representation is the same as that of the respondents (Bryman & Bell, 2015). The two pilot interviews helped in understanding the studied phenomenon (Gudmundsdottir & Brock-Utne, 2010). Both the authors were present during the interviews as well as during transcribing and coding processes. This contributed to having several observers analyzing and working with the same given knowledge and information base, which further contributed to the enhanced credibility of the study (Bryman & Bell, 2015). Interviews were done following a semi-structured approach as that allowed for the use of iteration in the questions as well as the participants, which according to Shenton (2004) can ensure the credibility of similar studies.

4.2.2 Transferability

Transferability of a study refers to whether the same results can be obtained in a different context and time given similar input conditions (Merriam, 1998). The study examined the data-driven services in the automobile – bus industry. As a result, the findings may not be transferable to other industries in manufacturing which might have more complex or simple technologies. With this in mind, the transferability outside of the industry is limited. However, some aspects of the study might be transferable to the automobile industry when companies are developing services from vehicle data in other countries.

4.2.3 Dependability

A study is said to be dependable if using the same methods in a similar context comparable results can be achieved. Similar outcomes are a rarity in a qualitative study, however, by framing, outlining, and describing the research process and method, dependability can be established (Shenton, 2004). Dependability in the study has been ensured by following the steps as suggested by Bryman & Bell (2015), by keeping documents and recording from the various interviews, collected data, coding and analysis, interview guide, and the participant sample.

4.2.4 Confirmability

Although, it is impossible to have a study completely free of the author's personal biases and prejudices it is important to ensure that the study is conformable and has been done with utmost objectivity (Bryman & Bell, 2015). This has been done by framing the interview so as to make the question's objective and avoid leading questions that might cloud that judgement of the participant and drive him in a perceived direction.

4.3 Ethical Considerations

Ethically care should be taken to avoid activities that might lead to potential harm and possible identity disclosure of participants, especially in cases with a small number of participants (Bryman & Bell, 2015). Based on that it is disclosed that the study targets an automobile manufacturer and employees from different departments related to service business were considered as interview subjects, the sample size is relatively small and specific. Explicit permission was sought from the participants before the commencement of the interview process to record the interviews as well as use their quotes for the study in a manner that maintained their anonymity.

Participants were informed about the study and care has been taken to ensure that they did the interview out of their own free will and were aware of the possible implications of their responses (Bryman & Bell, 2015).

A set of questions representative of the interview guide (Appendix 4) was emailed to each interviewee well in advance to avoid any possible situation which might distort the actual purpose and explanation of the study. Thereby, helping to mitigate possible ethical deception within the study (Bryman & Bell, 2015).

5 Empirical Findings

Following the theoretical framework, this section is divided into three processes, data collection, information creation, and service delivery and use. These three processes contain different factors, describing how vehicle data can be used to develop service propositions for customers of the case company. This section is mostly descriptive and structured to follow what happens to the data in real-time by describing the processes involved in collecting, analyzing, and transforming the data to usable and valuable information and delivering it to the customer. The findings presented in the empirics will then be analyzed based on the theoretical framework.

5.1 Data Collection

This section will identify different types of data and data sources and describe the process for data collection as well as highlight the challenges, shortcomings and future trends related to relevant elements. It starts with data sourcing, which describes various objects, parts, or components from which data can be obtained. This is followed by the data collection, which follows the actual process of data assimilation and storage and finally ends with describes the various types of data which are obtained.

5.1.1 Data Source

''Here are interim on-board sensors, which relay data directly from the vehicle to the control room at the backend. It monitors the vehicle's performance status, track malfunctions, and enable predictive maintenance. We extract all the information from the sensors, all the modules of the vehicles.''

Interviewee 14, Sales Manager

In the era of ICT and big data, roadway traffic is being monitored by various sensors. These sensors equipped in vehicles, can be used to provide different vehicle data such as location, speed, and direction, as well as surrounding traffic data in the environment. Data are collected from different parts of the vehicle for different purposes pertaining to different types of services. Some of the main sources of data are the vehicle body, chassis and the power unit, which in most cases, is the battery in case of electric vehicles. For example, the vehicle body might be useful to gain data on occupancy levels in the vehicles and most frequently used routes at different times of the day that might help in route optimization and fleet mobilization for the customers. Similarly, data obtained from brakes and the engine, such as braking rate and levels as well as acceleration, and movement behaviour obtained from the transmission and the drive trains might be useful in determining the health of the parts. and tentative time and schedule of maintenance and preventing unwarranted and unscheduled downtime.

With the increase in the number of electric vehicles on the road, the battery also provides a unique source of high-quality data. Strategically placed sensors can provide valuable data about battery health, charge levels, temperature and overall efficiency levels, which can then be analyzed to get an idea about the optimal route to the nearest charging station, the time for which the vehicle can run on the residual charge, the tentative time for battery maintenance and when the battery needs to be replaced. Interviewees also pointed out that this information regarding the battery becomes all the more important for the reason that the battery cost forms the bulk of the total cost of the vehicle thus ensuring that the battery is maintained, and its efficiency kept intact.

''Both AI Consult and Suggest uses data from vehicle on-board sensors.''

Interviewee 23, Sales Manager

The software platforms which collect data from the vehicle as well the interface which is used to provide information and alerts to the drivers in the vehicle use on-board sensors to collect, receive and transmit data between the vehicle and the back-end platform. In addition to giving the users as well as the automobile manufacturers access to a vast amount of useful data related to different aspect of the operation and health of the vehicle, these sensors, collecting data on running vehicles, allow automobile manufacturers and suppliers to observe how their products withstand regular and abnormal operational usage and establish a clear cause-effect relationship for breakdowns. However, one of the persistent challenges that the manufacturers face in this regard is to set the type and frequency of data gathering and integrating the findings with R&D processes.

5.1.2 Data Collection

We only have the gateway specific for one way traffic. So, what it does is, it collects all of the data on-board through an information center, which is one of the on-board telematics computers to collect the data, it processes the data, and then sends that to the central database, and that's where all this data is stored through the connected services.'

Interviewee 1, Director

The data in vehicles is mostly collected through on-board sensors which collect the available data from different parts of the vehicle like the body, power unit and the chassis before transmitting and feeding the data into the data server where it is stored for further processing and analysis. In some cases, however, these data can also be stored within the vehicle hardware itself instead of a central data bank owing to security and accessibility issues. In most cases, though, it is a one-sided communication in which data only fed from the vehicle parts and components to the data storage unit, which might be on-board or remote. It is seldom a two-way communication up until now, which means that automobile manufacturers are still looking for practical, economic and secure ways to feed useful information obtained from vehicle data from the central server back to the vehicle.

''We try to work with the integrators company, who provide the sensors. It's a really good data obtained from sensors, and they have all this system and transmitting all time every three seconds, five seconds.''

Interviewee 3, Support Director

Data collection is mostly done by integrating the sensors and sources with the backend platform which is normally housed in a remote location away from the vehicle. However, in some cases, data can also be stored in a cloud server for immediate or future use in terms of analysis or refining before any use can be made of that data. In a platform, data can be collected from moving vehicles by using smartphones along with On-Board Diagnostics sensors and on data libraries, which can be stored in a remote server for real-time and offline analysis.

''Data generated by the vehicle is mostly stored on-board. It is important to manage who has access to data while protecting it from external attackers.''

Interviewee 10, Director

One of the main issues that a lot of automobile manufacturers have regarding data is the storage, security and accessibility aspect. While some choose to have the data uploaded directly to a remote server in a real-time setting as it is generated, in most of the cases, it chooses to store data in the vehicle itself due to various governmental and policy-related constraints related to data accessibility and sharing risks. This poses two problems in particular. Firstly, this information can only be accessed, if at all, only when the vehicle comes in for a routine maintenance or scheduled check in. This makes the data outdated and unreliable for the managers. One of the prime causes for this is due to the absence of any set time for when the data might be retrieved and made available for analysis. Also, if at all the data is collected, it might be after a significant amount of time when any critical event has happened, rendering the analysis and correlation difficult. Secondly, it also makes it difficult to spot trends of abnormal readings and data originating from various sources like the body, chassis or the battery and power unit, which makes it difficult to ascertain the health of the parts at any given point of time decreasing the chances of any preventive maintenance thus increasing the risk of unforeseen downtimes.

‘‘What would be beneficial is, if we are able to use the telematics in a way that could perform remote data download or log file to support technician diagnostics, when we have a dealer raising a case.’’

Interviewee 14, Sales Manager

In order to tackle the problems highlighted above, sometimes, due to the complexity of the vehicles in question, features like the ability to download a log file remotely or access the live data stream through a secure connection or in an encrypted form_become more important for easy access of the data. This would not only ensure connection data sharing between the vehicle and the remote interface but also provide a way for quicker maintenance and diagnosis of the vehicle once a fault code or alert is generated.

5.1.3 Data

‘‘We have data like mileage, like speed, like harsh braking, like, fuel consumption, idle times and others.”

Interviewee 21, Manager

Due to the rise of services in automobile companies, the value of data collected from vehicles is growing in importance. All interviewees agreed that this includes data related to increased throughput, vehicle performance, and increased vehicle security, which can then be analyzed to provide a better transit experience. This calls for significant improvements in not only the data analysis capabilities but also in types of data collected from the vehicle. This includes real-time transport information related to vehicle health as well as that of the mobility of the vehicle. Vehicle data include braking trends or accelerating behaviour that can be important to ascertain the level of wear and tear on the vehicle transmission and chassis which is directly related to the overall health and maintenance requirements of the vehicles. With the advent of electric vehicles, battery health, charge level and efficiency are also valuable information that needs to be collected and monitored in order to ensure that any unscheduled downtime or breakdown is prevented. Increased throughout data includes mileage and idle times that can serve to provide information on the running trends and behaviours of automobiles on the road. Data related to vehicle security can be obtained from telematics systems that help to know the positioning of the vehicle that can help reduce the speed of the vehicle to the prescribed limit for example when it passes a school.

‘‘Suggest displays data from vehicle on a portal to help us suggest customers which part of the vehicle should they replace.’’

Interviewee 23, Sales Manager

The Suggest portal is responsible for sourcing data from different parts and critical components of the vehicle. This includes data related to vehicle weight, tire pressure, wear and tear level of the brake, wheel rotation and speeding and acceleration behavior. All these correspond to data, which directly relate to the health of the respective parts. Additionally, similar software can also collect data about the power unit, engine temperature, battery efficiency and charge levels of electric vehicles and similar features, which correspond to overall well-being and optimum operating levels of the vehicle. Any fault code or abnormal readings related to these data might be in accordance with a requirement to change or replace the relevant part.

‘‘There’s data about remote diagnostics as well. With the system today, it can report fault codes etc. But it will only report fault codes, when you look in history.’’

Interviewee 15, Director

The above extract suggests that an important service proposition coming up in the automobile industry is the proposal of remote monitoring and preventive maintenance. It means care and protection of the vehicle proactively to prevent major auto repairs and replacements. Some interviewees suggested that for proactive maintenance, real-time monitoring of data is required. Data is related not only to the health of the automobile body and the chassis but also to the underlying equipment and moving parts like the battery and engine. The data are needed as the failure of such parts can potentially lead to unwanted and untimely breakdown of the automobile. However, the interviewee mentioned that currently, such remote monitoring is not present on a real-time basis. Managers can log into the systems to see the historic data with the provision of daily report monitoring and downloads.

This system, however, has considerable scope of improvement even further. One of the main vulnerabilities of current systems is that it collects historic data, thus rendering the counteractive measures reactive rather than preventive. That means that unless the data collected are real-time, there is very little chance to provide any useful information, service or alerts related to fault code diagnosis, or alerts related to unusual or abnormal functioning of critical parts or components.

5.2 Information Creation

The process contains two elements, namely, data analysis and information. This section will describe the process of how data collected from vehicles through various sensors and other means are analyzed using different analytical tools and computing methods to transform and refine them into information, which is basically usable information which is ultimately deemed valuable by the users. The challenges, shortcomings and future trends related to relevant elements are also highlighted.

5.2.1 Data Analysis

‘‘The data collected from the vehicle also needs to be sort of processed and you need to add value to that data that is take the raw data and add value to it. And then you need people from throughout the organization, locally or centrally to work with the data and to make it sort of actionable.’’

Interviewee 4, Director

Vehicles have become increasingly equipped with a variety of sensors, generating massive amounts of data such as vehicle position, acceleration and speed, rotations per minute, engine oil temperature, or steering wheel angle. Most of these are used to ensure the functionality of vehicles and safety of driving. These data can also be used to enable novel services that extend beyond the vehicle sector. If these vehicle data are linked with other contextual, geo-spatial data, such as on-board telematics and position-related control and monitoring, even more interesting and potentially valuable services would be possible. In order to create value from the data captured, several steps must be performed, which have already been explained in the preceding sections ending with the capture and storage of data. Similar to other analysis, vehicle data signals also have to be searched for missing values, wrong values, or outliers and removed. Signals may contain a lot of noise and must be smoothed and separated to separate the signals into empirics and grouped based on distinct categories. Simultaneously, each signal needs to be sampled to a common sampling rate. The "right" sampling rate, which is the rate of collection of data points with respect to time, again depends on the data which are being collected and the type of value that is intended to be created from it.

''Real-time processing for data analysis is a challenge. We need to determine which parts of the analysis will be performed on-board, which will be done in the cloud or do we need to upgrade the hardware in vehicle or information center to analysis data real-time.''

Interviewee 7, Manager

In order to ensure real-time data processing and analysis, high-performance computing is a key in unlocking the potential of the vehicle data. High-performance computing is a process, which can enable the real-time processing and communication of vehicle data. Decisions need to be taken not only on the aspects of which data to analyze but also with regard to determining which elements of computing are performed on-board, and which would be performed in the cloud and if the hardware will be upgradable.

Additionally, big data analytics will also be required to process the large amounts of data generated by vehicles connected to the central servers as well as to one another. Internal competences will need to be developed specifically to advanced analytics, which would help to leverage this information asset.

5.2.2 Information

''We have a platform with the telematics information, and you can extract all the information from an Excel sheet, or the same e- tool you can look the information of all the process in the vehicle in the platform.''

Interviewee 11, Director

Information is collected on an online telematics platform which contains all the information about the different processes in the vehicle. It can be accessed by the user through the portal, or it can also be obtained in the form of reports in different formats for the ease of understanding.

‘‘AI Consult is a dashboard that shows real-time data to driver to help them understand how they are driving.’’

Interviewee 19, Director

AI Consult is a dashboard within the vehicle, which shows various driver trends and behaviors. For example, there is information about these drivers and drivers’ condition or drivers’ habits, which may ultimately result in increased fuel consumption. So, this is important to have all the driver’s information to know how we can improve the drivers’ habits, the driver's knowledge to implement in the fleet, the braking system and functioning of various other critical parts and components of the vehicle.

‘‘Our company is very much driven from engineering, and we tend to focus on what signals and data we can get out from the vehicle. The big challenge, of course, is how to actually take that data and, and transform it into actionable information that you can actually take actions on and making sure that you package it in a way that adds value to the customer.’’

Interviewee 11, Director

Many interviewees suggested that out that services in general, have been seen as add on to the product, that the customer sees as something that could add value to the product. Today, customers are of the opinion that if they will buy the vehicle, they need such services bundled together as a complete offering. For example, the fleet reports that have data and information from the vehicles, and different alerts, notifications through software and dashboards are included with the vehicles. But the interviews pointed out that going forward a trend is coming where customers are starting to look at buying vehicles as a service from automobile manufacturers, instead of purchasing and paying an upfront cost for that specific vehicle. They are asking for a service offering bundled with vehicle and pay by the usage instead. This is where the vehicle data and the value created have the potential to drive a change in the company’s service proposition.

From the extract, one can understand that the use of value created from the data. The interviewees mentioned that the most basic value from the information customers wants is related to the maintenance of the vehicles. They are asking about replacement of parts and help them do the same. The vehicle data and its analysis help the company to provide a maintenance schedule. Managers can also download the data with the fault codes and based on that order parts before the vehicle comes to the workshop. Hence, the manager is able to avoid a second visit required for replacement of parts. Second, customers want an uptime service system, where the main focus is to keep the vehicle available for the maximum possible time. This is done via service contracts, for example, help with the battery monitoring and other related productivity services, such as fleet management and route optimization. There are also facilities like AI-coach, the driver feedback system, which shows the performance of the driver related to speeding, harsher accelerating or practices which may result in higher fuel consumption.

''Everyone can be swamped with reports, but it's the information they want. What customers find the most useful are the information that alert them of the need for change of components via predictive maintenance.''

Interviewee 20, Sales manager

One of the most important information that is valuable to vehicle users and owners is the unusual and abnormal functioning of any part of the critical component, which, if left untreated can cause an unforeseen breakdown on the road, resulting in an unplanned downtime. Therefore, it is important for the automobile manufacturers to ensure data is analyzed in a way to obtain information about the health of parts like the transmission and the brake system, the power unit and similar parts. It is also important to ensure that in case of fault codes and abnormal operating conditions, alerts are sent directly to the vehicle highlighting the problem and any preventive or diagnostic measure, if relevant.

Another type of information can be helpful for customers is lifecycle management and monitoring of critical components of the vehicle. For example, through one of the interviews, it was revealed that the threshold for one of the components of the braking system was approximately 750,000 applications before it needed to be serviced for wear and tear. However, when actual data were obtained about the activity of the component through a test case, it was found that it had already exceeded 1 million uses which beyond the threshold life cycle of the component. Similar operations of equipment operating beyond the levels of their capability present unwanted security risks and health hazards, which are difficult to know unless data is collected and analyzed in a real-time setting to provide information.

5.3 Service Delivery and Use

This process contains three elements namely, service delivery, service users and value in service use. This section describes how services are delivered, who are the users of these services and what value they obtain from these services. The challenges, shortcomings and future trends related to relevant elements are also highlighted.

5.3.1 Service Delivery

''We have software called Suggest that tells which part the customer should replace in the moment that the vehicle is, and we have AI- Consult, the system that I told you fuel consumption service.''

Interviewee 8, Director

The above extract mentions one of the ways for information delivery. AI-consult is the name for the software that can display information related to vehicle driving and performance such as braking, acceleration fuel consumption via dashboard to the driver. The driver can see on the dashboard where he did a harsher braking, acceleration or where he must have done a robust curve. So, this different kind of information appears on the dashboard for the driver to see and understand.

Connected services are about pulling a lot of information from a central database and interacting with the vehicle system. For example, for a vehicle, which has a driving limit of 100,000 kilometers per year, this has to be preset in the system, which will provide alerts and alarm signals as and when the limit is being approached. This alert may be related to servicing of the tires, changing the brakes as well as booking a full inspection and maintenance of the car. Also, for example, by the mid-year point, if the vehicle has done under or over the scheduled maintenance requirement, there is a need for an automated system that sends notifications or triggers, according to the maintenance program that was set from day one.

''So, one of our software provides the information to the customer that displays information about the speed of the vehicle.''

Interviewee 18, Director

Customers can put a speed limit for vehicles depending upon where they are operating. For example, customers can put a speed limit when the vehicle is near a school or a church. The telematics systems help in understanding the position of the vehicle and when it passes areas for which the speed limit is set, the software in vehicle displays the information according to the set limit, so the driver can reduce the speed.

''I think one key element that we pride ourselves in, and we deliver and do well, even during the COVID situation where we could not travel, we had to look at new ways means and methods to deliver training. I think COVID and the lockdowns etc, really proved the system's usefulness to provide value using remote diagnostics.''

Interviewee 22, Manager

There have been new ways in which value can be created for the customers during the COVID and lockdown. Vehicles are connected with systems that show fault codes when there is a problem. The customers called the managers and sent them a photo of the error that is displayed on the dashboard in the vehicle. Managers then logged into the portal and found commonalities between the code displayed in the vehicle and the old, historic data. Then the ability of telematics is used to look at the frequency of the particular fault code and diagnose for example that a particular component is failing to be a sensor. Finally, the part is sent to the customer, who can actually fix the problem by using the part. It was also revealed that due to lockdown, the managers could not travel to deliver trainings, so the company created platforms to provide videos on how to fix particular problems in the vehicles. The customers revealed to the managers that it was as simple as to find and follow a YouTube video to fix a fridge.

''Customer don't see benefit of paying a monthly subscription, which can be is quite costly considering the large fleets that they operate. And they don't see the benefit to pay for a subscription if they're only looking to monitor certain areas within fleet management.''

Interviewee 4, Director

Monthly subscription of services not only includes services such as real-time monitoring or remote diagnostic services but also different aspects of fleet management like, safety management of fleets, route optimization, fuel efficiency monitoring and preventive maintenance and remote diagnostics of vehicles. However, customers normally do not want to pay for services like preventive maintenance alerts or fault signals on the vehicle dashboard as they feel that they can always get access to the information when the vehicle is in the workshop for scheduled stoppages or maintenance. So, if they are only specifically looking at fuel information, they can actually obtain that themselves from when they are refueling vehicles. This is partly because they feel that they do not need an electronic format, or a portal where they need to log in to get sensitive information. So consequently, customers' adoption rate and willingness to pay, are important factors, which influence and drive the economic attractiveness of the opportunity.

''The one criticism that our customers have about maintenance contracts, is everything is reactive.''

Interviewee 5, Service Manager

Customers expect services to be more preventive, which prevents a breakdown or malfunction by taking appropriate steps before it occurs, rather than repairing a failure of a system. For example, an automobile manufacture should be able to tell how long a brake chamber, or a fuel cell is going to last and in doing so, replace it well beforehand before it has run out is lifecycle. This will prevent unscheduled downtime resulting in increased on road time.

''We're using the portal at the minute for many areas to look at for preventative maintenance, but the capabilities of the system do need to change in certain areas to give us more information and feedback. The system capabilities need to have the two-way traffic capability, so we could remotely upload software, cover campaigns, and then we can do upgrades, and so on, so forth, and they all assist with the remote diagnostics at the same time.''

Interviewee 2, Manager

Customers are spread over long geographical distances. So, when a software update is launched by company, one must physically travel such long distances to do the software updates in a vehicle. Hence, a system with two-way capability is needed. Remote software updates could really benefit the company as well as customers. The ability to perform updates without having to visit a vehicle would massively improve the customer's downtime. In the current system, the technician has to go to the vehicle to do the software upgrade and the vehicle must be off the road. However, with remote diagnostics, upgrade can be planned ahead in time and performed overnight, when the vehicle is not in use. This could really benefit customers and save the company time and money.

''I think it's important that we, that we see the vehicle as a smartphone, just imagine if you need to go to your phone store to do an upgrade or install an app on your phone.''

Interviewee 5, Service Manager

When asked about the ways for information delivery, some interviewees pointed out that it is important to see the vehicle as a smartphone, and all facilities like maintenance, monitoring, and real-time feedback as similar to an upgrade or install an app on the phone. Taking from the simplicity of access and exchange of data, the main expectation is that everything can and should be done remotely, so that the vehicle can be monitored and made sure works in an optimized way. The most important input in this aspect is the ability to take the right data from the vehicle and combine that with data from other systems and share data in a controlled, GDPR secured way. Hence, all kinds of data need to be shared in a controlled way to build solutions for the customer.

‘‘We're trying to work with the customer now, you can structure a lot of information here, and maybe deliver a monthly report for the customer. But the idea is to have real-time information exchange and share the critical aspects of every vehicle that is running at any point of time.’’

Interviewee 9, Director

For automobile manufacturers, it is also extremely important that the data is shared and delivered to the users in a way that is easy to understand and comprehend. Customers are increasingly becoming aware and interested in the benefits related to data-driven services. In vehicles, the information will be displayed on the dashboard for the driver. Additionally, managers conduct monthly meetings with the customer to frame the data and information in a way that customers can take advantage of this data exchange and use them for their benefits. Some interviewees pointed out that these data are valuable only if it is live data and shared real-time instead of sharing a data dump for a definite preceding period.

However, the interviews also uncovered that, data and personal security are another aspect that influences how automobile manufacturers want to deliver information and data to the customers. With data increasingly becoming the currency of exchange between customers and businesses, it becomes increasingly important to convince customers of the value of the information and data exchange. Managers must ensure that the customer sees the worth in getting information, which can potentially enhance the service offerings. Hence, trust plays an important role in information delivery between the company and customers. As this trajectory continues, all businesses, particularly automobile manufacturers will need to shift their focus on their ability to build trust with their customers.

‘‘What we have today on batteries is a completely separate system, what we should have is the ability for the vehicle to upload the condition of his batteries to report so that then we can plan when batteries need to be changed.’’

Interviewee 16, Director

Currently, the company has a system that collects all the data on-board through an information center, which is an on-board telematics computer to collect data. It processes data and sends it back to the central database where data is stored. However, an ability is needed to have a two-way traffic to remotely upload software and do upgrades through the assistance of remote diagnostics. For example, an ability can be created to upload the conditions for batteries through the assistance of remote diagnostics to set a maintenance schedule.

‘‘So nowadays, with our telephone, the customer should be able to go in web platform, like all the Apple Store, select which kind of service he would like, just use the credit card and select the service and we provided the service to the customer.’’

Interviewee 8, Director

Existing procedure for delivery of demanded services involves signing a document at local office by the customer and then sending it to the central headquarter. After that, a log-in and password are sent to the customer to access the demanded services. The company can build a new system to provide such services where the customer can select the required services, pay via debit or with credit card and then company provides the service.

‘‘When we introduced the fleet management platform to customers, they came back to us with questions, areas of improvements and good feedback.’’

Interviewee 17, Director

From the fleet management, customers expect following things. First an ability monitor tire pressure. Second, speed-limiting functions that give an ability to intercept vehicles, for example, if a vehicle is stolen, there is an ability to physically and remotely switch that vehicle off. However, such ability and functions are not available that can allow remote uploading of software to the vehicle.

‘‘There are certain elements within fleet management today that you can report on safety events, but what customer want is real-time safety.’’

Interviewee 22, Service Manager

The fleet management software provides safety features such as displaying the fault codes, which can help the managers identify the broken and faulty parts. Managers can then report the customers and suggest the replacement for the parts. However, customers expect services that can provide real-time safety, for example, if the tire is deflating, customers want an alert sent in real-time to the workshops. The workshop manager can then alert the driver to advise that he might need to pull over the vehicle owing to a trigger that shows that there are a safety-related issue. Therefore, the company has an opportunity to focus on real-time safety for vehicles through data collection.

5.3.2 Service users

‘‘We have a different kind of customer here, we have long distance customer, we have customer within cities, we have some government that has the equals that we do the dedicated customer team.’’

Interviewee 9, Director

From the above extract, one can understand the information user is the customer who buys the vehicles from the company. There are two types of customers , namely, the customers who operate the vehicles for longer distances and others that operate the vehicles within a city.

5.3.3 Value in service use

‘‘Customers are interested in increasing their uptime, reduces chances of unforeseen breakdown. AI Consult and Suggest helps us to provide that value.’’

Interviewee 3, Support Director

As has been described before, customers place the most emphasis on ensuring that their vehicles and fleets are in running condition for the greatest possible time and in this regard, AI Consult and Suggest can create value for customers. This can be done by ensuring that critical aspects of vehicle are always monitored for fault signals and abnormal operations.

5.4 Concluding Remarks

Automobile manufacturers have started, but this is just a start of overall the big journey. The empirics highlight that primarily, the company needs to understand what can be done with the data and what are the different processes involved in data-driven service provision. Using advanced analytics, AI, and machine learning to create value from these data, is still a new area and it will take significant capabilities within the company to create a system that can support the data-driven service offerings of the automobile manufacturing business.

6 Analysis

In this section, the authors will draw on the theoretical framework for proposing the key processes involved in providing data-driven services by automotive manufacturers because all the data that was collected can be sorted into one of the three processes, namely, data collection, information creation and, service delivery and use. The section will be divided into the same three overarching processes as the 'Empirical Findings' section. This section is divided according to the research questions.

Section 6.1 has been formulated to answer the sub question 1, *"What are the processes involved in data-driven service provision for automobile manufacturers?"*

Section 6.2 addresses the sub question 2, "*What are the dynamic capabilities needed by automobile manufacturers for data-driven service provision?"*

Section 6.3 will aggregate the entire analytical framework to answer the main research question: ***"How can automobile manufacturers leverage vehicle data for data-driven service provision?"***

6.1 Processes involved in Data-driven Services

This section provides an answer to the research sub-question 1: "What are the processes involved in data-driven service provision for automobile manufacturers?" The authors aim to identify the specific processes, factors and elements involved in data-driven service provision by examining the case company.

6.1.1 Data Collection

The concerned team at the case company recognized the opportunity to develop an additional service offering in addition to the already existing product portfolios. In order to transform the idea into a service, they conducted research on what inputs might be required to develop the kind of services that are being expected by the customer. Some of the services that came into focus were those based on value created out of the vehicle data, for example, fleet management services, telematics, monitoring of vehicle health, idle time and braking and acceleration behaviours.

Currently, the *data is sourced through a wide range of sensors and physical devices* placed at strategic points in the vehicle. For example, different kinds of data will be best obtained from different parts of the vehicle. Data related to vehicle health and operations are mostly obtained from the sensors placed in the vehicle power unit, transmission, and the chassis as these provide data related to the internal components of the vehicle. The *technical data can be obtained from both on-board monitoring and telematics platform* as well as those mounted on the body of the vehicle to ensure that the data collected is shared and exchanged between the vehicles and platforms responsible for storing or analysing to derive value out of the data. Normally, *these data are stored in the vehicle itself*, which is then downloaded and accessed once the vehicle is brought in for maintenance. As far as the type of data collected is concerned, it has been observed that vehicle data can be broadly classified into the following. First, it is *vehicle data related to the overall well-being of the vehicle*. This includes data, which give an idea about general wear and tear levels of various machines and components. For example, vehicle health data include data and alerts related to engine temperature, tire pressure, performance of the power unit, transmission, or the chassis as well as any aspect like wheel alignment or brake fluid leakage, which may affect the overall health and need for maintenance of the vehicle. Second, it is *operational metrics. These are data, which provide insights into the operational aspects of the vehicle*. For example, these include braking and accelerating behaviour, speeding trends, charge levels of electric vehicles, and the idle time. It also includes efficiency aspects like fuel consumption, fuel efficiency, mileage. Third, it is *technical data. These are the aspects, which correspond to the physical aspects of the vehicle like weight, running time, routes*.

However, there also exist significant challenges on the data collection front. For example, data *related to fault codes and abnormal functioning of the key components are still accessible only as historical data*. The real value of these can only be obtained and recognized when this data can be collected in real-time. However, this process of sourcing, collection and storage of vehicle data must be done in a manner that ensures the security and accessibility of the same. One of the key risks is the *threat of a purposeful attack that compromises sensitive data or interferes with safety of operation*, targeting and disabling a vehicle's safety systems, exploiting navigation/positioning information, and using a vehicle's infotainment system as a gateway to wiretap apps and gain access to personal data. Such breaches can have a cybersecurity threat in connected/autonomous vehicles allowing an attacker to gain access to safety-critical systems of the vehicles and steal personal data, compromise infotainment/navigation GPS units, and neutralize vehicle alarm systems. This might even threaten drivers' physical safety if they manage to hijack systems like steering and braking. Besides the potential physical harm, security breaches can cause severe reputational damages to manufacturers and their suppliers and reduce confidence in advanced driving assistance systems (ADAS) and, further along, in autonomous vehicles.

With the increase in importance of services such as telematics, speed control and proactive monitoring, there has been a growing *need for live and real-time data exchange*. However, simply collecting these data is not enough. There should be an appropriate provision made to ensure that the data collected is shared and exchanged between vehicles and platforms responsible for storing or analyzing it in real-time. This can be in the form of *cloud-based computing where data can be stored and monitored in a closed server as and when it is generated*. This not only allows steady interchange of data, but also helps in accurate monitoring, control and prediction of the vehicle movement and driver behaviour from a centralized database. It will also require significant setup of back-end processes and costly infrastructure to do the same.

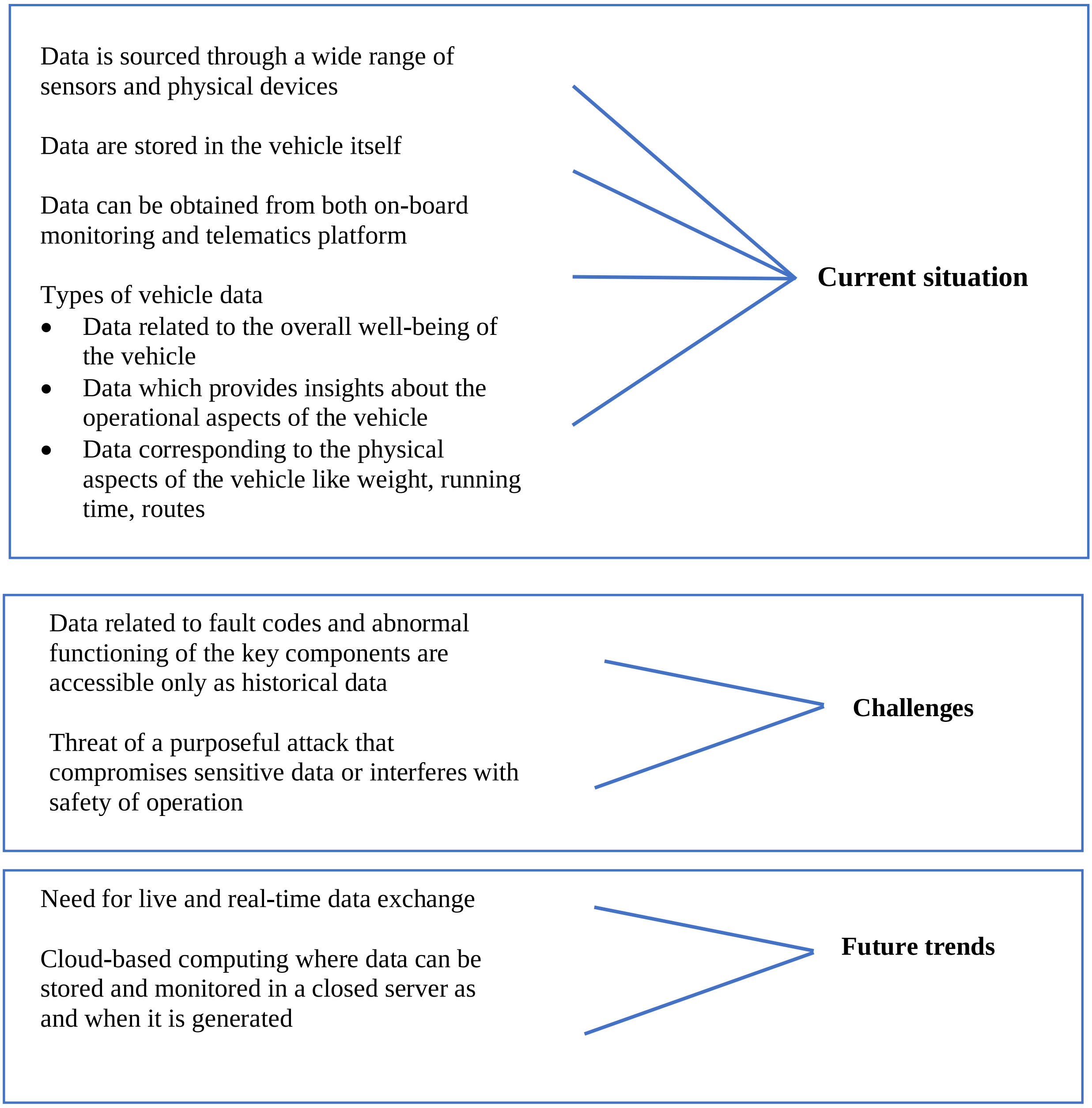

Figure 4 : Data Collection process

6.1.2 Information Creation

Once this data from the vehicle have been collected and monitored, it needs to be filtered, analyzed, and enriched to separate the useful data (referred to as the information) from the noise. This refers to subjecting the raw data to gather insights and information through automated algorithms and automated processes to optimize the performance of the vehicle and transport systems.

There is an opportunity to gather valuable information that can be obtained by analyzing the vehicle data. For customers and users, one of the advantages would be the information related to *predictive maintenance and change of components*. Customers today are approaching automobile manufacturers about the shelf life of different parts and components and more importantly, about getting real-time information. That is critical in understanding the customer's business and helps in obtaining insights about vehicle health and optimal operational metrics of the vehicle at any given point in time. Another aspect where *the* *generated data need to be thoroughly analyzed is the battery and the battery software*, which involves packaging and developing the own battery-controlling software. It also includes taking care of the battery in terms of its health and operating efficiency and ensuring that one of the most expensive components of the vehicle runs seamlessly to the optimum capacity. Thus, *a clear demarcation is required* regarding which data need to be fed directly to the central server for instantaneous analysis and computing and which can be accommodated to be stored in the vehicle as historical data.

The information that can be obtained by subjecting the vehicle data to different analytical and computing processes can be classified as follows. First *external road and environmental conditions*, which use real-time maps and data feed on ice and fog conditions on the road through camera sensors and feed to provide information and alerts related to preventive safety measures and live road condition reports. Second, *technical status of the vehicle* like measuring oil temperature, airbag deployment and technical fault codes to enable predictive maintenance and remote service booking and run car repair diagnostics and automatic emergency calls. Third, *vehicle usage levels* such as speed, location, and average load weight to enable quickest route to the destination, optimize the toll and on road payments and reduce engineering and operating costs. Fourth, direct communication from vehicle voice recognition and speech control to provide services such as proactive navigation services and virtual assistant facilities.

Additionally, trends in the markets and customers show that in addition to this information, *customers greatly value any information that helps them understand the need for predictive and preventive maintenance of their vehicles and fleet*. It provides a unique opportunity for automobile manufacturers to develop capabilities and services based on the sensors and vehicle data and provide information on overall vehicle health and maintenance schedules.

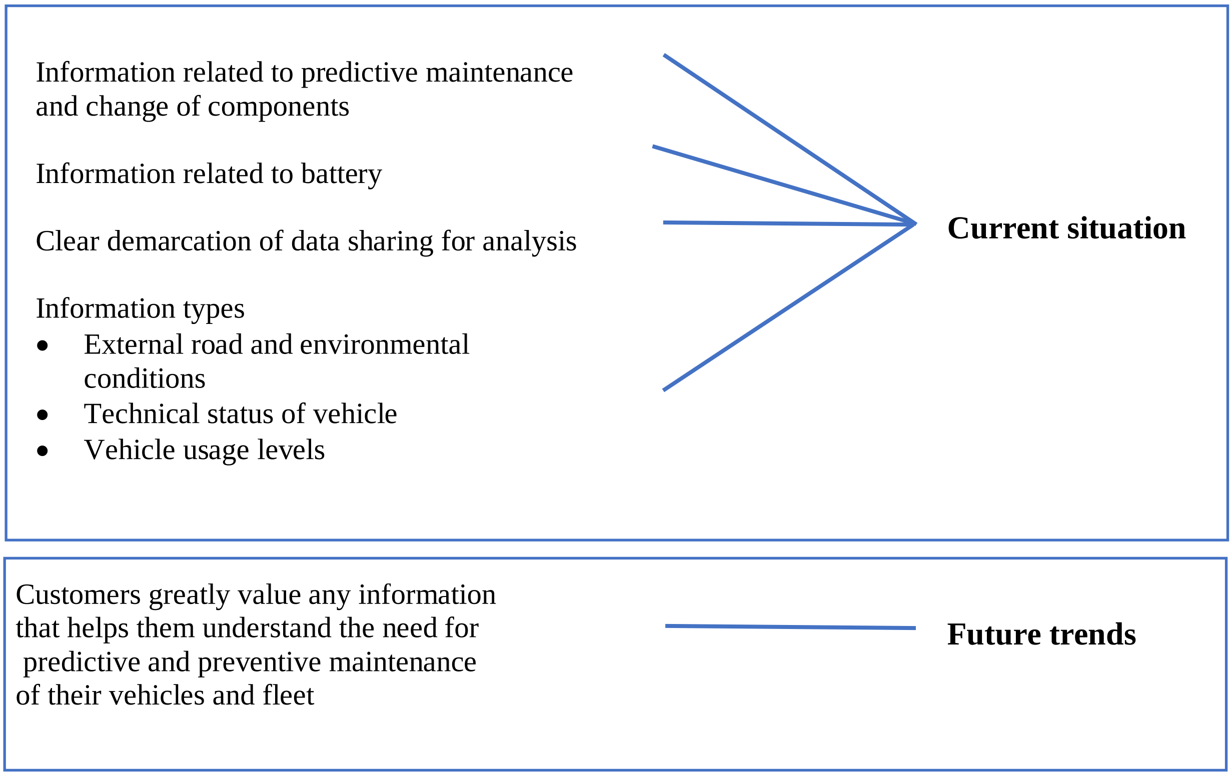

Figure 5 : Information Creation process

6.1.3 Service Delivery and Use

The final process is the delivery of service based on the information obtained from the analysis of the vehicle data. First, it can be in the form of *sharing information between the vehicle sensors and the remote platform* which feeds critical information to the vehicle related to functioning and operations of its parts and components. Second, *services can also be in the form of real-time information streaming between the monitoring platform and the driver* and driving mechanism. Third, *on-board information through signals and alerts* about vehicle performance and key performance measures can also help in providing services. Fourth, it can also be delivered in the form of *remote predictive maintenance alerts,* which might make the fleet owner and the driver aware of certain abnormal fault signals or codes for potential malfunctioning and downtime in future, all of which are common and are undertaken by most vehicle manufacturers nowadays to varying degrees.

There are, however, various challenges that automobile manufacturers face in this regard. For example, in most cases, these kinds of *diagnostic services are reactive,* that is, they are mostly focused on repairing and diagnosing the faults rather than preventing them from happening. This is because, as described in the data collection section, what the vehicles mostly collect are historical data which is stored in the vehicle. Thus, the absence of real-time data prevents the automobile manufacturers from finding potential hazards in the operations of the parts and critical components as these malfunctioning is only made accessible once there is a breakdown and the vehicle must be brought into the workshop for relevant maintenances. Thus, the only form of service that can be given by the automobile manufacturers is based on safety events as opposed to real-time safety, which is a key customer expectation. Additionally, the *absence of a two-way communication system,* which enables information sharing between the vehicle and the central server across both ways is a challenge that has made the development of similar services difficult. This prevents proper information upload from the central server to the vehicle dashboard, resulting in gaps and delays in sending alerts and preventive diagnosis to the vehicle. These above-mentioned challenges are also in part because *customers are becoming less and less willing to pay for such services* related to vehicle health, preventive maintenance and diagnostic services. It is the customer's expectation that these services aimed at smooth running and optimum operation of the vehicle should be a part of the upfront cost of the vehicle. Thus, it is important to develop capabilities that correlate customer willingness to pay and adopt these services for their vehicles and fleet.

The process of service delivery and use has shown some trends for the future, which can potentially prove to be unique opportunities for the industry. *Vehicles will probably be increasingly seen and used like smart phones, as a platform or an interface,* which can perform all kinds of tasks like predicting or tracking the vehicle, ticketing systems, predicting and displaying the load capacity of the vehicle, hence contributing to customers deliverables such as revenue collection. Therefore, *necessary capabilities are required to form a comprehensible package of services* for the vehicle operators and fleet owners.

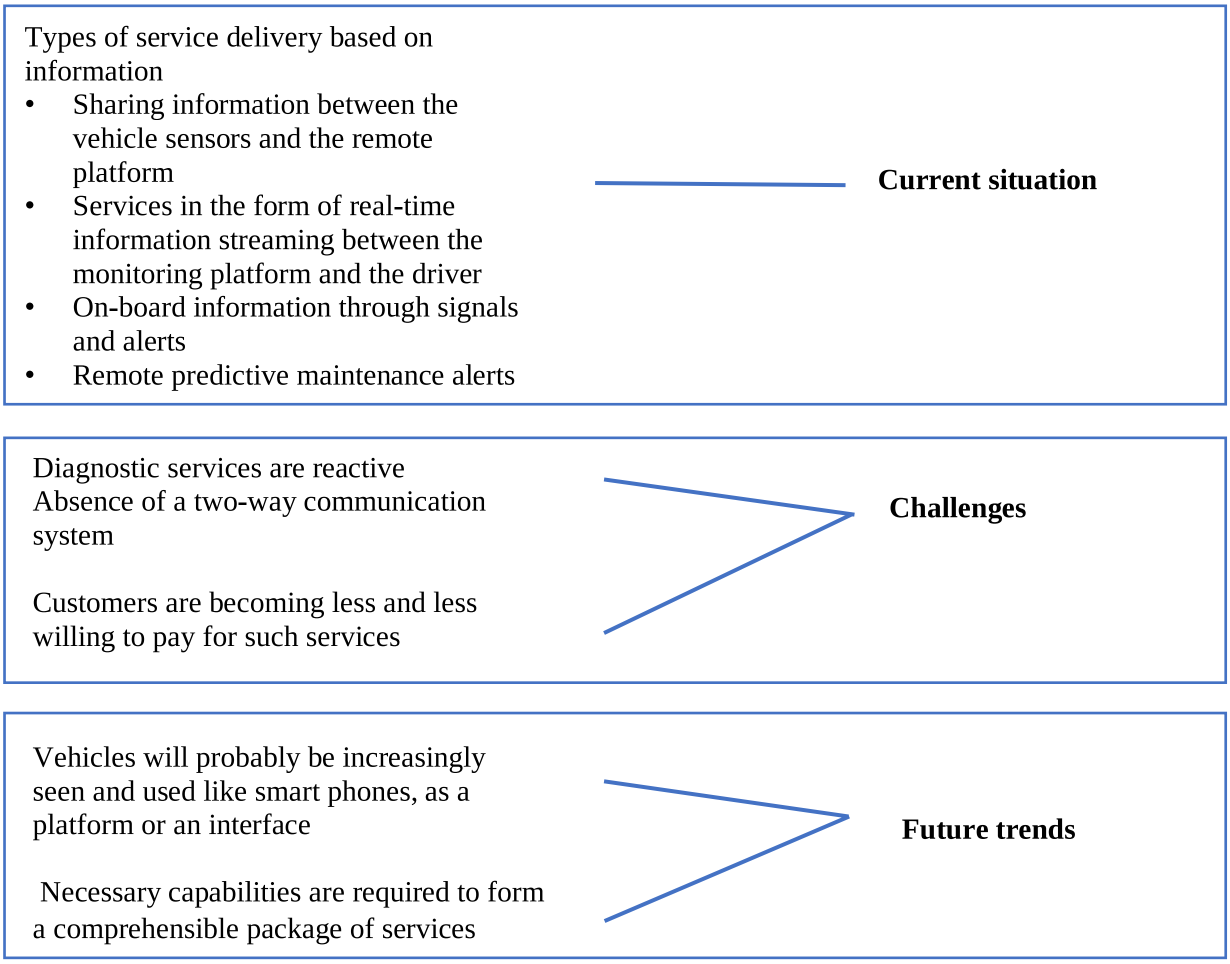

Figure 6 : Service Delivery and Use process

6.1.4 Concluding Remarks

To answer the research sub-question 1 "What are the processes involved in data-driven service provision for automobile manufacturers?" This part of the analysis section identified the processes, which govern this transformation currently, for example, through strategic collection of data such as operation and health of key parts like body and the subsequent storage and analysis of the data through various means.

However, this section also highlights the key challenges faced during this process. For example, for data collection, one of the key challenges has been the absence of real-time data from the on-board sensors while ensuring safety and security of the data at the same time. In terms of analyzing these data to a usable information, it must be done in real-time to gain live insights about vehicle performance and health of critical parts and components. Finally, in terms of the services provided based on these data and information, a major challenge has been to ensure accessibility and security of the information and using them to provide more predictive and preventive services instead of being reactive in providing service.

	Current Situation	Challenges	Future Trends
Data Collection	Data is sourced through a wide range of sensors and physical devices Data are stored in the vehicle itself Data can be obtained from both on-board monitoring and telematics platform Types of vehicle data 1. Data related to the overall well-being of the vehicle 2. Data which provides insights ab out the operational aspects of the vehicle 3. Data corresponding to the physical aspects of the vehicle like weight, running time, routes	Data related to fault codes and abnormal functioning of the key components are accessible only as historical data Threat of a purposeful attack that compromises sensitive data or interferes with safety of operation	Need for live and real-time data exchange Cloud-based computing where data can be stored and monitored in a closed server as and when it is generated
Information Creation	Information related to predictive maintenance and change of components Information related to battery Clear demarcation of data sharing for analysis Information types External road and environmental conditions 1. Technical status of vehicle 2. Vehicle usage levels	Diagnostic services are reactive Absence of a two-way communication system Customers are becoming less and less willing to pay for such services	Customers greatly value any information that help them understand the need for predictive and preventive maintenance of their vehicles and fleet
Service Delivery and Use	Types of service delivery based on information 1. Sharing information between the vehicle sensors and the remote platform 2. Services in the form of real-time information streaming between the monitoring platform and the driver 3. On-board information through signals and alerts 4. Remote predictive maintenance alerts		Vehicles will probably be increasingly seen and used like smart phones, as a platform or an interface Necessary capabilities are required to form a comprehensible package of services

Figure 7 : Current Situation, Challenges and Future Trends

6.2 Dynamic Capabilities needed for Data-driven Service provision

This section aims to provide an answer to the research sub-question 2: “What are the dynamic capabilities needed by automobile manufacturers for data-driven service provision? “. The author aims to identify the specific processes, routines, activities that help in data-driven service provision and categorize them into dynamic capabilities required by automobile manufacturers to embrace challenges while moving toward the future trends.

6.2.1 Dynamic Capabilities for Data Collection

Data is collected from different parts of the vehicle and the company needs to collect and exchange data in a secure way so that purposeful attack on sensitive data, targeting the safety of vehicles can be averted. Especially, when the company plans to provide services based on real-time data, it presents a new opportunity to focus on real-time safety for vehicles through the data collection process.

These propositions require some capabilities within the firm which is mostly technical. Company can seize these opportunities through managerial decisions to invest in specific resources and technologies, and offer it customers new product and services, and connected business model to its customers (Teece 2007). This can be capability and competence related to data collection, analysis and cyber security which will contribute to better data collection, assimilation and security which is instrumental in providing a richer customer experience through data-based service. Firm will thus, needs to invest in *skilled and competent people such as cybersecurity specialists (seize)* that will not only protect the company from the threat of data theft but also ensure the safety of drivers. In addition, one of the abilities important for the future of data-driven service provision, is live and real-time data exchange. Hence, the capabilities related to *cloud-based computing (reconfigure)* is needed for seamless integration between sub-systems and enable a link between different kinds of data and make advisories to the end user. For example, if the systems are integrated, managers can have access to real-time data to react quicker to the customers.

There are also capabilities which aim at organizational realignment of necessary resources to increase its value to the firm. This can be done by deciding on an *organizational design in which such capabilities will be implemented (reconfigure)*. For example, a team will be based at headquarter that will handle the vehicle data to provide platform-based analytics and cloud computing. Alternatively, a decentralized team will be set up that will manage the data at a regional level.

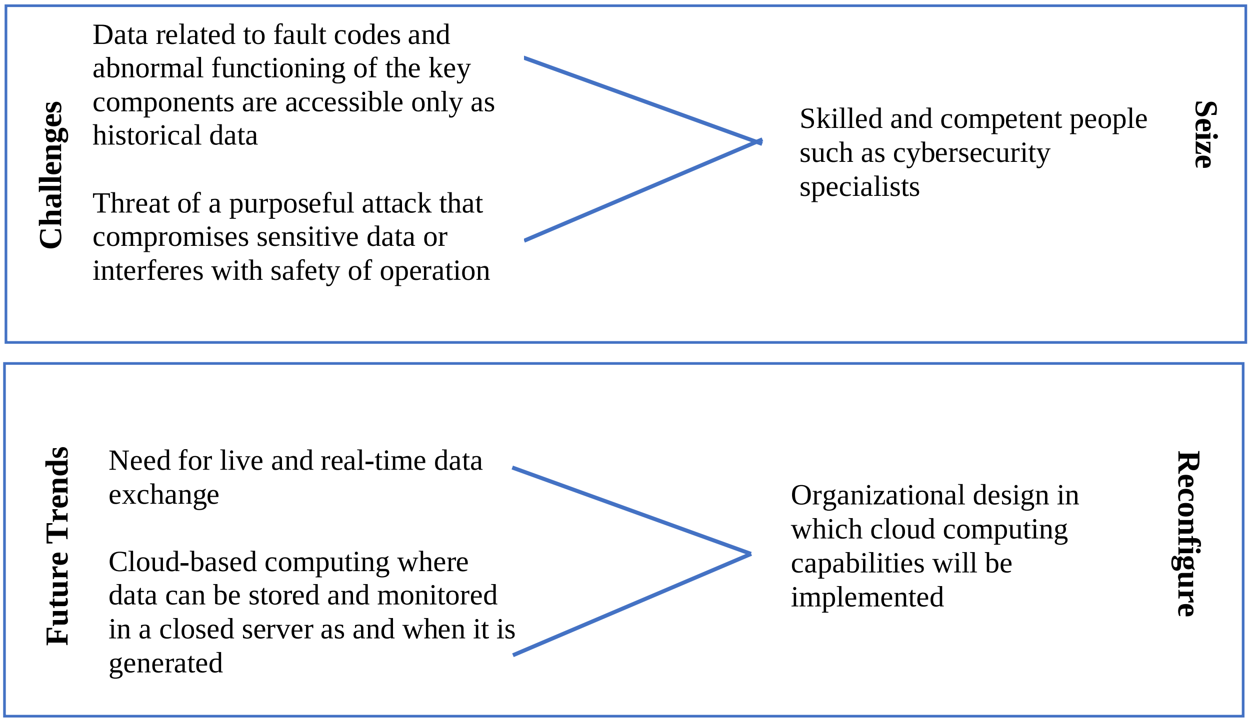

Figure 8 : Dynamic Capabilities for Data Collection

6.2.2 Dynamic Capabilities for Information Creation

Large amounts of data collected from the vehicle and transformed into valuable information, present new opportunities for the company to invest in it. Firm needs to develop capabilities that aim to find new opportunities by studying related trends, analyzing competitor behavior, and examining the market to find out about unaddressed requirements. This can be done by carefully studying the type of services that can be rolled out to customers and users and which information can be the most useful to provide the same. For example, as the collected data when transformed presents valuable information related to the health and operation of the vehicle firm can focus *on retail/e-commerce opportunity (sense)*. It can help the company direct services to the customers such as replacement of parts via measuring and monitoring the health and performance of the critical parts and components before the breakdown of the vehicle.

The real-time analysis can provide services such as predictive maintenance, speed control, etc. Firm needs to restructure its assets and resources to provide such analysis from the existing system of downloading and then analyzing data. For real-time data analysis, company needs to develop capabilities related to *big data analytics (reconfigure)* as it will help in processing of vast amounts of real-time data from the vehicle. For example, if the tire is deflating, customers want an alert sent in real-time to the workshops. The workshop manager can then alert the driver to advise that he might need to pull over the vehicle owing to a trigger that shows that there is a safety-related issue. The development of *internal competencies in advanced analytics (reconfigure)* will enable the company to leverage the data obtained from various parts of the vehicle. This might involve organizational as well as structural reconfigurations. For example, novel services like the one described above involve coworking between different teams at different levels. This needs specific capabilities from the organization that allows them to work in an agile manner in a specific work flow. In addition, it also needs some degree of overlap between the capabilities as far as the technical and the business knowledge is concerned as that allows departments to use data and information and interpret them from the customer and business point of view and vice versa.

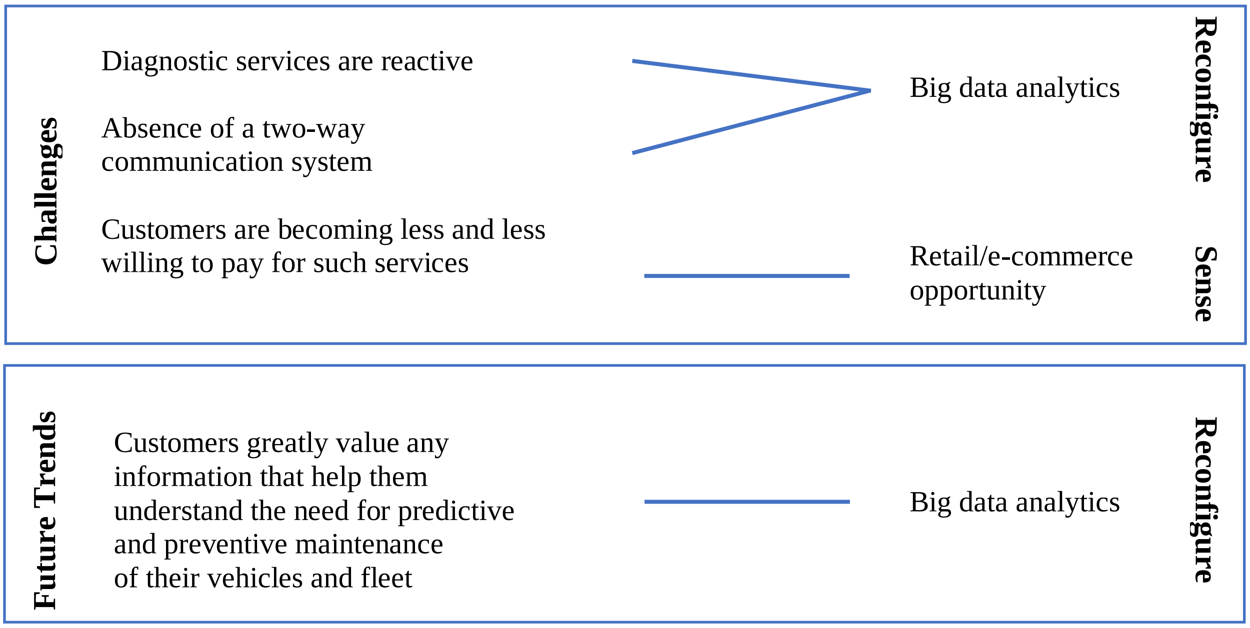

Figure 9 : Dynamic Capabilities for Information Creation

6.2.3 Dynamic Capabilities for Service Delivery and Use

In service delivery to customers, there are opportunities for the company to improve on. Firm needs to invest in the *ability to use software platforms for purchasing services (seize)* that supports seamless and integrated payment methods for purchasing services. Existing procedures involve signing a document at a local office by the customer and then sending it to the central headquarters. After that, a log-in and password are sent to the customer to access the demanded services. A cultural transformation is also needed to a *more people-firm approach (reconfigure)* for data-driven service provision as the company needs to understand data to develop new offerings and solutions such as integrated payment methods and new services such as predictive maintenance in order to meet the needs from the market.

Currently, the company has a system that collects all the data on-board through an information center, which is an on-board telematics computer to collect data. It processes data and sends it back to the central database where data are stored. However, an *ability is needed to have a two-way traffic (reconfigure)* to remotely upload software and do upgrades through the assistance of remote diagnostics. The remote diagnostics allows numerous service delivery provisions. First, the company can invest in two-way traffic ability can control the vehicle when hacked or *speed-limiting functions with an ability to intercept vehicles (seize)* to physically and remotely switch off the vehicle. This helps company to provide real-time safety data-driven services. Second, if the vehicle has a *reset maintenance schedule through predictive maintenance (seize)* throughout a year and the vehicle has done under or over the scheduled maintenance requirement at the half-year mark, then a two-way traffic capability automated system can send a notification or trigger and adjust the maintenance program that was set from day one. Third, an ability can be created to *upload the conditions for batteries (sense),* especially in electric vehicles through investment in research activities. *Innovation-based partnerships (sense)* between automobile manufacturers and various suppliers/service providers will be an opportunity for the company to provide tailor made service provisions such as ticketing systems, predicting and displaying the load capacity of the vehicle. Such partnerships help in understanding customer needs and market trends that should be targeted (Teece, 2007). This customizable service provision increases the probability of customers willing to pay and adopt the data-driven services for their vehicles and fleet.

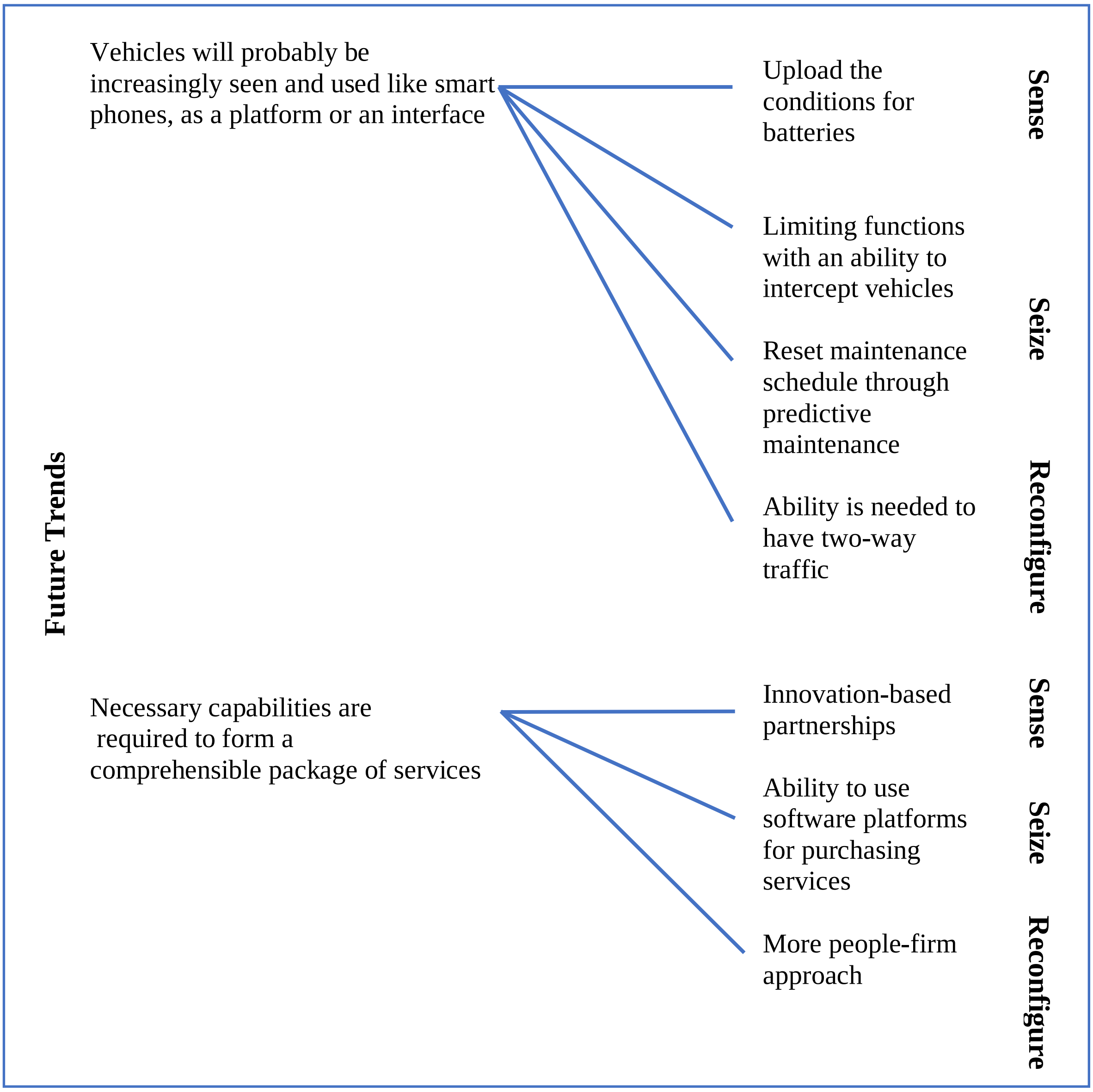

Figure 10 : Dynamic Capabilities for Service Delivery and Use

6.2.4 Concluding Remarks

To answer the research sub-question 2: “What are the dynamic capabilities needed by automobile manufacturers for data-driven service provision?” this part of the Analysis section identified “distinct skills, processes, procedures, organizational structures, decision rules” (Teece, 2007), which form the basis of the dynamic capabilities. This section will be broken down into the dynamic capability categories of Sensing, Seizing, and Transforming (Teece, 2007) and will address what dynamic capabilities are required during the three-overarching processes for service provision.

6.2.4.1 Sensing

The company’s sensing capabilities need to change over the different processes for data-driven service provision. In information creation, company can focus on *retail/e-commerce opportunities* to direct services to customers. In service delivery and use, for data-driven services, there is opportunity for *uploading battery conditions* in real-time for electric vehicles. Additionally, the company can also focus on *Innovation-based partnerships (sense)* between automobile manufacturers and various suppliers/service providers to provide tailor-made services.

6.2.4.2 Seizing

The company’s seizing capabilities are related to investing in *skilled and competent people such as cybersecurity specialists* in data collection process. In the information creation process, the focus is needed on *using software platforms for purchasing services.* There are opportunities to provide real-time data-driven services such as s*peed limiting functions with an ability to intercept vehicles* for real-time safety and *resetting maintenance schedule through predictive maintenance.*

6.2.4.3 Reconfiguring

In the data collection process, company needs to reconfigure the *organization design* to a*dd cloud-based computing. Big data analytics* and further investment in *internal competencies in advanced analytics* is needed in the information creation process. Further to provide real-time service delivery, an *ability is needed to have two-way traffic* (reconfigure) that can remotely upload software and do upgrades. A cultural change is needed in the company to a more *people-firm approach.*

To conclude, the answer to the research sub-question “*What are the dynamic capabilities needed by automobile manufacturers to develop data-driven services*?” is that company uses different activities and processes related to sense, seize, and reconfigure to renew and realign the organization, key aspects businesses and culture over time. At different processes for data-driven service provision, the company focuses on different aspects of dynamic capabilities.

	Data Collection	Information Creation	Service Delivery and Use
Sense		Retail/e-commerce opportunity	Upload the conditions for batteries Innovation based partnerships
Seize	Skilled and competent people such as cybersecurity specialists		Limiting functions with an ability to intercept vehicles Reset maintenance schedule through predictive maintenance Ability to use software platforms for purchasing services
Reconfigure	Organizational design in which cloud computing capabilities will be implemented	Big data analytics	Ability is needed to have two-way traffic More people-firm

Figure 11 : Dynamic Capabilities for Data-driven Services

6.3 Leveraging vehicle data for data-driven service provision

This section will aggregate the previous two sections to answer the overarching research question: ***"How can automobile manufacturers leverage vehicle data for data-driven service provision?"***

The author conducted an analysis of an automobile company developing dynamic capabilities for data-driven service provision. By combining Lim et al., (2018) and Teece (2007) model with this perspective, the authors could confirm that the company engages in sensing, seizing, and reconfiguring in the three overarching processes of data collection, information creation, and service delivery and use. Sensing in the data-driven service proposition is based on recognizing market trends and opportunities to provide direct services to the customers while forging new innovative partnerships. These opportunities will need to be worked on and implemented by taking relevant decisions related to the technological requirements and need for resources related to correct data collection and generation of information. This is done by reconfiguring the existing routines and processes of the organization, adapting to the changing market trends and user behaviours related to services obtained by leveraging the value created from vehicle data.

7 Conclusion

Customer data enable companies to create updated service offerings as per market demands (Lim et al., 2018). However, most existing literature discuss how services are developed by leveraging customer data in areas of manufacturing and healthcare (Opresnik & Taisch, 2015, Raghupati & Raghupathi, 2014). This study on the other hand focuses on how data can be used to transform to information which can then be leveraged to provide data-driven services. The study premises that data in itself cannot be used to meet customer expectations. This data needs to be transformed into valuable information by following a set of steps which can then, in turn, be used as a basis for the data-driven services. By following the three key processes, namely, data collection, information creation and service delivery and use, the study seeks to establish how the automobile manufacturing industry can use the data generated from various vehicle components like the power unit, transmission, chassis and the body to monitor various operational, functional and technical parameters and use them to provide services like predict malfunctioning, proactively analyze and diagnose fault codes and reduce downtime and unscheduled breakdowns.

The concepts of dynamic framework have been in effect for a long and have been steadily increasing in importance in the managerial setting right from its inception by Teece et al. (1997). While in the more recent and progressive works on this subject have focused on micro-foundations of the three overarching concepts, namely, sensing, seizing, and reconfiguring, (Teece, 2007), few have focussed on studying the connecting a firm's dynamic capabilities for data-driven service provision. In addition, the dynamic capabilities for generic services are known (Kindström et al., 2013; den Hertog et al., 2010), but with the advent and increase in the use of data in the process, operations and manufacturing industries, it was evident that a certain lack of literature remained in the realms of using process data and use it to provide service propositions aimed at monitoring, maintaining and improving the same service (Coreynen et al., 2017; Ostrom et al., 2015; Barret et al., 2015).

This study focussed on the specific automobile manufacturing industry and how the data generated from various vehicle components like the power unit, transmission, chassis and the body can be used to monitor vehicle health, overall functioning of components and process functionalities like driver behaviour, route management and functioning of critical components to perform services like predict malfunctioning, proactively analyze and diagnose fault codes and reduce downtime and unscheduled breakdowns. While there has been considerable research in the area of designing new data-driven services and using data to create value (Lim et al., 2015; Lim et al., 2018; Opresnik & Taisch, 2015; Raghupati & Raghupathi, 2014), this study helps to contribute toward what dynamic capabilities are required by companies for data-driven service provision. This has been done using the elements of dynamic capabilities (Teece, 2007) to view the individual processes of data to information and service delivery (Lim et al., 2018) and find and address key challenges and future trends and expectations related to data-driven services.

While the process from data to value is governed by a definite process of frameworks and elements, (Lim et al., 2018), organizations still need to develop capabilities related to data collection, information creation and service delivery and use, to transform the organization to obtain a competitive advantage based on data-driven services, the service system must be effectively reconfigured (Schymanietz, 2020). This study provides an insight on overcoming the challenges and addressing future trends and customer expectations by sensing the opportunities and threats, seizing them through specific capacity building and reconfiguring the structure and organizational culture to implement them (Coreynen et al., 2017; Ostrom et al., 2015; Barret et al., 2015) while developing related service propositions. Organization can sense opportunities that support product sales by offering opportunities for further data-driven provision (Kindström et al., 2013). It includes technological opportunities such as uploading battery conditions in real-time and retail/e-commerce and innovation-based partnerships that offer possibilities for new ways of interaction with customers or individualized service offerings (den Hertog et al., 2010). After sensing, the next step is to seize the opportunity. Company needs to determine and understand the needs for resources and investments and decisions related to technology (Teece, 2007). One of the investments that could facilitate data-driven service provisions is investing in skilled and competent people such as cybersecurity specialists and using software platforms for purchasing services. Opportunities to provide real-time data-driven services such as speed limiting functions with an ability to intercept vehicles for real-time safety and resetting maintenance schedule through predictive maintenance enables the offering of highly specialized solutions to the customers, that can be charged separately and can be extended with additional features in future (den Hertog et al., 2010). For a sustainable competitive advantage, organization needs to reconfigure its resources and assets (Teece, 2007). In context of data-driven services, company needs to reconfigure the system in an efficient way (Kindström et al., 2013) that includes organization design to add cloud-based computing and ability is needed to have two-way traffic that can remotely upload software and do upgrades. Organizations should introduce data-driven service-oriented functions such as internal competencies in advanced analytics to pursue successful service provisions. Finally, for a data-driven service provision, a culture change and development of service-oriented mindset is needed such as people- firm approach that allows to examine the organizational routines and if needed discard the old ones in favor of more effective and efficient ones (Kindström et al., 2013).

8 Discussion

In this chapter, the study's theoretical contributions and its practical implications is discussed. Subsequently, the limitations of the study are presented,followed by suggestions for future research .

8.1 Theoretical Contribution

This study contributes to the theoretical development in two main ways. First, it gives an insight into the dynamic capabilities required for data-driven service provision. The study enhances the understanding of data-driven services by identifying specific capabilities. It also extends the application of dynamic capability framework (Teece, 2007) to the level of the various processes involved in using the vehicle data to create new service propositions for customers of automobile manufacturing companies. Therefore, addressing the gap in the theory of what dynamic capabilities are required for data-driven services (Schymanietz, 2020).

Second, the contribution of this study has been toward providing three overarching processes involved in data-driven service provision. These processes describe the mechanism of collecting, storing, and analyzing the data to transform it into valuable information to provide services. Additionally, the resources and activities involved in the processes are also identified.

Third, the contribution of this study has been toward the third overarching process of "value creation" in the nine- factor framework for data-based value creation (Lim et al., 2018). Value is created in all three processes of the framework, namely, "data collection," "information creation" and "value creation." Hence, the process is renamed as "service delivery and use".

Additionally, the process of the framework, namely, the “value creation” was unambiguous in the sense that it did not specify for whom the value was created. In a scenario, which involves new service propositions to be created with the use of data, value can be created for a variety of actors. There can be value for the customers, value for the vehicle operators as well as the end users and there can also be a significant value from the information for automobile manufacturers. In this study, value through the process “service delivery and use” is focussed at customers.

8.2 Managerial Implication

For managers, vehicle data provide a unique opportunity to get a real-time view of their operating performance levels, thereby suggesting customized and personalized service solutions depending upon the health and requirement of the particular vehicle or fleet. This study can serve as a guiding research on how a team can focus on the journey to create value from data and the process and culture that accompanies with the use of this data to create service propositions. For example, this study can be used by organizations to determine the investments that need to be made with regards to inculcating required capabilities and resources needed to drive the trends of data collection, analysis and value creation. In addition, it can also help to reconfigure and align existing processes and competencies, which might be helpful to consolidate the newly formed processes and teams and supplement the progress in this direction. Finally, with digital service offerings more as a function of customer demands and user behavior it will help teams engage in sensing and seizing activities and derive an idea of where the next opportunity might come from.

8.3 Limitations

This study has the following limitations. First, the study is highly contextual based on a single case. Additionally, the dynamic capabilities framework makes the applicability of the study likely limited, which could be improved by conducting multiple in-depth case studies across companies of different industries. Second, study has considered the customer behaviours and requirements obtained through interviews with the employees in an automobile manufacturer who works closely with customers but are not the customers themselves. Thus, the actual expectations, trends and requirements of the customers are unknown, which may or may not be different from the perceived expectations as obtained from the interviews. Third, the study has been conducted for a predominantly business-to-business ecosystem where the automobile manufacturers deal with other corporates, businesses, and operators instead of commercial or retail consumers. This might influence the final findings as the requirements, expectations and usage behaviours for business-to-business can be different from business-to-customers. And finally, the study focuses on different processes involved in data-driven services creating value for customers and excludes the influence that other actors involved in services such as suppliers, network providers, and partners can have on the process of transforming data to information or the capabilities.

8.4 Future Research

Along the course of the study, there have also been findings that might benefit from future research. For example, the study focused on different processes involved in data-driven service propositions for automobile manufacturers. However, data can be generated and obtained from a variety of different sources. This includes customer data, data from the end-users as well as those obtained from the market and other network providers and partners in the value chain. An avenue of research can be made along the lines as to how data from all or some parts of this value chain can be collected and analyzed to create a service offering that can be of value to not only the automobile manufacturers but also others in the chain. Additionally, the study can also include the inter-relations of these different members of the value chain and how this inter-relation affects the value created.

Secondly, this study can be done in an industry different from an automobile manufacturing one to examine what dynamic capabilities might be applicable depending on their industry segment, customer expectations, and the data generated to create a similar data-driven service offering. Finally, a longitudinal study could help to gain more insights about real-time dynamic tensions that different companies and industries face in addition to a precise sequence of dynamic capabilities in their digital service development journey.

Third, this study focuses on processes of “data collection”, “information creation” and “service delivery and use”, and studies these overarching processes linearly. A new area of research can be how the element of service delivery helps in identifying new data in the data collection process for new service provision and what is the inter-relation between the two processes.

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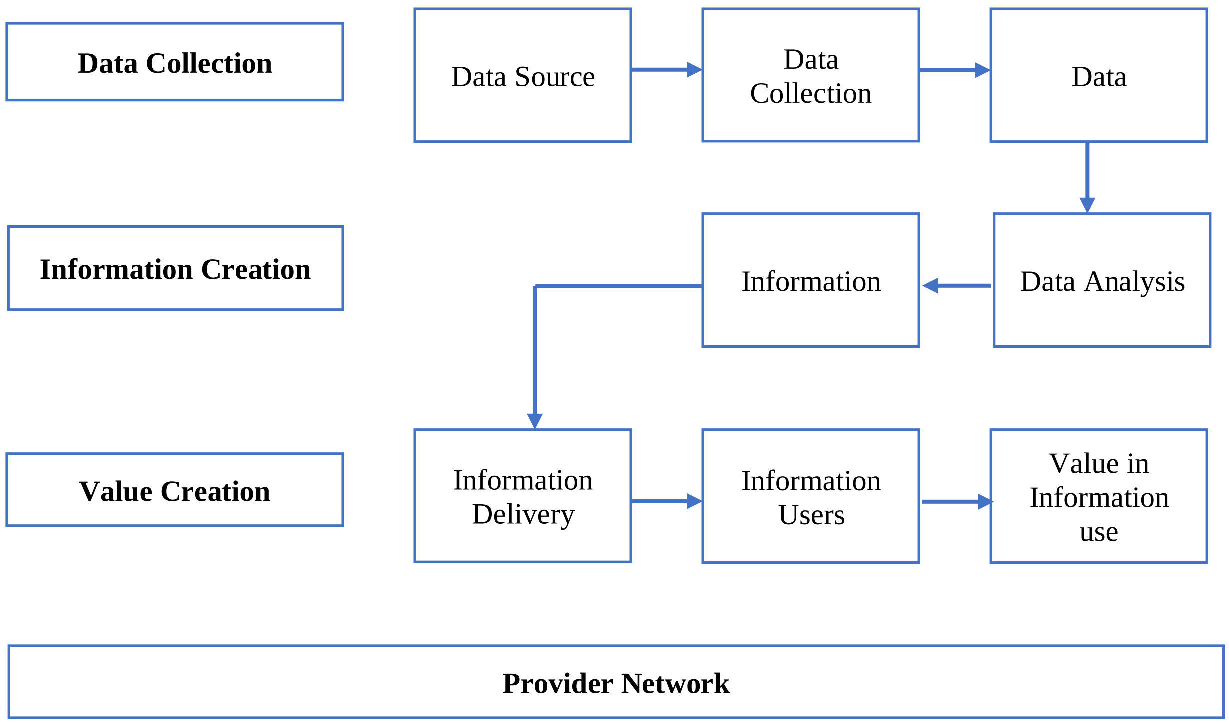
Appendices

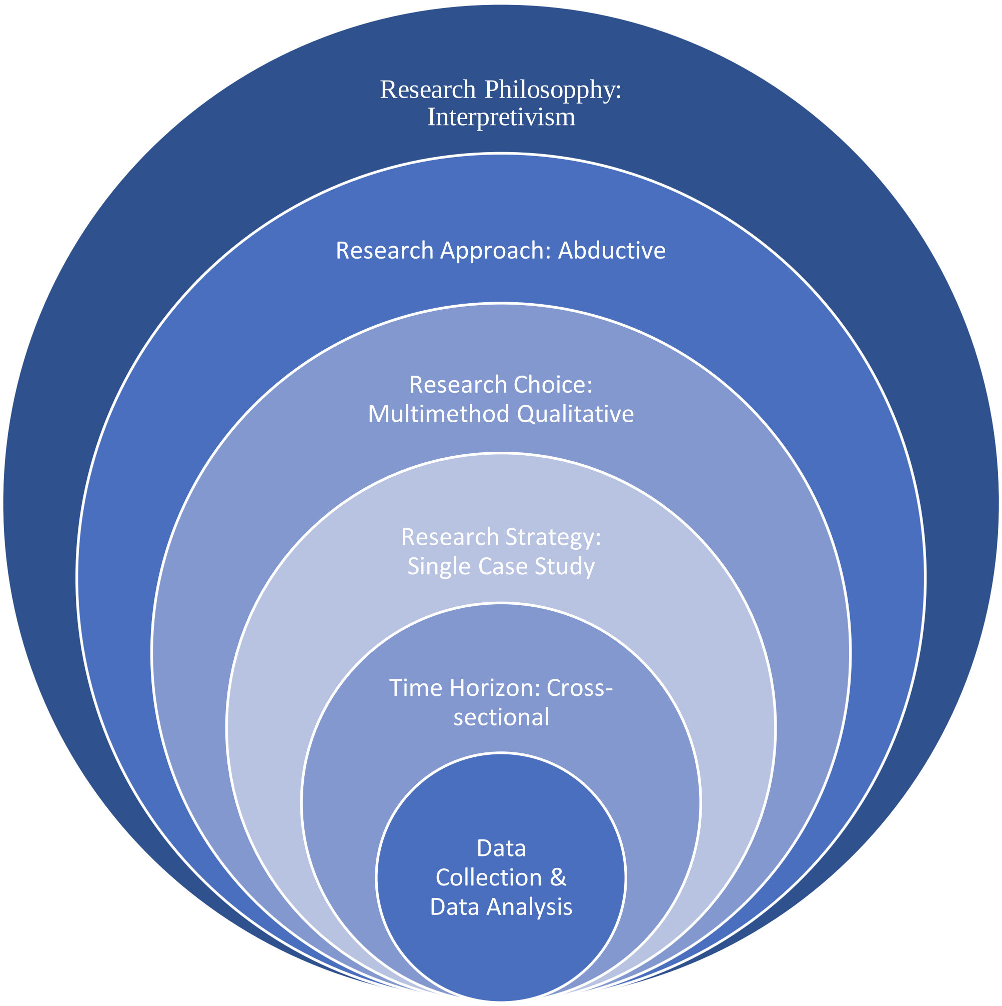
Appendix 1

Data–Value Chain: Nine-factor framework characterizing data-based value creation in information-intensive services (Lim et al., 2018)



Appendix 2

Research Onion. Adapted from Saunders et al. (2007)



Appendix 3

List of interviews

Interviewee initials	Position	Date
Interviewee 1	Director	11-Mar
Interviewee 2	Director	15-Mar
Interviewee 3	Support Director	15-Mar
Interviewee 4	Director	16-Mar
Interviewee 5	Service Manager	16-Mar
Interviewee 6	Director	17-Mar
Interviewee 7	Manager	17-Mar
Interviewee 8	Director	18-Mar
Interviewee 9	Director	18-Mar
Interviewee 10	Director	19-Mar
Interviewee 11	Director	23-Mar
Interviewee 12	Manager	23-Mar
Interviewee 13	Senior Manager	25-Mar
Interviewee 14	Sales Manager	01-Apr
Interviewee 15	Director	03-Apr
Interviewee 16	Director	12-Apr
Interviewee 17	Director	13-Apr
Interviewee 18	Director	14-Apr
Interviewee 19	Director	14-Apr
Interviewee 20	Sales Manager	15-Apr
Interviewee 21	Manager	15-Apr
Interviewee 22	Service Manager	20-Apr
Interviewee 23	Sales Manager	21-Apr
Interviewee 24	Sales Manager	21-Apr

Appendix 4

Interview Guide

General question

1. Tell us briefly about yourself and the company.
1a. Can you elaborate on your business set up and does it vary with the country?
2. What are customers expectations and needs with regard to connected services and service-related demands? What do you think are the drivers of these demands?
2a. Which of the above demands are being met by the OEMs? How are you meeting the remaining demands?
2b. Would customer prefer an OEM over a third-party service provider for the additional services?
3. What kind of additional services do you think are the customers willing to pay for?
4. What kind of services are demanded by your customers?
5. Where do you see yourself in the electromobility and connected services value chain?
6. What are your perceived threats from the connected service sector?
7. Who do you see as your competitors?
8. How do you think will the industry change if the bus is used as a product as a service?
9. How does your company strategically manage the different levels of market maturity related to connected services?

Questions related to current offerings and services

1. What kind of data are collected from the vehicle? How are they collected?
2. Are there any in-house platforms that collect, store or transmit data to and from the vehicle?
3. What happens to the data collected from the vehicle?
4. How is the information obtained from the vehicle data used?
5. How can this information help in monitoring and tracking vehicle and driver behaviour?

Questions related to challenges faced

1. Can the vehicle collect fault code data in real-time?
2. What information is further required to make a packaged service offering?
3. What are the challenges related to the analysis of vehicle data?
4. What are some customer grievances related to the current service offerings? What can be done to improve them and address those issues?
5. How can this information help in predictive maintenance and proactive fault diagnosis in vehicles?

Questions related to future trends and customer expectations.

1. Is information transmitted from the central database to the vehicle?
2. How does being an automobile manufacturer help/hinder the process of providing data-driven service propositions?
3. What kind of information are the customers looking for?