A Study on Corporate Social Responsibility Impact Analysis and Design for Environment

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A Study on Corporate Social Responsibility Impact Analysis and Design for Environment

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Abstract

In recent years, companies are expected to coexist with society and the environment. In order to respond to changing social conditions and consumer needs, it is a challenge to clarify customer perspectives toward the companies. This paper proposes and demonstrates a causal structure model of corporate social responsibility (hereinafter referred to as CSR), cost of ownership, quality dimensions, customer satisfaction, and customer loyalty. In addition, the assurance case was applied to the environmentally conscious design of automobiles, and the effectiveness of the assurance case was verified. The results of this study aim to obtain knowledge that will help strategic decision making in corporate efforts toward society and the environment. This paper consists of three studies in the automotive industry. The first study compares the causal structure of automobile serviceability, cost of ownership, CSR, customer satisfaction, and customer loyalty across countries based on the results of a questionnaire survey of automobile users in Japan and France. Exploratory factor analysis (hereinafter referred to as EFA) was used to extract the above five factors, and a hypothetical model was constructed from the extracted factors. Subsequently, confirmatory factor analysis (hereinafter referred to as CFA) and structural equation modeling (hereinafter referred to as SEM) were conducted. The results showed that CSR affects customer satisfaction in Japan, but not in France. In contrast to France, Japan places more importance on CSR, indicating that it is a factor that improves customer satisfaction. The second study examined the causal structure of CSR, social quality, perceived quality, customer satisfaction, and customer loyalty in Japan, where CSR influences customer satisfaction, by means of a questionnaire survey. The results showed that CSR was associated with customer loyalty. The results showed that CSR does not directly affect customer loyalty, but it does affect customer satisfaction through the mediation of perceived quality. Social quality was also found to affect customer satisfaction through the mediation of perceived quality, although it does not directly affect customer satisfaction. The second study showed that perceived quality is a mediator of CSR and social quality. In the third study, the assurance case was applied to the management of Design for Environment (hereinafter referred to as DfE), which is one of the initiatives listed as a CSR promotion item. We proposed an assurance case description method to be applied to the process of conceptual design based on evidence from multiple studies at the product planning stage in DfE for automobiles. As a result, it was shown that the assurance case enables the person in charge to act autonomously by visualizing the work process in the execution of DfE. In this paper, we clarified the causal

structure of customer intentions and the improvement of customer satisfaction in the social trends surrounding the automobile industry, and visualized and structured the environmentally friendly design process.

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Chapter 1 Introduction

1.1 Background

Twenty years have passed since the beginning of the 21st century, but human society is faced with global problems such as the global environment, poverty, disparities, and cultural conflicts. Wakabayashi (2022) mentions that there are still many problems with long-term development, that is, sustainable development. A representative definition of the 1987 United Nations World Commission on Environment and Development final report was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their needs." At the United Nations Conference on the Global Environment in 1992, social aspects such as poverty, education, and discrimination were included in addition to the environment and economy, and it was argued that the environment, economy, and society should develop in a balanced manner (Wakabayashi, 2022). The 2015 United Nations Sustainable Development Summit adopted the Sustainable Development Goals (SDGs). Along with this, all countries are asking for the participation of governments, companies, NGOs, and the general public. Companies need to develop strategies for the 17 Sustainable Development Goals. The 17 goals include social and environmental themes and other objectives that manufacturers and other companies should address. There are also various government-led initiatives regarding the SDGs: the SDG Action Plan 2020 (Ministry of foreign affairs of Japan, 2019), which was announced at the end of 2019. “The SDGs Action Plan 2020” will continue to have the following three frameworks in 2019. The first one is promotion of "Society 5.0" linked to SDGs. Second one is creation of local communities and development of resilient, environmentally friendly, and third one is attractive cities driven by the SDGs empowering the next generation and women as bearers of the SDGs. For these initiatives, Japan is providing $900 million in SDG-related support and $3 billion in initiatives, or a total investment scale of about 400 billion Japanese yen (Ministry of foreign affairs of Japan, 2019). It is very significant that the Japanese Cabinet would consider such a scale of investment, and it is an indication of Japan's attitude toward the SDGs. As the Internet evolves and everything becomes connected, the value chain, on-site operations, the nature of services, and the relationships among people are rapidly changing on a global scale. Society is in a constant state of change, but society is still consuming energy such as oil and coal as before. As a result, the amount of carbon dioxide in the atmosphere has increased by about 40% compared to pre-industrial times. It is said

that the amount of carbon dioxide emissions and the increase in the global average surface temperature have a roughly proportional relationship, and therefore, if humans continue to engage in similar activities, the global average temperature is expected to increase, which may cause various problems. Therefore, it is necessary to address environmental issues within a global framework, and numerous treaties and international laws have been enacted, with each country trying to work in the same direction to protect the environment.

Due to the above social situation, a large change has been brought about in Corporate Social Responsibility (CSR). First of all, corporate social responsibility is emerging in the fields of environment, society and politics. Corporate improvement activities and organizational reforms in environmental and social aspects, which are also listed in the 17 goals of the SDGs, are essential. Policy coordination is also essential. In addition, instead of silently accepting this responsibility, companies are expected to explain to society how to take it, and are required to issue and disseminate CSR reports. Herein, according to Robins (2013), the definition of corporate social responsibility is not limited to legal and economic obligations, but also to act correctly, to be useful to society, and to respond to social needs. And the company's triple bottom line (Figure 1.1) is emphasized. In other words, the point is to carry out sustainable corporate management with an emphasis on the economic, society, and environment.

However, there are cases where the discussion of sustainable economy and sustainable corporate business is interpreted as being too macroscopic. Wakabayashi points out that macro-level discussions (environmental ecosystems, global society, etc.) and micro-level issues (corporate behavior, business activities) are being discussed together and deterministically (Wakabayashi, 2022). Sustainability for a business organization is to "contribute to goals and results that increase sustainability over the long term," mainly with the goals set in the SDGs (Feeney et al., 2022). On the other hand, it is important to discuss whether corporate business can be sustainable (Dyllick et al., 2016). Table 1.1 shows the view point of sustainable business. Dyllick et al. (2016) referred the limitation of traditional market economy model. First issue is the bias toward short-term results rather than long-term perspective. Second issue is to emphasize only financial capital and neglecting psychological and social capital. Third issue is Negligence of accountability in environmental and social aspects. Therefore, in order to implement sustainability management, it is necessary to consider the perspective which is showed in Table 1.1 rather than sticking to the conventional business model. In addition to environmental measures, it is also important to consider the many unspecified people who live socially in the municipality, other than those involved in the project. Examples include noise and odor problems. Noise and odors are classified into different categories

according to the type of reduction, etc., but all of them are unpleasant to an unspecified number of people other than the people concerned, and they are obstacles to a comfortable life. In Japan, a number of laws have been enacted to address these issues, and efforts are being made to create a society that takes into consideration not only the environment but also unspecified third parties other than those involved. The following are examples of products found in the market that are considered to meet social quality standards. For end products that end up in the hands of users, it has become common to see commercials that promote products with improved energy-saving and water-saving functions that have less impact on the environment. In addition, it is necessary to understand the local situation and conduct such efforts globally according to the local situation. For example, there is knowledge gained from a case study on Toyota Motor Corporation and its way of global knowledge creation. Toyota's knowledge creation shift from simply transferring knowledge from Japan to subsidiaries and affiliates around the world to focus on creating knowledge in overseas markets by local staff and leveraging local tacit knowledge It shows that In fact, Toyota's new strategy of "learn locally, act globally" and its knowledge-based marketing approach in its international business development have successfully utilized the rich local knowledge base, giving it a competitive edge in the automotive industry. and secured the global lead (Ichijo, 2008). It is thought that it is necessary to promote activities for SDGs on a global basis by making use of such examples. Contributions to the SDGs have also been promoted at the same time. In recent years, some products have been seen to appeal to the public by incorporating functions to suppress noise and odors emitted by the use of the product so as not to bother people around. Increasingly, products that consider not only the environmental impact but also the impact on third parties are being developed. Examples of such products are diverse. For example, personal computers, mice, printers, and many other products.

In the automotive industry, which is an end-product industry, there have been many advertisements for improved fuel economy and less environmental impact, but in recent years, products that consider the impact on third parties and society, such as pedestrian protection and environmentally friendly eco-products, have also been increasing. The size of the Japanese automotive industry market is 63.9667 trillion yen in 2021-2022 (sum of the top 9 finished car manufacturers in terms of sales, including Toyota, Honda, and Nissan). In addition, according to a survey by OICA (International Automobile Manufacturers Association), the number of new vehicles sold in Japan in 2021 was approximately 4.45 million (Japan automobile manufacturers association, 2021). The reason for selecting the automobile as the subject of this study is not only because of its large industrial scale. While one reason is that we chose automobiles because of their

large industrial scale in order to maintain the generality of our research, the most significant reason is that "environment" and "society" are keywords in the automobile industry. In recent years, the development of smart cities, for example, has been seen as a change of the times, with automobiles, as mobility, fulfilling a function that is integrated with municipalities. In this study, automobile industry is focused on.

Companies have continued to work on their corporate social responsibility (CSR). CSR activities include the environmental and social initiatives described above. However, after COVID-19, the whole society has changed. Living in an internet environment is necessary and consumer's behavior is changed. Along with changes in consumer behavior, COVID-19 also brought changes to corporate activities. It is to discuss the issue of CSR and what firms are doing or should be doing in the face of a pandemic crisis. It is to discuss the question of what firms are doing or should be doing in the face of a pandemic crisis. To do so, however, requires a general discussion of CSR in order to establish a basis for analysis. Research and development is essential for a company to conduct sustainable management.

In recent years, ambidextrous management has become a key concept (Iriyama, 2019). In creating innovations and designing new concepts, it is necessary to promote "knowledge deepening" and "knowledge exploration" in a balanced manner. In its "deepening of knowledge" and "search for knowledge," when considering the creation of new discoveries, it is effective to go outside of cognition. It involves a change of location, i.e., movement. The difference in physical location shows the difference in ideas and perceptions that we think about there. It is effective for the same person who has specific profession to perform a move that changes location. And also, that person does not need to think seriously and deeply. It is important to relax and feel with sensitivity. (Iriyama, 2019). Uchida (2022) states that in order to create sustainable business models and innovations, it is necessary to explore the key factors that transform customer behavior.

Based on the above, the main objective of this study is to accumulate knowledge toward a sustainable society by investigating and demonstrating CSR and environmental and social issues at the R&D and planning stages in companies. And, this study is not limited to perception surveys only in a specific region, but will examine a wide area from urban to rural areas to obtain findings outside of location-based bias.

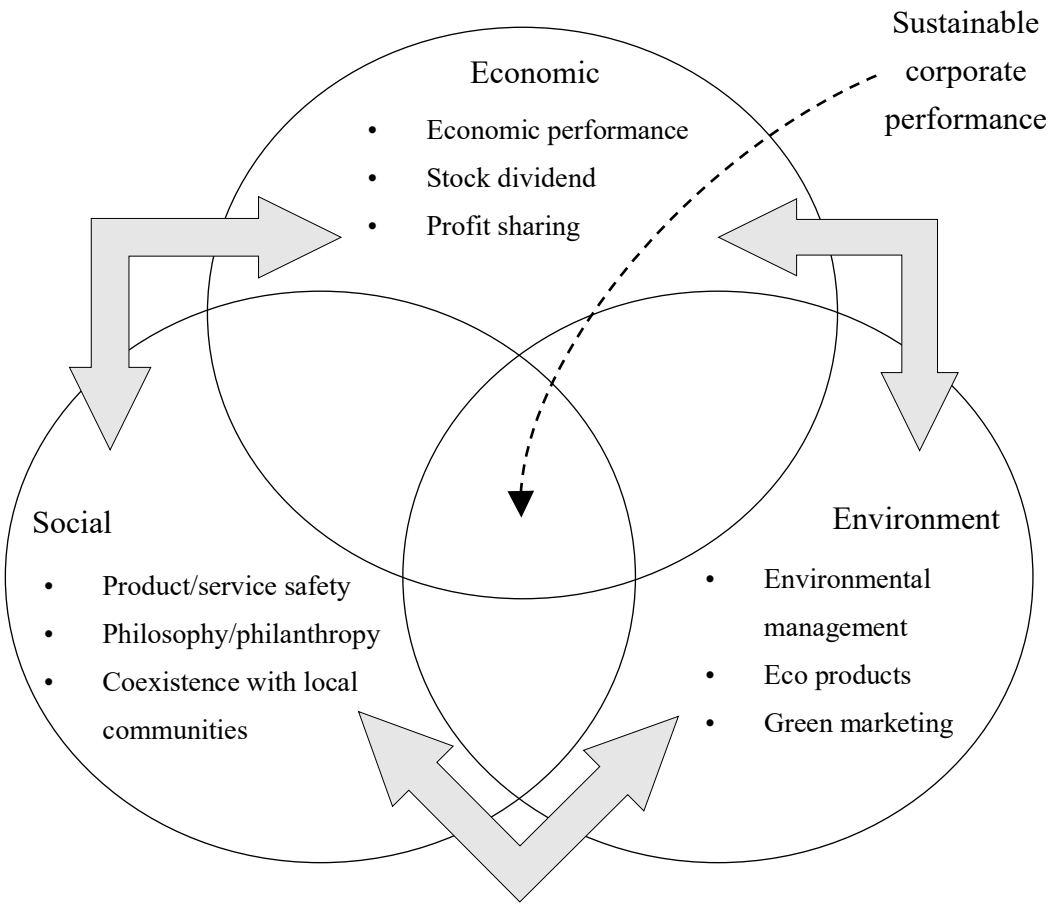


Figure 1.1: Triple bottom line as sustainable corporate performance and relationship (Added by the author to Fauzi et al. (2010))

Table 1.1: Business sustainability typology with key characteristics and shifts and company management activities
(Added by the author to Dyllick et al. (2016))

Business sustainability typology	Concerns	Values created	Organizational perspective
Business-as-usual	Economic concerns	Shareholder value	Inside-out
Business Sustinability 1.0	Environment, Social, Economic concerns	Refined shareholder value	Inside-out
Business Sustinability 2.0	Environment, Social, Economic concerns	Triple bottom line	Inside-out
Business Sustinability 3.0	Starting with sustainability challenges (SDGs compass)	Creating value for the common good (Creation of new business value)	Outside-in
The key shifts involved:	1st shift: Broadening the business concern	2nd shift: Expanding the value created	3rd shift: Changing the perspective

1.1.1 Definition of CSR and literature review

Corporate Social Responsibility (CSR) refers to efforts by companies to contribute to sustainable development by fulfilling their social, environmental, and economic responsibilities. According to Carroll (1991), CSR encompasses four dimensions: economic responsibility, legal responsibility, ethical responsibility, and charitable responsibility, and companies are expected to fulfill these responsibilities appropriately. And also, further surveys of business executives also found that the relative values or weights of each of the components as implicitly depicted approximated the relative degree of importance placed on the four components (Aupperle et al., 1985; Pinkston and Carroll, 1996; Edmondson and Carroll, 1999). Carroll (2016) described that the economic responsibility is a baseline requirement that must be met in a competitive business world. Economic responsibility means making a profit, legal responsibility means complying with the law, ethical responsibility means acting in a fair and equitable manner, and charitable responsibility means meeting the needs of society. By properly fulfilling these responsibilities, a company can meet society's expectations and contribute to sustainable development. After 2019, the COVID-19 pandemic was found to have important implications and implications for most areas and sectors of business. It was found to have important implications and implications for most areas and sectors of the business community. Employees, consumers, and communities have been most affected. The global pandemic has put CSR to the test, and has confirmed the efforts of many companies to rethink their CSR approach and behavior. Evidence is emerging to support the notion that many companies are striving to reset their CSR thinking and efforts in response to this crisis and to meet society's expectations (Carroll, 2021). Covering the four dimensions of CSR (environmental protection, society, employees, and governance), the report examines the impact of CSR activities on employee attitudes and behaviors, and shows that CSR contributes to employee satisfaction, commitment to the organization, and improved performance in the workplace (Gond et al., 2017). Peloza and Shang (2011) focus on four dimensions to investigate how CSR activities create value for stakeholders: environmental protection, society, employees, and governance. They find that CSR activities improve corporate reputation, customer loyalty, employee satisfaction, and investor confidence. Hence, this study focuses on investigating the impact of CSR on customer loyalty and customer satisfaction.

1.1.2 Definition of quality and literature review

Before touching on quality, it is necessary to discuss "ility". “ility" is a required

characteristic of a system, such as flexibility or maintainability, that is often considered to appear after the system is first put into use. Of the "ility," the classic one is quality. Although there is a large body of literature on quality, the main points are discussed below, citing the literature that forms the basis of this thesis. “ility” occupies a very important meaning when considering software architecture. There are various types of “illity”. Some indicate quality characteristics, some include the meaning of operability and availability, some include reliability and durability, and so on. These are classified as traditional types of “ility”. On the other hand, in today's world of continuous evolution from the invention of transportation, communication, and electric power to complex systems, extensibility and robustness are added in the era of complex systems. It is further noted that in the era of engineering systems, resilience, flexibility, and sustainability will become more important (De Weck et al., 2014). As “Quality”, “Cost”, “Delivery” are often used as a measure of competitiveness in manufacturing, quality is recognized as an important element of competitiveness. One of the most important quality stories is that of W. Edward Deming. Deming has a history of promoting statistical process management methods in Japan to those who are entrusted with business leadership. Deming is said to have told Japanese managers that they could reduce costs by improving quality, while at the same time increasing productivity and market share. Taguchi was a Japanese engineer and statistician who in the 1950s applied statistics to develop a method to improve the quality of manufactured goods. Taguchi (1986) extended Deming's ideas and introduced additional new concepts. For some products, physical satisfaction is user satisfaction, while for others, it is not considered sufficient. Kano (1984), one of researcher in Japanese quality control, named the former "attractive quality" and the latter "natural quality" for "quality elements that give satisfaction if they are fulfilled, but are perceived as inevitable if they are insufficient" and "quality elements that give satisfaction if they are fulfilled, but cause dissatisfaction if they are insufficient. Thus, although "quality" is defined, its concept, measurement, etc. are not always clear. Garvin (1987) states that quality can be divided into the following five categories (Ross, 2006). It can be seen that each automobile maker focuses on five different quality perspectives. The first one is “User satisfaction concept”. This is to satisfy the customer from the customer's point of view. The perspective in this thesis is the "user satisfaction concept". Second one is “Transcendental quality concept”. This perspective means the highest quality, including beauty, aesthetic sense, and other five senses that people feel. Third perspective is “Product attribute concept”. This perspective means superior performance and functionality. Forth perspective is “Product quality concept”. This means the product must be built according to the design specifications that incorporate the initial aims of the

project. Finally, fifth one is “Value concept”. This means excellent cost performance and cost-effectiveness and excellent cost-effectiveness and confirmed superiority in cost-effectiveness. Also, the customer must determine that there is a desired value for the product. Many researchers have discussed definitions of quality elements of products, and among these discussions, the eight quality elements proposed by Garvin (1987) are widely recognized. The eight elements are as follows Performance, Features, Conformance, Durability, Reliability, Serviceability, Aesthetic, Perceived Quality. The following is an overview of the 8 dimensions in turn.

1.1.3 Definition of customer satisfaction and customer loyalty

The concept of customer satisfaction is often used to evaluate products and services. Customer satisfaction is generally defined as "the feeling generated by the difference between customers' expectations of a company, product, or service and their perception of the degree of achievement of those expectations. Regarding "customer expectations" in the definition, Zeithaml et al. (1996) states that there are two levels of "customer expectations": "the level of desirable products and services" and "the level of reasonable products and services. If a product or service falls between the above two levels, it is considered to be an acceptable level. If the customer perceives that the product/service exceeds the "desirable product/service level," the customer will be "very satisfied" with the product/service. On the other hand, if the customer perceives that the product or service is provided below a "reasonable level of product service," the customer becomes "dissatisfied" with the product or service. As the definition shows, customer satisfaction is affected not only by the level of product/service but also by the level of expectation. Naturally, the level of expectation differs from customer to customer. In order to reduce the influence of differences in the level of expectations, it is important for a company that provides a product or service to control the level of expectations held by its customers in order to obtain high customer satisfaction.

In other hand, the concept of customer loyalty has been emphasized in addition to customer satisfaction. The concept of customer loyalty is defined by Reichheld (2003) as follows. Customer loyalty is the customer's willingness to continue to receive and purchase products and services from a company. Dick (1994) defines customer loyalty as "the willingness of a customer to continue to purchase a product or service from a company" classified customer loyalty based on these two aspects. A truly loyal customer is a customer who repeatedly purchases a product and has a strong attachment to that product, and increasing the number of such customers is a goal of a company. Potentially

loyal customers are customers who like the product but have not yet reached the point of purchase behavior, and companies should target these customers to acquire new customers. Customers with show loyalty are customers who repeatedly purchase the product but do not have a particularly favorable impression of the product, and companies should be aware that these customers may switch to other products if the restrictions are removed. Customer loyalty is measured by actual behaviors such as purchase intention, actual purchase amount and number of purchases. Reichheld (2003) also found that customer loyalty is measured by the question "Would you recommend this company (product or service) to your friends and colleagues? Reichheld (2003) claims that customer loyalty can be effectively measured by the question, "Would you recommend this company (product or service) to your friends and colleagues?". Suzuki (2006) has conducted empirical research with a number of companies and industries to examine how customer satisfaction affects customer loyalty. The results of this study showed that higher customer satisfaction also increases customer loyalty. This suggests that customer satisfaction leads to customers' continued purchase intentions and recommendations to the company through word of mouth, which in turn increases customer loyalty. Suzuki's study shows that companies can increase customer loyalty and long-term success by improving customer satisfaction. Moreover, Syahrial et al. (2018) research focuses on the relationship between customer satisfaction and customer loyalty. In his study, Syahrial et al. (2018) examines how customer satisfaction influences customer loyalty in various industries and contexts. They found that higher levels of customer satisfaction lead to increased customer loyalty, which in turn results in customers continuing to make purchases and recommend the company to others through word-of-mouth. Based on the above, in this study, as in previous studies, we believe that there is a strong correlation between customer satisfaction and customer loyalty and treat it as such.

1.2 Social issues and research overview

Global initiatives continue to be taken against the SDGs, including the United Nations. At summits such as the G7, interest has shifted from efforts to prevent global warming in the 2000s to decarbonization and carbon neutrality in the 2010s, and to climate change in the 2020s. Sustainability has long been a key word in the accumulation of such global concern and proposals for global environmental issues. Since the 17 goals of the SDGs were set as targets, the world has been led in setting goals and investing budgets. The Cabinet Office of the Japanese government has also been compiling the report under orders from the Prime Minister's Office. In the private sector's approach to the SDGs,

industry and government have been working together to promote the SDGs. This study will focus on the guidelines promoted by government agencies, ministries, and the Cabinet Office to clarify the social issues and key elements of Japanese companies' global approach to the SDGs. Table 1.2 shows summary of social issues and corporate commitment of companies. First, the SDG Action Plan (Ministry of Economy, Trade and Industry, 2021) discusses digital transformation, referring to Society 5.0 promoted by the Cabinet Office. At the same time, it provides a direction toward resource reuse that promotes recycling and the realization of a carbon-neutral society. It is also stated that partnerships and joint operations with the community and various local governments will be necessary to promote these efforts. Throughout, environmental preservation and effective use of resources are keywords that are part and parcel of the issues being addressed and recognized. In response to these issues, companies need to promote management and corporate structures that take environmental protection into consideration. Second, the Guide for SDGs Business Management (Ministry of Economy, Trade and Industry, 2019) states that simultaneous realization of economic, social, and environmental value. Symbiosis and harmony between the environment and society enrich people's lives and are indispensable for the realization of Quality of Life. Companies are also required to build a sustainable foundation for the environment and society, and they need to publicize the results of their efforts. Therefore, the creation of innovation and collaborative creation are listed as items to be addressed, and in many areas national budgets are also being invested to promote technological innovation. It also mentions the need to plan and manage projects that take into account the product or service, as well as the project life cycle. From the above, the Guide for SDGs Business Management (Ministry of Economy, Trade and Industry, 2019) consistently guides companies in their environmental and social efforts, and social responsibility in corporate activities is a perspective. Third, SDG Compass (GRI, UNGC and WBCSD, 2016) is taken up. The SDGs will be a joint effort by industry, business, and politics. The important point of view is that companies should not go it alone. It is stated that stakeholders should expand the scope of exchanges of opinions and areas of cooperation, and work together as one. Hence, the emphasis is consistently on customer-centric management. Forth, TQM Activities and Quality Management Activities Stage Up Guide (Union of Japanese Scientists and Engineers, 2015) is picked up. Many companies, such as Toyota Motor Corporation, place quality at the center of their corporate management. Sony, Panasonic, Toshiba, and other electronics manufacturers also place quality at the center of their corporate management and have dedicated organizations for this purpose. In addition, on the factory floor, QC circles are held regularly to promote improvement activities on a

daily basis. In addition, they are developing company-wide implementation of quality management systems and environmental management systems. Guidelines have been developed for such efforts. Also, quality can be expressed in one word: product quality, service quality, and so on. Quality is also categorized into attractive quality and natural quality (Kano, 1984), which are also incorporated into the marketing activities of companies. Consistently, quality first is a corporate proposition.

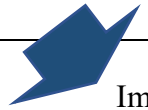
In the automotive industry, companies are expected to coexist with society and the environment. In order to respond to changing social conditions and consumer needs, it is a challenge to clarify customer perspectives toward automobiles and automobile manufacturers. This paper proposes and demonstrates a causal structure model of corporate social responsibility (CSR), cost of ownership, quality dimensions, customer satisfaction, and customer loyalty. In addition, the assurance case was applied to the environmentally conscious design of automobiles, and the effectiveness of the assurance case was verified. The results of this study aim to obtain knowledge that will help strategic decision making in corporate efforts toward society and the environment. This paper consists of three studies in the automotive industry. The first study compares the causal structure of automobile serviceability, cost of ownership, CSR, customer satisfaction, and customer loyalty across countries based on the results of a questionnaire survey of automobile users in Japan and France. Exploratory factor analysis (EFA) was used to extract the above five factors, and a hypothetical model was constructed from the extracted factors. Subsequently, confirmatory factor analysis (CFA) and structural equation modeling (SEM) were conducted. The results showed that CSR affects customer satisfaction in Japan, but not in France. In contrast to France, Japan places more importance on CSR, indicating that it is a factor that improves customer satisfaction. The second study examined the causal structure of CSR, social quality, perceived quality, customer satisfaction, and customer loyalty in Japan, where CSR influences customer satisfaction, by means of a questionnaire survey. After confirming the validity of the measurement model by CFA, the total and mediation effects were examined by SEM and bootstrapping. The results showed that CSR does not directly affect customer loyalty, but it does affect customer satisfaction through the mediation of perceived quality. Social quality was also found to affect customer satisfaction through the mediation of perceived quality, although it does not directly affect customer satisfaction. The second study showed that perceived quality is a mediator of CSR and social quality. In the third study, the assurance case was applied to the management of Design for Environment (hereinafter referred to as DfE), which is one of the initiatives listed as a CSR promotion item. We proposed an assurance case description method to be applied to the process of conceptual

design based on evidence from multiple studies at the product planning stage in DfE for automobiles. As a result, it was shown that the assurance case enables the person in charge to act autonomously by visualizing the work process in the execution of DfE. In this paper, we clarified the causal structure of customer intentions and the improvement of customer satisfaction in the social trends surrounding automobiles, and visualized and structured the environmentally friendly design process.

Table 1.2: Summary of social issues and corporate commitment of companies

Literature	Citation	Extracted social issues	Corporate commitment to social issues of companies
SDGs Action Plan	(Ministry of Economy, Trade and Industry, 2021)	• Society 5.0 and Digital Transformation • Sustainable, recycling-oriented society • “Carbon neutral" with virtually zero greenhouse gas emissions • Local SDGs public-private partnership platform	• Environmental conservation initiative
The Guide for SDGs Business Management	(Ministry of Economy, Trade and Industry, 2019)	• Simultaneous realization of economic, social, and environmental value • Materiality setting • Innovation Creation and Collaboration • Product life cycle and environmental impact reduction	• Emphasis on social responsibility
SDG Compass	(GRI, UNGC and WBCSD, 2016)	• Inclusive collaboration with stakeholders • Stakeholders paying close attention to issues, interests, concerns, expectations, etc. of stakeholders • Customer oriented	• Customer-oriented management
TQM Activities and Quality Management Activities Stage Up Guide	(Union of Japanese Scientists and Engineers, 2015)	• TQM and quality management activities • Activity status monitoring of TQM and quality management activities • Scoring Assessment and Diagnostics • Understand current status, overcome weaknesses, and raise the level of TQM activities	• Quality-first management

Table 1.3: Corporate commitment and existing literature

Corporate commitment to social issues of companies			
Environmental conservation initiative	Emphasis on social responsibility	Customer-oriented management	Quality-first management
View point of CSR and social quality (Carroll, 2016; Carroll, 2021; Schvaneveldt, 2005; Schvaneveldt, 2011)			
			
Customer needs / Clarification of customer perspective (Carroll, 2021; Suzuki et al., 2018; Syahrial et al., 2018)		Environmental and social requirements into product / service (Ministry of Economy, Trade and Industry, 2019)	
			
(Research 1) Social Perceptions of Corporate Social Responsibility and Garvin's Quality Dimensions		The environmentally friendly design of products The social friendly design of products (Raz et al., 2013; Spence, 2016)	
	(Research 2) Impact of perceived quality, social quality and corporate social responsibility on customer perceptions and the effect of the mediating role of perceived quality		
		(Research 3) Visualizing the Project of Design for Environment to Improve the Feasibility for Corporate Social Responsibility	

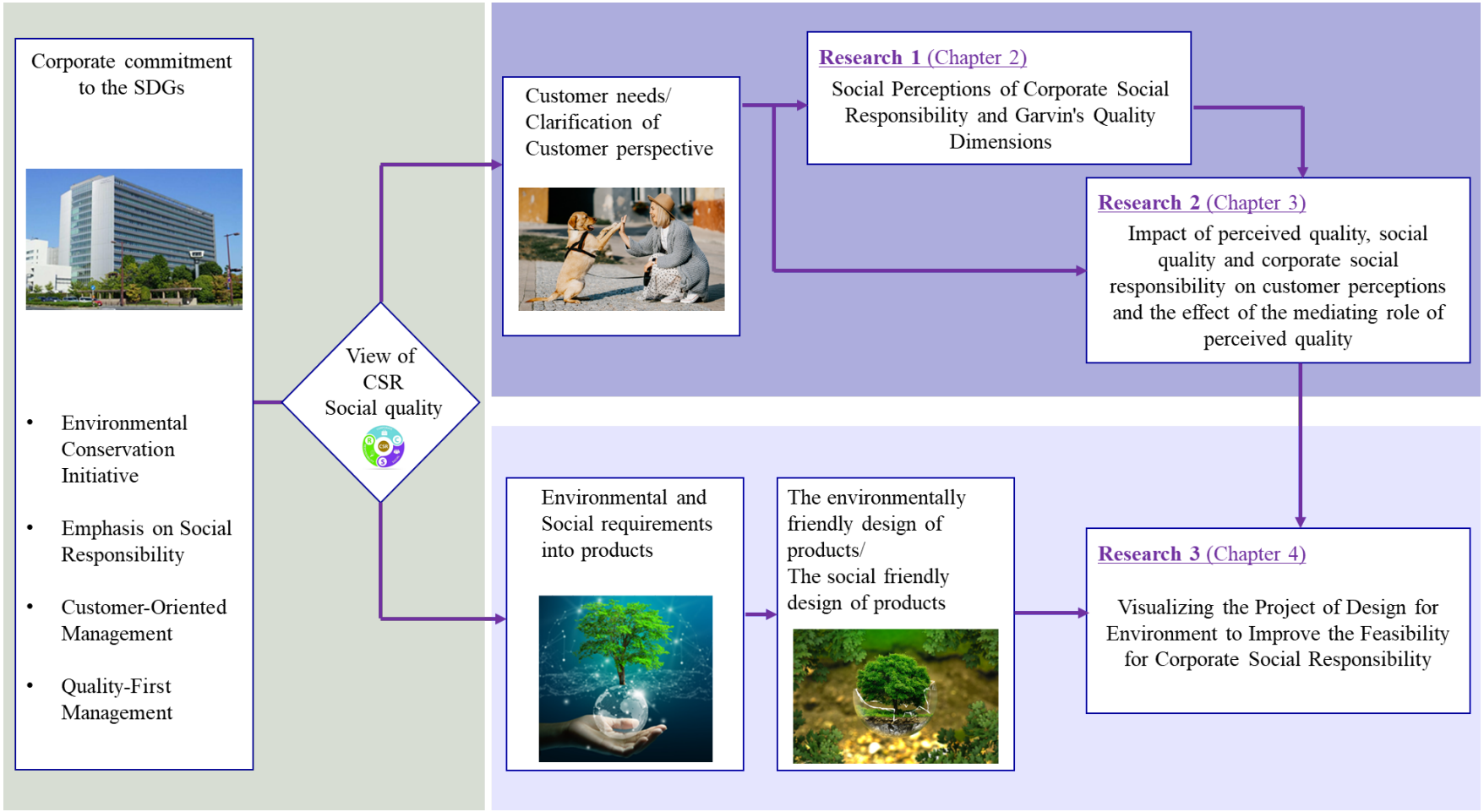


Figure 1.2: Schematic of three interrelated studies

1.3 Research objective

Before conducting this study, which is important to current and future researchers and practitioners, we surveyed the literature for studies that contribute to CSR and environmental quality and identified issues to address. There are several motivations for conducting three interrelated studies.

In the first study, while companies are expected to coexist with society and the environment, and while there is a growing body of knowledge on the causal structure between product quality, including automobile serviceability, cost of ownership, customer satisfaction and customer loyalty, little has been done to conduct cross-national research that takes CSR into account This is one of the reasons why cross-national surveys have rarely been conducted, taking CSR into account. In this study, we attempted to compare the differences in causal structure between Japan and France.

Second, despite the attention paid to social quality and CSR, little empirical research has been conducted to clarify the causal structure to customer satisfaction and customer loyalty mediated by perceived quality from the customers' perspective. This study examines the causal structure of social quality and CSR on customer satisfaction and customer loyalty by examining the direct effect and the indirect effect mediated by perceived quality.

As for the third study, one of the issues was the attribution of personnel in charge to manage Design for Environment (hereinafter referred to as DfE), where environmental consideration is regarded as social quality, and managing DEF is one of the items to promote CSR. Therefore, in this study, the DfE process was visualized, and an assurance case that does not depend on the knowledge of the person in charge was created and applied. The effectiveness of the system was also verified and its effectiveness was confirmed.

From the above research, along with the effects on customer satisfaction regarding CSR, social quality, and serviceability, we have accumulated effective knowledge on the actual implementation of DfE in the automotive industry as a case study. This is important for the future SDGs and other corporate social and environmental coexistence.

1.4 Guideline of the thesis

The remaining chapters of this thesis are organized as follows. Chapter 2 through Chapter 5. Chapter 2 describes each of the studies entitled "A France-Japanese Comparison of the Impact of CSR, Service Quality, and Cost of Ownership on Customer Satisfaction and

Customer Loyalty." The automotive industry is discussed and the importance of serviceability and cost of ownership is explained from the perspective of Syahrial et al. (2018) firms, and then CSR is incorporated into the dimension by focusing on social and environmental characteristics, which have been the focus of attention in recent years. Using a newly developed conceptual model, the causal structure of these dimensions, customer satisfaction, and customer loyalty is compared from the perspective of automobile customers in Japan and France by country. Chapter 3 clarifies the causal structure in which CSR and social quality influence customer satisfaction through perceived quality, and explains the dimensions of perceived quality and social/environmental characteristics, which have been attracting attention as social conditions have changed since COVID-19, from the customers' perspective using a newly developed conceptual model. Chapter 4 applies the assurance case to the Design for Environment (DfE) process, one of the items promoted in CSR, and proposes a management methodology in which the person in charge acts autonomously and executes the project without relying on the genus. Chapter 2, Chapter 3 consist of an introduction, literature review on key terms and establishment of hypotheses and conceptual model, methodology, results of analysis, discussion, conclusions, and managerial implication. Chapter 4 consists of an introduction, literature review, methodology, results and discussion, conclusions, and future research describing. Chapter 5 discusses the overall conclusions of this thesis. In terms of the appropriate methodology for each individual study, the first study requires a search for appropriate measurement items belonging to the extracted constructs. Therefore, in research 1, an exploratory factor analysis (EFA) based on the customer's perspective was initiated first, followed by a confirmatory factor analysis (CFA), and then structural equation modeling (SEM) was conducted. For the research 2, hypotheses were developed from the dimensions of existing research. For the hypothesized model, CFA was conducted to confirm the validity of the measurement model, followed by mediation effect validation using SEM and bootstrapping methods. On the other hand, research 3 proposed application of an assurance cases using Goal Structuring Notation (GSN) proposed by Kelly et al. (2004) to Design for Environment (DfE). For effectiveness testing, tests of corresponding differences are conducted before and after the assurance case application.

Chapter 2 Comparison of Japanese and French customer's perceptions of corporate social responsibility and serviceability and ownership cost

2.1 Introduction

The quality management system (QMS) is intended to be integrative element which brings together aspects of the company, the core business domain and customer satisfaction, integrating people, processes, regulatory requirements, technology, risks and opportunities, with the main purpose of delivering the best practice (Seljan, 2018). In order to improve the quality of products, Japanese quality management has been recognized worldwide, especially for its success in increasing efficiency and reducing costs (Akiba et al., 1992). For this purpose, it is useful to consider various quality dimensions, such as the eight quality dimensions proposed by Garvin (1987): performance, function, fit, aesthetics, perceived quality, reliability, durability, and maintainability. In recent years, other scholars (Hazen et al., 2016; Yogi, 2016) have continued to examine Garvin's quality dimensions in various fields as a way to understand and meet customer demands for product quality and to bridge the gap between changing consumer demands. On the other hand, Corporate Social Responsibility (CSR) is gaining attention as a way to enhance brand image, as various customers have recently begun to take a stronger interest in corporate ethics and sustainable development. Considering the positive brand reputation generated by CSR and the criticism surrounding it, the impact of CSR on customer behavior has been studied since its introduction. As an approach to environmental, social, and governance investments and sustainable development goals (SDGs), the corporate endeavor needs to be implemented based on the guidelines of United Nations (United Nations, 2019) and Ministry of economy, trade and industry of Japan (Ministry of economy, trade and industry of Japan, 2019). According to the Stern Review on the Economics of Climate Change (Banerjee, 2007), The Economist (Barnett, 2007; Barnett et al., 2006), ecological sustainability could become the central social responsibility challenge for business. Thus, managers must be able to determine how their organizations can become more socially responsible, ecologically sustainable, and economically competitive (Orlitzky et al., 2011). Against this background, further research from the customer perspective on automotive quality is important for the

continued development and success of the automotive industry. Although existing research has shown that Garvin's quality dimension provides significant benefits to manufactured products, however, no studies have been conducted that simultaneously take into account Garvin's quality dimension in the context of the customer's perspective in CSR.

Therefore, research objectives of this study is aimed at three main objectives as follows. First one is that to determine relevant variables of serviceability, ownership cost, customer, CSR, customer satisfaction and customer loyalty have to be determined through the factor analysis. Second one is that to conduct an empirical study and then test the hypotheses for entire relationships. And third one is that to clarify national differences between Japan and France.

The remainder of this paper is organized as follows: In 2.2, previous studies are explained. In 2.3, the methodology of analysis is presented. 2.4 presents discussion and implication. Finally, 2.5 concludes this research and discusses future research topics.

2.2 Previous studies

Garvin (1987) attempted to bring together these and other definitions through eight aspects of quality to guide manufacturers in providing high quality products. Based on Syahrial et al. (2018), this study extracted serviceability and ownership cost as dimensions that have a particularly high impact on customer satisfaction.

2.2.1 Serviceability

Serviceability refers to "speed, courtesy, and ability to repair" (Garvin, 1987). Maintainability, reliability, and serviceability are engineering and management functions that span the life cycle of a product or service. It is a characteristic of equipment design, installation, and operation, expressed in terms of ease and economy of maintenance, equipment reliability, and safety and accuracy of maintenance operations (Schmidt, 2018). It also states that to achieve a more sustainable development process, industry must not only improve energy efficiency and reduce costs, but also improve the wellbeing of operators to promote social sustainability (Peruzzini, 2017). Serviceability is one of the performance characteristics of the automobile that exists through the dealer as the point of contact between the automobile manufacturer and the user. Furthermore, we find reports that serviceability affects brand image. It has been pointed out that customer satisfaction is a variable that partially intervenes in the impact of product quality, brand

image, and price on customer loyalty (Khoironi et al., 2018). Since efficient after-sales service is essential from the customer's perspective, serviceability is expected to impact customer satisfaction, cost of ownership, and customer loyalty.

2.2.2 Ownership cost

Cost of ownership is a concept that goes beyond the initial product purchase and represents the total customer costs thereafter along the product life cycle (Ellram, 1994). The cost of ownership in automobiles is a major issue in passenger cars, where different powertrains compete in terms of reducing environmentally harmful emissions, smooth integration into future energy systems, and economy (Grube et al., 2021). However, it is difficult for customers to independently assess depreciation expense. Exclude depreciation as a component of cost of ownership to capture the benefits of cost of ownership for customer satisfaction and loyalty. Total cost of ownership is essentially a combination of purchasing and operating costs to select the most economical vehicle (Palmer et al., 2018). According to Faria et al. (2012), new vehicle purchases are directly linked to vehicle ownership costs, which customers should consider as depreciation. This is because, in addition to depreciation, fuel consumption for product operation has a great impact on the user's economy. When considering the total cost of ownership, it consists of running costs such as fuel costs, repair costs, insurance premiums, and the cost of purchasing the vehicle (Sutcu, 2020). Running costs over the period of car ownership are considered a major concern for users. This study examines the impact of cost of ownership on customer satisfaction and customer loyalty.

2.2.3 CSR

Since Sheldon first defined corporate social responsibility (CSR) in 1924, CSR has been examined from many angles. Since then, CSR has been examined from various angles. In fact, the relationship between stakeholder theory and stakeholder theory and CSR has been examined (Henriques, 2010). From a corporate perspective, CSR is a social influence and an important corporate resource. From this perspective, CSR is considered to be a social influence and an important corporate resource. It is thought to influence customers' perceptions of a company (Yuen et al., 2016). There are couple of types of social responsibility: voluntary social responsibility, such as charitable donations, and compulsory social responsibility. A couple of types of social responsibility have been proposed: voluntary social responsibility, such as charitable donations, and compulsory

social responsibility, which is defined by law or regulation (Frederick, 1983). Research often divides corporate CSR activities into four dimensions: environment, social environment, society, employees, and governance (Waller, 2016). The social dimension refers to how a company interacts with society, the employee dimension refers to how a company interacts with and treats its employees, and finally governance. Governance is how well a company controls its various aspects, and is also defined as a company's obligation to its shareholders (Waller, 2016). Defined but self-regulatory, companies have a choice of guidelines to disclose beyond the Global Reporting Initiative, which was established in 1997. Various studies have found new indicators (Rahdari and Rostamy, 2015) and composites. We propose indicators (Doˇ Calov´a and Kocmanov´a, 2016), which are used to evaluate companies' participation in CSR activities from a stakeholder-based perspective.

2.2.4 Customer satisfaction

Customer satisfaction is the customer's evaluation of a product or service based on the cumulative experience. According to a widely held view, customer satisfaction is the overall evaluation of a product after purchase (Fornell, 1992). The ACSI (American Customer Satisfaction Index) model (American Customer Satisfaction Index, 2023) is widely known as a method of measuring overall evaluative total satisfaction with a product or service. ACSI is a method to construct a causal model consisting of six constructs: customer expectation, perceived quality, perceived value, customer satisfaction, customer complaint, and customer loyalty, and to obtain the construct score of customer satisfaction in the model as customer satisfaction score. ACSI states that there is a causal relationship between customer satisfaction and customer loyalty. In this evaluation, customers consider their prior expectations of the product and their perceptions of the product's long-term performance. The products or services used can affect customer satisfaction. According to Crosby et al., (1990), customer satisfaction is the result of evaluating the quality of previous transactions between customers and organizations (Boulding, et al., 1993). As a result, future expectations of product or service quality are created. Customer satisfaction is the result of a customer's evaluation of the quality of previous transactions (Rust et al., 1994). Achieving high customer satisfaction reduces customer complaints about the organization and increases customer loyalty to the product (Fornell et al., 1987). Logically, companies that excel in these areas are rated higher and achieve better customer satisfaction. Moreover, satisfied customers have a more positive attitude towards products and are more likely to purchase again

(Chang, Wang & Yang, 2009).

2.2.5 Customer loyalty

Customer satisfaction and loyalty are well-known and well-established concepts in fields such as marketing, consumer studies, economic psychology, welfare economics, and economics. Especially in a highly competitive business environment, there is a big difference between satisfaction, which is a passive customer state, and loyalty, which is an active and proactive relationship with an organization. Some researchers argue that they are not physically correlated (Rahim et al, 2012). However, customer loyalty is an indispensable discussion when considering customer purchasing behavior. It is important for companies to find ways to ensure sustainability in the market and gain competitive advantage in the competition. As a result, customer loyalty is receiving more attention than ever before (Leninkumar, 2017). Duffy (1998) argues that building customer loyalty is more than just a marketing program, it's a business strategy, and every company should strive to increase loyalty and maximize customer share. Customer loyalty indicates a customer's willingness to repurchase similar products or services in the future (Zeithaml et al., 1996). A positive relationship between customer satisfaction and customer loyalty has been demonstrated by various studies (Flint et al., 2011). Customers responded by voluntarily promoting the products and services they experienced to third parties who sought their advice. Positive reputation is a strong representation from customers and is expected to enhance the manufacturer's image.

2.2.6 Research hypotheses

The purpose of this study is to establish the relationship between product serviceability, cost of ownership, CSR, customer satisfaction and customer loyalty. And to clarify the differences between Japan and France on a country-by-country basis.

Based on the relevant literature review, we propose five hypotheses. These relationships reflect customers' impressions of the serviceability they experience at car dealerships and their perceived costs during the period of ownership of the product. In addition, the novelty of the study is to incorporate customer perceptions of CSR, which has been the focus of much attention in recent years. We construct a model to test whether these factors affect customer satisfaction and customer loyalty. Based on the results of the above review of existing studies, the following hypotheses are proposed:

Hypothesis 1 (H1): Serviceability positively influences ownership cost
Hypothesis 2 (H2): Serviceability positively influences customer satisfaction
Hypothesis 3 (H3): Ownership cost positively influences customer satisfaction
Hypothesis 4 (H4): Corporate social responsibility positively influences customer satisfaction
Hypothesis 5 (H5): Customer satisfaction positively influences customer loyalty

Figure 2.1 is a hypothetical conceptual model representing the relationship between serviceability practices, cost of ownership, CSR, customer satisfaction, and customer loyalty in relation to all the components presented.

2.2.7 Research limitation

In this chapter, we discuss the limitations of the research1. We have constructed a hypothesis, which we detail here because it is a hypothesis under constraint. First, the study was limited to automobiles and the survey was limited to automobile users. The automotive industry is a key industry in Japan and is characterized by high automobile ownership and awareness. In addition, the business type has a “Business to Customer” format and is an indispensable part of citizens' daily lives. On the other hand, in areas with well-developed train lines, especially in urban areas, there are users who hold a driver's license for a car but do not use it on a daily basis. Therefore, we will attempt to obtain data reflecting the national population by surveying the number of years of driving experience along with the frequency of driving. Next, we focus on serviceability among Garvin's quality dimensions. This is based on the study of Syahrial et al. (2018), which found a high impact on customer satisfaction. The same is true for addressing the cost of ownership as a dimension. In addition, from the customer perspective, customer satisfaction and customer loyalty are used as measurement scales. In existing studies, some of them have adopted trust in the company as a measure (Park et al., 2014; Jalilvand et al., 2017; Alam et al., 2016). However, trust has become a measure used even when customers have no experience with the product or service. On the other hand, customer satisfaction used in this study is defined as the ratio of the customer's experience with the product or service to his or her expectations. The ACSI model is also widely used for the relationship with customer loyalty because it is known as an internationally standardized measure, including ACSI. The fact that quantitative evaluation is possible is the reason for its global adoption. In this study, customer satisfaction is also used as a scale to quantitatively evaluate the survey results. Furthermore, while it is a novelty of this study

to make country-by-country comparisons, we have chosen to focus on Japan and France. Japan was chosen because it is a country in which the automobile industry is a key industry. France is chosen because it has the automobile industry as its core industry and is familiar to Japan, but its cultural background is different from that of Japan. Germany is strongly recognized as the country in Europe with a thriving automotive industry and a high level of awareness of environmental issues. However, Japan and Germany have many similarities in terms of national characteristics, and it is possible that meaningful differences may not be expressed in extracting Japan's uniqueness for the purpose of country-by-country comparisons. France has a completely different cultural background from Japan, but shares some aspects in common with Japan, such as being a signatory to the Paris Agreement.

Table 2.1: Summary of previous studies

	Research type		Subject	Before beginning of project / Initial phase of project					
				Quality dimensions	Cost dimensions	Customer view		Social view	
	Case study	Survey	Automobile	Serviceability	Ownership cost	Customer satisfaction	Customer loyalty	CSR	Country comparison
Murali et al. (2016)	○			○		○	○		
Syahrial et al. (2018)		○	○	○	○	○	○		
Mohammed et al. (2018)	○					○		○	
Carroll et al. (2021)	○							○	
Zhang et al. (2013)	○			○		○	○		
Kianpur et al. (2014)				○				Environ-mentally friendly	
Devaraj et al. (2001)	○			○		○	○		
This study		○	○	○	○	○	○	○	○

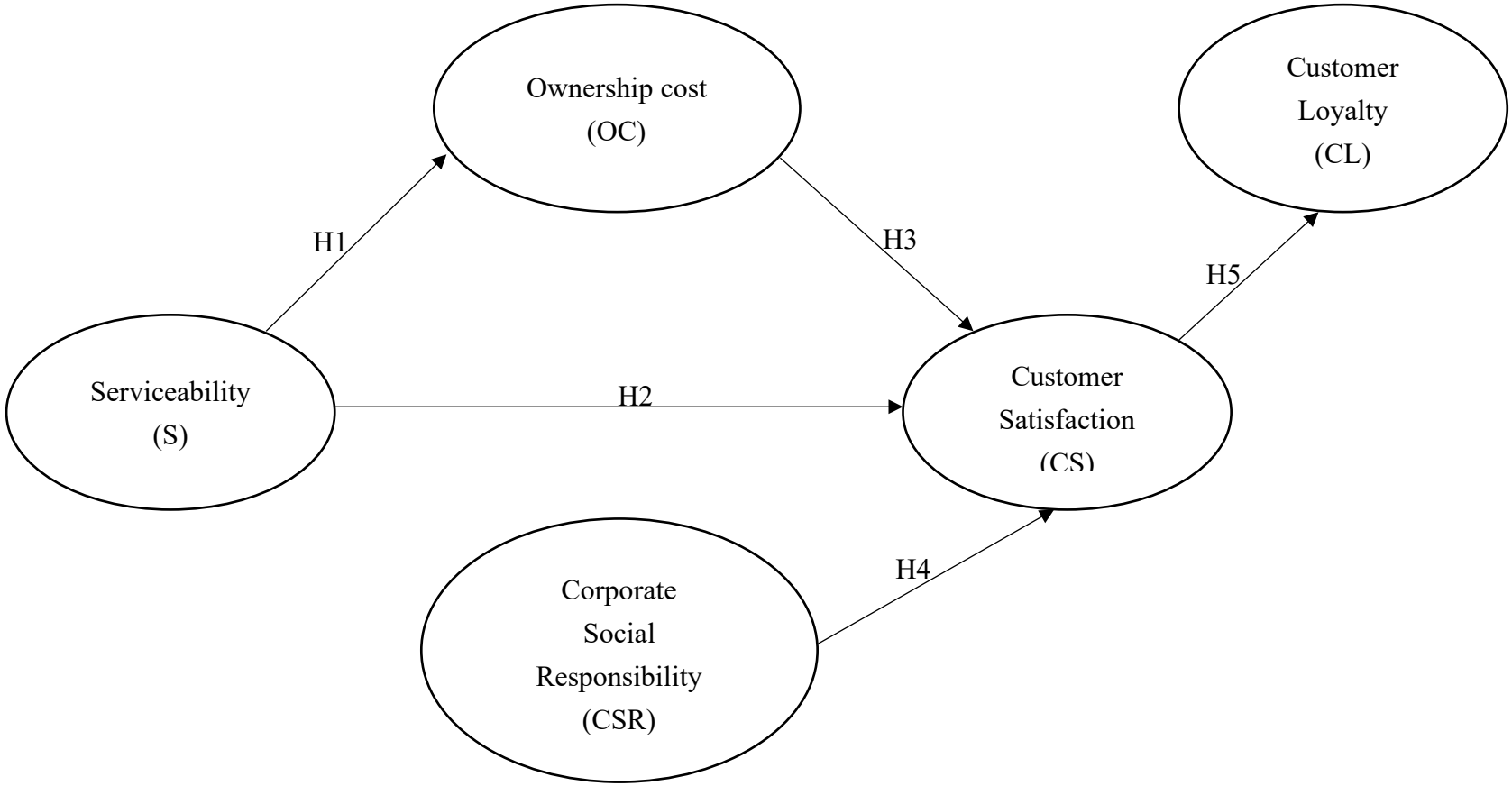


Figure 2.1: The conceptual model

2.3 Research methodology

This section describes the research method. In order to analyze customers' perspectives on automobile quality and CSR, a quantitative survey was conducted among automobile users in Japan and France. Here, car users are people living in Japan and France, and the area of residence is not limited. In a previous study (Hazen et al., 2006), a questionnaire survey, one of the quantitative survey methods, was conducted to achieve the research objectives. In this study, for the online survey, the questions were developed and then outsourced to a research firm. Analysis of the data obtained from the online questionnaire survey was performed by the following procedures. Data were cleaned to exclude duplicate responses before analysis. After acquisition of quantitative data and data cleaning, we conducted basic statistics. We obtained demographic data of questionnaire survey. And then, an exploratory factor analysis (EFA) was carried out. All new measurements were validated and validated through live surveys. Next, Reliability analysis is performed on the extracted factors. Here, Cronbach's alpha coefficient is used. Confirmatory factor analysis (CFA) was conducted to validate the conceptual model developed from the EFA-extracted factors. In implementing a comprehensive EFA and CFA methodology, the following subsections focus on measures, surveys, content effectiveness, data collection and development of dem graphics, EFA, common method differences, and CFA.

2.3.1 Measurement and questionnaire

The measurement items adopted most of the established measurement scales. In addition, they were created with some modifications due to the need to adapt them to this research area. Through the items of these measurement scales, each hypothesis will be empirically tested. Prior to conducting this study, we commissioned a research firm to conduct an online survey of citizens living in Japan and France. Attribute items included gender, age, frequency of driving, and experience of driving. See the Appendix A for the specific questions and questions asked in the survey. The questionnaire items were extracted and developed from previous studies and relevant literature. The items on the measurement scale were described on a 7-point Likert scale ranging from 1 (not at all disagree) to 7 (very much agree). In this study, the approach which modifies and also adapts the existed scale items. Moreover, this study developed original items and they were practiced.

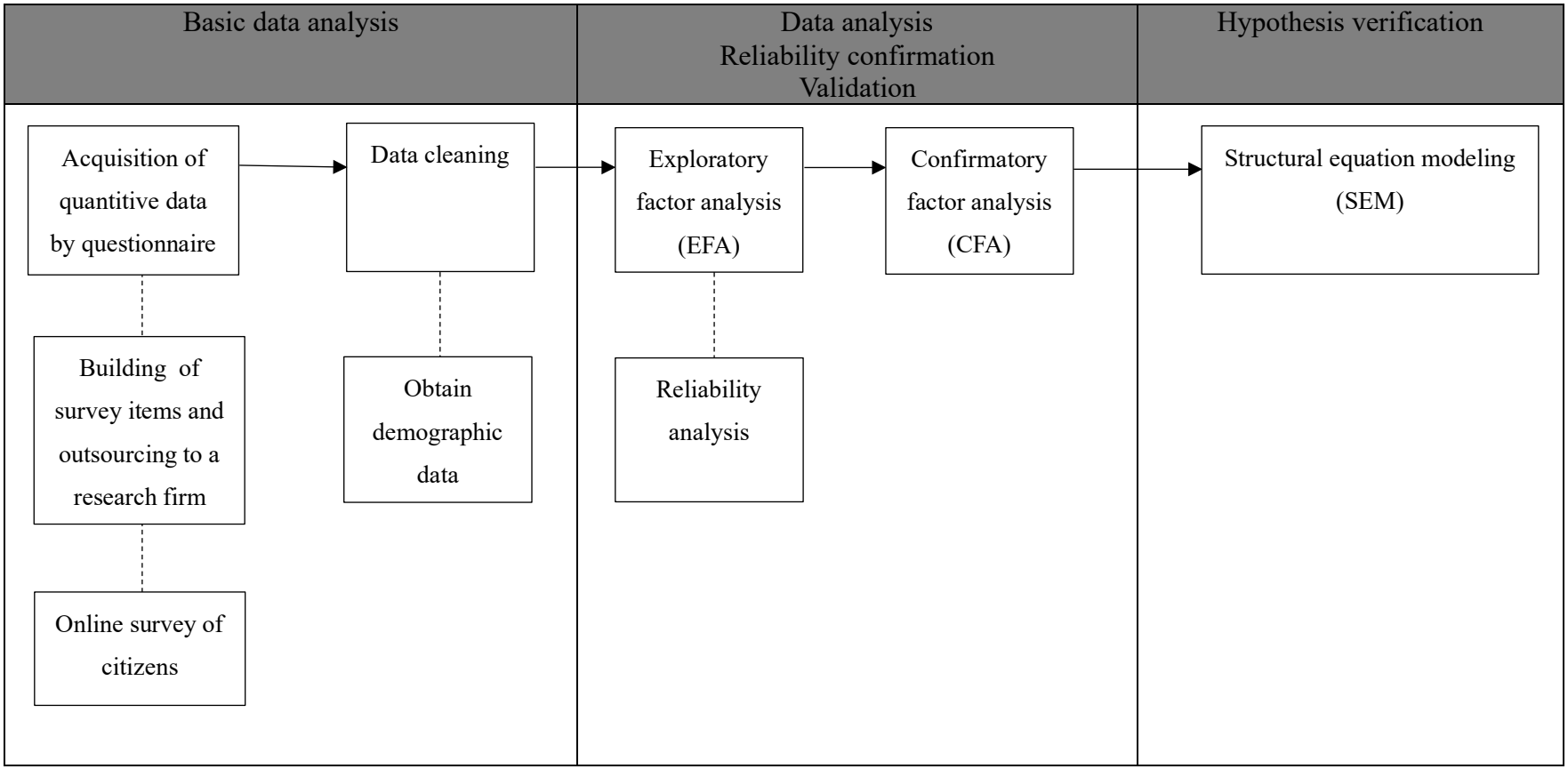


Figure 2.2: Analysis scheme of research1

2.3.2 Data collection and demographics

A total of 643 questionnaires were completed online in July 2022. Cleaning the data which we surveyed, we applied same way to Japanese and French. In order to confirm the theoretical model and established hypotheses which are described in the previous section, we conducted a questionnaire survey in Japan and France. Japan is recognized for the quality and engineering of its automotive industry, including Toyota (Liker et al., 1995), which they build Japanese manufacturing companies. The French manufacturers have also been very successful in the development of their vehicles. France also has automobile manufacturers such as Renault and Citroen, and has a history of partnerships with Nissan Motor Co. The fact that the company is based in Europe, where awareness of the environment and CSR is high, is also considered significant for country-by-country comparisons. The survey was conducted by a major business research database company. First, we excluded inappropriate responses (e.g., the same answer for all questions), total of 93 responses, 50 from Japan and 43 from France. Finally, 550 data were deemed useful for the analysis. This data cleaning brought down the sample size of respondents to 264 for Japan and 286 for France. The attributes of the survey respondents are shown in Table 2.1. The survey data revealed that 68.2% of Japanese respondents were male, and 48.6% of French respondents were male. In total, 52.3% of Japanese respondents, and 42.2% of French respondents were middle-aged (40-59 years old). Since this was an open survey covering all of Japan and France, the largest proportion of respondents were working adults (company employees, medical professionals, salespeople, government employees, etc.), with less than 3.0% of the respondents being students. Thus, it is expected that they have the knowledge to evaluate each of the scales in this study. For vehicle characteristics, a variety of vehicle makes and models were included. Japanese respondents drove Toyota, Honda, Nissan and so on. French respondents drove Renault, Citroen, Peugeot, Autre. Japanese respondents are with gasoline as the engine (65.9%), followed by hybrid (32.5%) and diesel (0.3%). French respondents are with gasoline as the engine (34.3%), followed by hybrid (7.3%) and diesel (41.3%). Thus, regardless of the automaker (six Japanese automakers and four French automakers) or type of vehicle powertrain, the study examined the customers' perspectives on the serviceability and ownership cost of their vehicles, which may differ in terms of product characteristics. Thus, given the diversity of customer backgrounds, makes, and models, this survey generalizes the results of the survey on the automotive experience in Japan and France. The attributes of the survey respondents are shown in Table 2.2.

Table 2.2: Demographic data of respondents

		Japan	France
Gender	Male	68.2%	48.6%
	Female	31.8%	51.4%
	Total	100.0%	100.0%
Age	Twenties (20-29)	3.2%	16.8%
	Thirties (30-39)	11.8%	22.6%
	Forties (40-49)	18.5%	22.9%
	Fifties (50-59)	25.8%	19.2%
	Sixties (60-69)	25.5%	13.8%
	Seventies (70-79)	15.2%	4.7%
	Total	100.0%	100.0%
Driving experience	More than 10 years	95.2%	75.4%
	Between 5 to 10 years	3.8%	16.7%
	Less than 5 years	1.0%	7.9%
	Total	100.0%	100.0%
Frequency of driving	Several times a week	36.0%	33.4%
	Everyday	42.3%	57.2%
	Once a week	15.0%	5.8%
	Few times a month	6.7%	3.6%
	Once a month	0.0%	0.0%
	Total	100.0%	100.0%
Powertrain type	Gasoline	65.9%	34.3%
	Hybrid	32.5%	7.3%
	Diesel	0.3%	41.3%
	Others	1.3%	17.1%
	Total	100.0%	100.0%

2.3.3 Bias and sample reliability

In order to assess non-response bias, we selected the first 10% of respondents and the last 10% of respondents to compare early and late respondents (Armstrong et al., 1977). t-test was used for these two samples and concluded that no significant differences existed. There is no non-response bias in this study. Common method bias is a possible problem in any survey (Tabacknick et al., 2007; Flynn et al., 1990). A common test for measuring common method bias is Herman's one-factor test (Possakoff et al., 1986). Since the extracted factors of Japanese data accounted for 76.84% of the total variance, where the first factor was 41.93% of the variance, it can be concluded that there was no single factor representing the majority of the variance. And also the extracted factors of French data accounted for 64.46% of the total variance, where the first factor was 40.52% of the variance Therefore, there are no significant issues of bias due to common methods in this study. In addition, the Kaiser-Meyer-Olkin (KMO) was applied in the quantitative analysis to examine normality and outliers for the acquired data; the KMO aims to measure sampling accuracy. In addition, the Bartlett sphericity test was applied. For sampling accuracy, a KMO value close to 1 represents a more accurate sample size, for the Bartlett's sphericity test, the p-value was used as a measure of the significance of the correlation between factors. The KMO value for this study was 0.927 for Japanese, and 0.917 for French, and the chi-square value for the Bart-lett's test were 8,045.654 for Japanese and 3,841.321 for French with a p-value <0.05. Reliability refers to the overall consistency of a test that yields a given measurement result. Table 2.3 shows the results in this section. The reliability of each factor was measured using Cronbach's alpha test. Factors with an alpha of 0.7 or greater were deemed reliable (Nunnally, 1978), indicating that the items on each measurement scale were appropriate for the survey.

2.3.4 Exploratory factor analysis

Exploratory factor analysis (EFA) was used to generate theories and hypotheses by analyzing the extracted factors and their respective measurement scale items. The items of the measurement scale are grouped into each factor extracted and share one variance. In this study, 5 factors were extracted, accounting for 76.84% for Japanese and 70.35% for French of the total. All factors obtained eigenvalues greater than 1.0 (Hair et al., 2007). Table 2.3 shows that nine new factors with high factor loadings (factor loadings >0.05) were identified. They are cost of ownership (4 items), serviceability (7 items), customer loyalty (4 items), customer satisfaction (6 items), and CSR (8 items). Thus, sufficient factor loadings of the variables indicated that all variables contributed significantly to

their respective factors. The basic relationship between the constructs can be confirmed as first evidence by the factor correlation matrix. According to the results of the correlation matrix, there were positive correlations among all constructs, significant at the 0.01 level (two-sided).

Table 2.3: Results of reliability analysis and EFA (Factors 1 - 3)

	Standardized factor loading		Eigen value		Reliability coefficient (alpha)	
	Japan	France	Japan	France	Japan	France
Factor 1. Serviceability (S)						
Your car has easy access to spare parts.	0.718	0.555				
Your car needs fewer self inspections.	0.698	0.458	12.16	12.25	0.918	0.921
Your car is easy to self-inspect.	0.783	0.564				
Your car is eligible for repairs and other maintenance services.	0.800	0.464				
Factor 2. Ownership cost (OC)						
Your car's fuel consumption is reasonable.	0.602	0.779				
Your car's maintance cost is reasonable.	0.738	0.757	5.54	3.90	0.869	0.873
Your car's service or repaire cost is reasonable.	0.714	0.799				
Factor 3. Corporate social responsibility (CSR)						
You think that environmental aspect of CSR is very important.	0.943	0.855				
You think that social aspect of CSR is very important.	0.956	0.883	2.32	1.69	0.940	0.918
You think that emploee aspect of CSR is very important.	0.931	0.817				
You think that governance aspect of CSR is very important.	0.956	0.794				

Notes: KMO = 0.927 ($x2 = 8{,}045.654$, $p < 0.05$); n=264 (Japan), KMO= 0.9172 ($x2=3{,}841.321$, $p < 0.05$); n=286 (France)

Table 2.4: Results of reliability analysis and EFA (Factors 4 - 5)

	Standardized factor loading		Eigen value		Reliability coefficient (alpha)	
	Japan	France	Japan	France	Japan	France
Factor 4. Customer Satisfaction (CS)						
You think that it is nice to use this company's services or products.	0.598	0.790	1.22	1.52	0.914	0.892
You do not regret using this company.	0.600	0.606				
You think that this company offers exactly what you need.	0.552	0.709				
Factor 5. Customer Loyalty (CL)						
You would not change for another company.	0.828	0.595	1.04	1.05	0.949	0.920
You use this company as your first choice.	0.821	0.612				
You intend to use this company's products and services again.	0.753	0.869				

Notes: KMO = 0.927 ($x2 = 8{,}045.654$, $p < 0.05$); n=264 (Japan), KMO= 0.9172 ($x2=3{,}841.321$, $p < 0.05$); n=286 (France)

2.3.5 Confirmatory factor analysis

A confirmatory factor analysis (CFA) was conducted with the goal of establishing the multi-dimensional constructs. CFA is a widely used statistical method of analysis used to assess how well each item on a measurement scale represents each factor. CFA also develops the acceptable measurement models. According to Gerbing et al. (1988), CFA is conducted to validate each factor studied and requires two levels of CFA to test a conceptual model, a measurement model and a structural model. It is stated that the measurement model was applied to identify relationships between factors and corresponding measurement scale items (observed variables). The structural model is then run to test the hypothesized relationships established. These goodness-of-fit indices are similar to those used in the study by Suzuki (2010) and are general in nature. Note that the sample size of this study was sufficient to conduct the CFA. In this study, the measurement model which is included the relationship between adopted dimensions and questionnaire items. Data were analyzed using IBM SPSS version 28 and AMOS version 28. The following subsections follow the procedures used in this study corresponding to CFA data validation.

2.3.5.1 Measurement model evaluation

Goodness-of-fit statistics were examined using a measurement model. The cutoff points for each goodness-of-fit index were a ratio of chi-square to degrees of freedom (x2 /df) less than 5.0, a comparative fit index (CFI) and an adjusted goodness of fit index (AGFI) between 0.9 and 1.0, and a mean square error of approximation (RMSEA) value less than 0.080. The Japanese model fit indices resulted in a relative chi-square of 2.51, CFI = 0.975, GFI = 0.921, and RMSEA = 0.064. And the French model fit indices resulted in a relative chi-square of 2.09, CFI = 0.969, GFI = 0.918, and RMSEA = 0.062. These indices concluded that the measurement model was a relatively good fit and established one-dimensionality. After EFA, we examined the measurement model in a confirmatory factor analysis and identified several measurement scales in this study that did not directly measure the factors and were therefore excluded from subsequent analyses. In CFA, several measurement scales were excluded from subsequent analyses. Thus, the 17 scale items included in the goodness-of-fit measurement model are serviceability (4 items), ownership cost (3 items), corporate social responsibility (4 items), and customer satisfaction (3 items), customer loyalty (3 items).

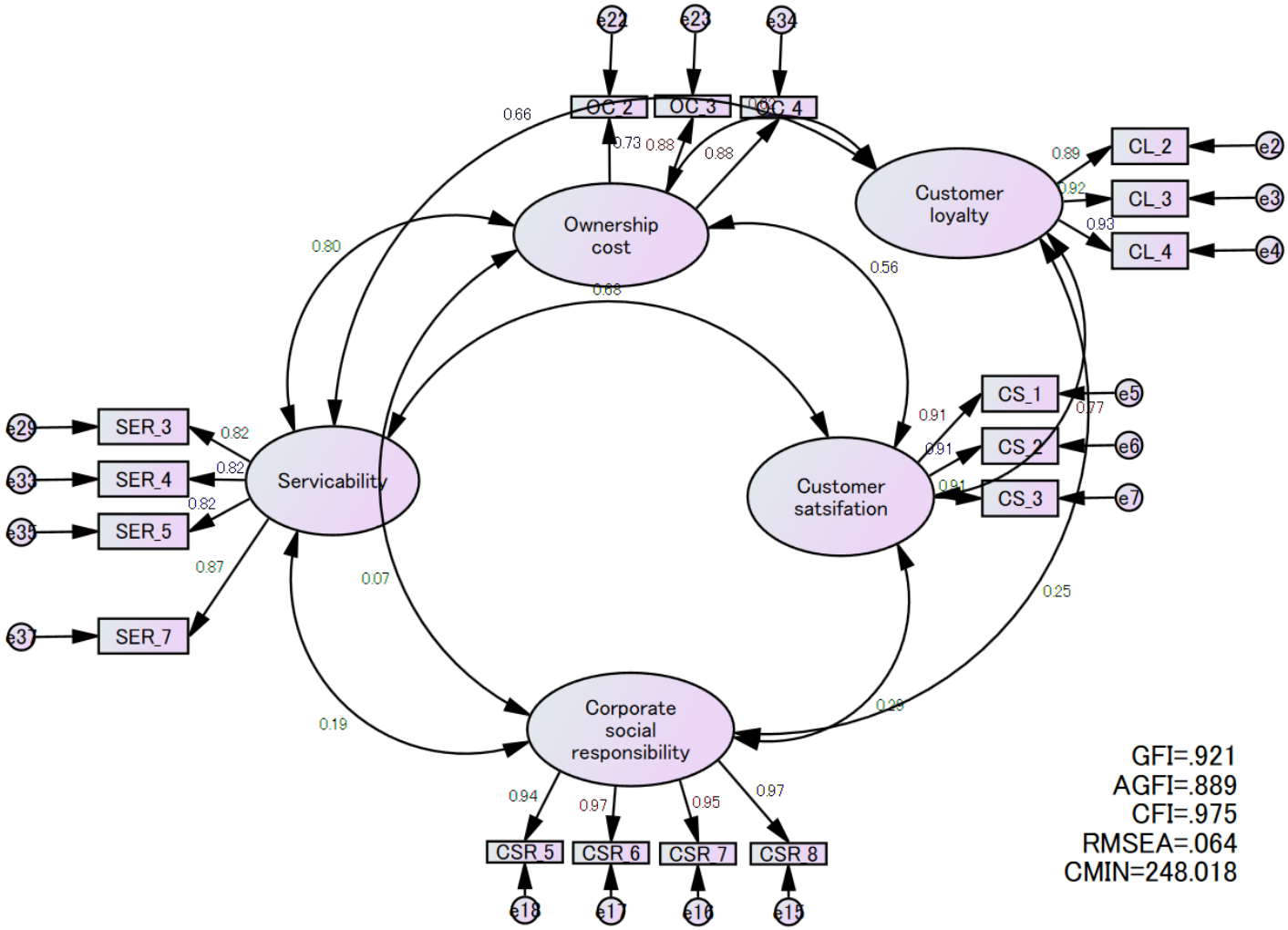


Figure 2.3: Measurement model of Japan

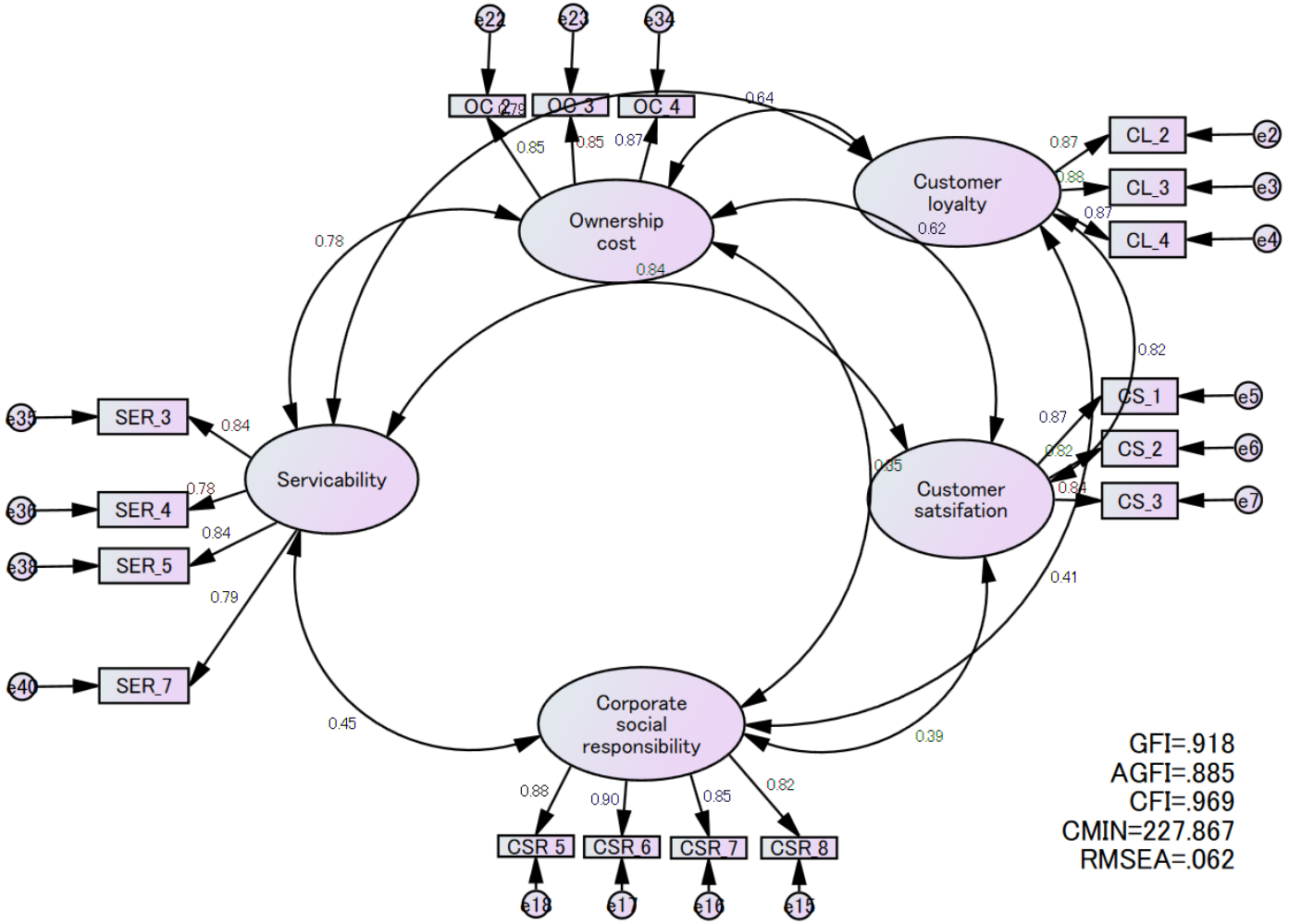


Figure 2.4: Measurement model of France

2.3.5.2 Verification of construct validity

Construct validity consists of convergent and discriminant validity. Of these, convergent validity refers to the extent to which the observed variable measures the inherited factor. A well-known analysis for assessing convergent validity is the average variance extracted (AVE), which is the value of the variance introduced by the factor relative to the measurement error. AVE is the value of the variance introduced by the factor for measurement error (Fornel et al., 1981). The standardized factor loadings for each factor were all greater than 0.7, directly explaining the high AVE and construct reliability (CR) and adequate convergent validity. The criteria for AVE is 0.5 and the CR is 0.7 (Bagozzi et al., 1988; Byrne, 1989). In this study, AVE ranged from 0.673 to 0.916 in Japan and from 0.659 to 0.761 in France and CR ranged from 0.861 to 0.978 in Japan and from 0.881 to 0.905 in France, as shown in Table 2.5 and Table 2.6. Hair et al. (2014) proposed to use the square root values of the AVEs to compare them with the square correlations between factors and in this study, we organized them in the same way. The diagonal values are the square roots of the AVEs for each factor. In this study, each diagonal value exceeded the respective inter-construct correlation. The discriminant validity was supported as shown in Table 2.7 and Table 2.8.

Table 2.5: Results of reliability analysis and CFA (Factors 1 - 3)

	Sum of the squared standardized loadings		CR		AVE	
	Japan	France	Japan	France	Japan	France
Factor 1. Serviceability (S)						
Your car has easy access to spare parts. Your car needs fewer self inspections. Your car is easy to self-inspect. Your car is eligible for repairs and other maintenance services.	2.69	2.64	0.892	0.885	0.673	0.659
Factor 2. Ownership cost (OC)						
Your car's fuel consumption is reasonable. Your car's maintance cost is reasonable. Your car's service or repaire cost is reasonable.	2.03	2.19	0.861	0.890	0.676	0.730
Factor 3. Corporate social responsibility (CSR)						
You think that environmental aspect of CSR is very important. You think that social aspect of CSR is very important. You think that emploee aspect of CSR is very important. You think that governance aspect of CSR is very important.	3.67	3.30	0.978	0.905	0.916	0.660

Notes: KMO = 0.927 (x2 = 8,045.654, $p < 0.05$); n=264; Japan, KMO = 0.917 (x2 = 3,841.321, $p < 0.05$); n=286; France

Table 2.6: Results of reliability analysis and CFA (Factors 4 - 5)

	Sum of the squared standardized loadings		CR		AVE	
	Japan	France	Japan	France	Japan	France
Factor 4. Customer satisfaction (CS)						
You think that it is nice using this company services/product. You do not regret using this company. You think that this company offers exactly what you need.	2.37	2.13	0.919	0.881	0.790	0.712
Factor 5. Customer loyalty (CL)						
You would not change for another company. You use this company as your first choice. You intent to use this company products/services again.	2.34	2.28	0.913	0.905	0.779	0.761

Notes: KMO = 0.927 (x2 = 8,045.654, $p < 0.05$); n=264; Japan, KMO = 0.917 (x2 = 3,841.321, $p < 0.05$); n=286; France

Table 2.7: Results of factor correlation matrix (Japan)

	S	CSR	OC	CS	CL
Serviceability (S)	**0.900**				
Corporate social responsibility (CSR)	0.180	**0.942**			
Ownership cost (OC)	0.787	0.029	**0.869**		
Customer satisfaction (CS)	0.671	0.253	0.555	**0.936**	
Customer loyalty (CL)	0.663	0.240	0.514	0.896	**0.937**

Note: All correlations are significant at 0.01 level (two-tailed).

Table 2.8: Results of factor correlation matrix (France)

	S	CSR	OC	CS	CL
Serviceability (S)	**0.885**				
Corporate social responsibility (CSR)	0.459	**0.905**			
Ownership cost (OC)	0.780	0.352	**0.890**		
Customer satisfaction (CS)	0.841	0.395	0.619	**0.881**	
Customer loyalty (CL)	0.787	0.417	0.642	0.818	**0.905**

Note: All correlations are significant at 0.01 level (two-tailed).

2.3.6 Structural equation modeling

Structural equation modeling (SEM) was applied to evaluate the proposed conceptual model. In this study, we use 264 samples from Japan and 286 samples from France as data considered reliable. This sample size exceeds the minimum sample size of 200 described in previous studies, and there is no difference in results due to the small sample size with respect to the results of the analysis (Hussey et al, 2007). structural equation modeling (SEM) as well as the measurement model validated in the CFA. The results for all goodness-of-fit indices were CFI=0.888, GFI=0.961, and RMSEA=0.077 for Japan. The results for all goodness-of-fit indices were CFI=0.952, GFI=0.897, and RMSEA=0.075 for France. Since the fit indices values were within the cut-off point (Hu et al., 1997), the structural model was statistically significant at a p-value of 0.01. These indices concluded that the measurement model was a relatively good fit. Table 2.9 shows the results of the analysis. In this study, hypothesis H1 indicates that serviceability has a significant effect on the cost of ownership in both countries (Japan; standardized coefficient = 0.788, p-value < 0.01. France; standardized coefficient = 0.7800, p-value < 0.01). This hypothesis is supported by previous studies (e.g., Sundin et al., 2009) that found that total labor cost, availability of spare parts. Hypothesis H2 showed that serviceability has a significant impact on customer satisfaction in both countries (Japan; standardized coefficient = 0.577, p-value < 0.01. France; standardized coefficient = 0.898, p-value < 0.01.). This result is supported by Cavalieri, Gajardelli and Ierace (2007) that after-sales service is important for manufacturers to provide quality services to their customers and thus establish customer satisfaction. We tested hypothesis H3, which examined the impact of cost of ownership on customer satisfaction. This hypothesis was not supported for Japan and France (Japan; standardized coefficient = 0.109, p-value > 0.05. France; standardized coefficient = -0.056, p-value > 0.05). This indicates that impact of ownership cost could not be determined in Japan and France. Hypothesis H4 showed that CSR has an impact on customer satisfaction in Japan, not in France (Japan; standardized coefficient = 0.170, p-value < 0.01. France; standardized coefficient = 0.081, p-value < 0.01). This result is supported by Mohammed (2018) that CSR affects to customers and thus establish customer satisfaction. Hypothesis H5(+) showed that customer satisfaction was highly significant for customer loyalty (Japan; standardized coefficients = 0.899, p-values <0.01. France; standardized coefficients = 0.842, p-value <0.01). In previous study, H5 was also supported (Cronin et al., 1992). In summary, the hypotheses, the path, the standardized coefficient, and the results of hypotheses (direct effect and mediation) are listed in Table 2.9.

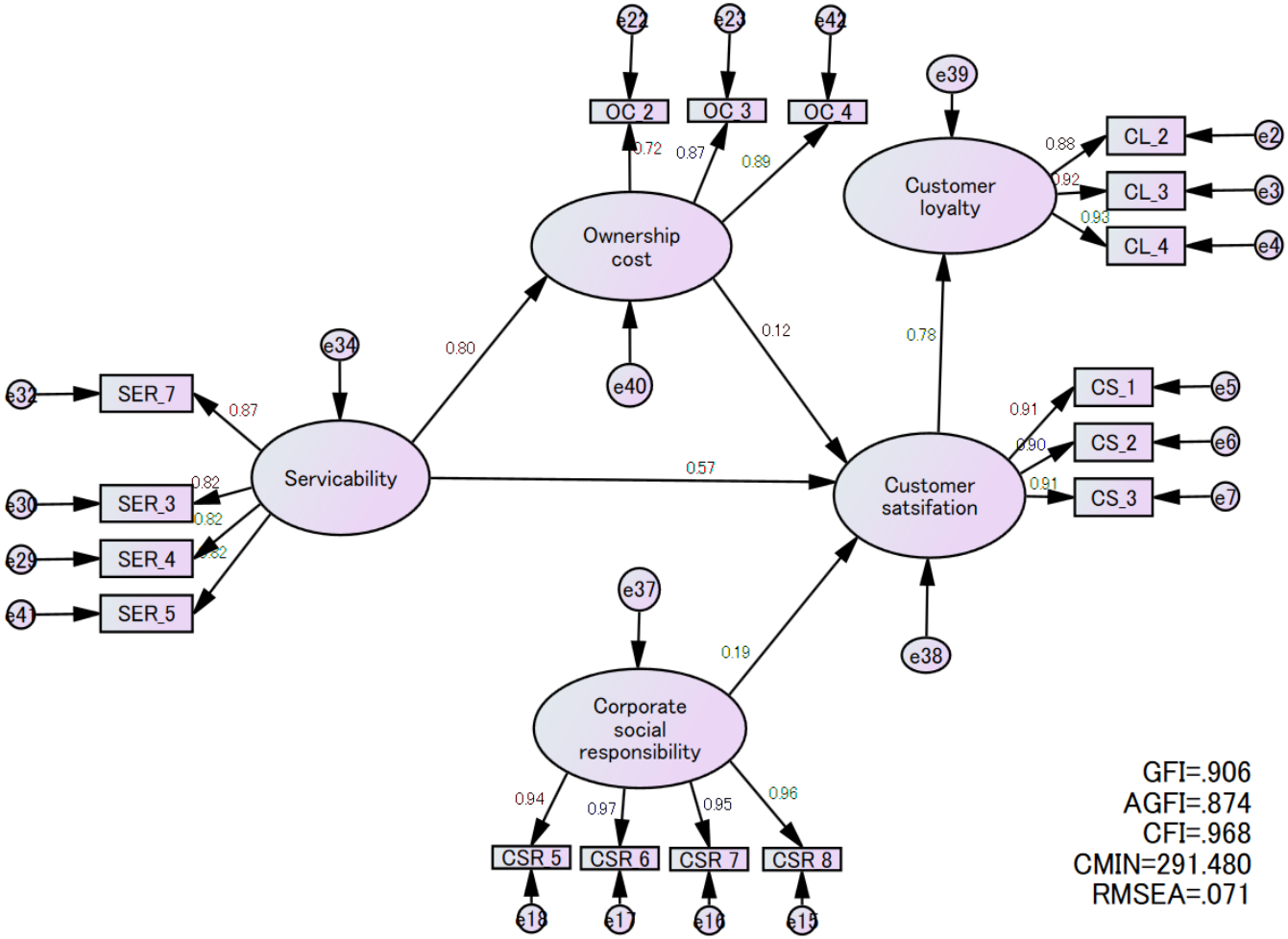


Figure 2.5: Structural model of Japan

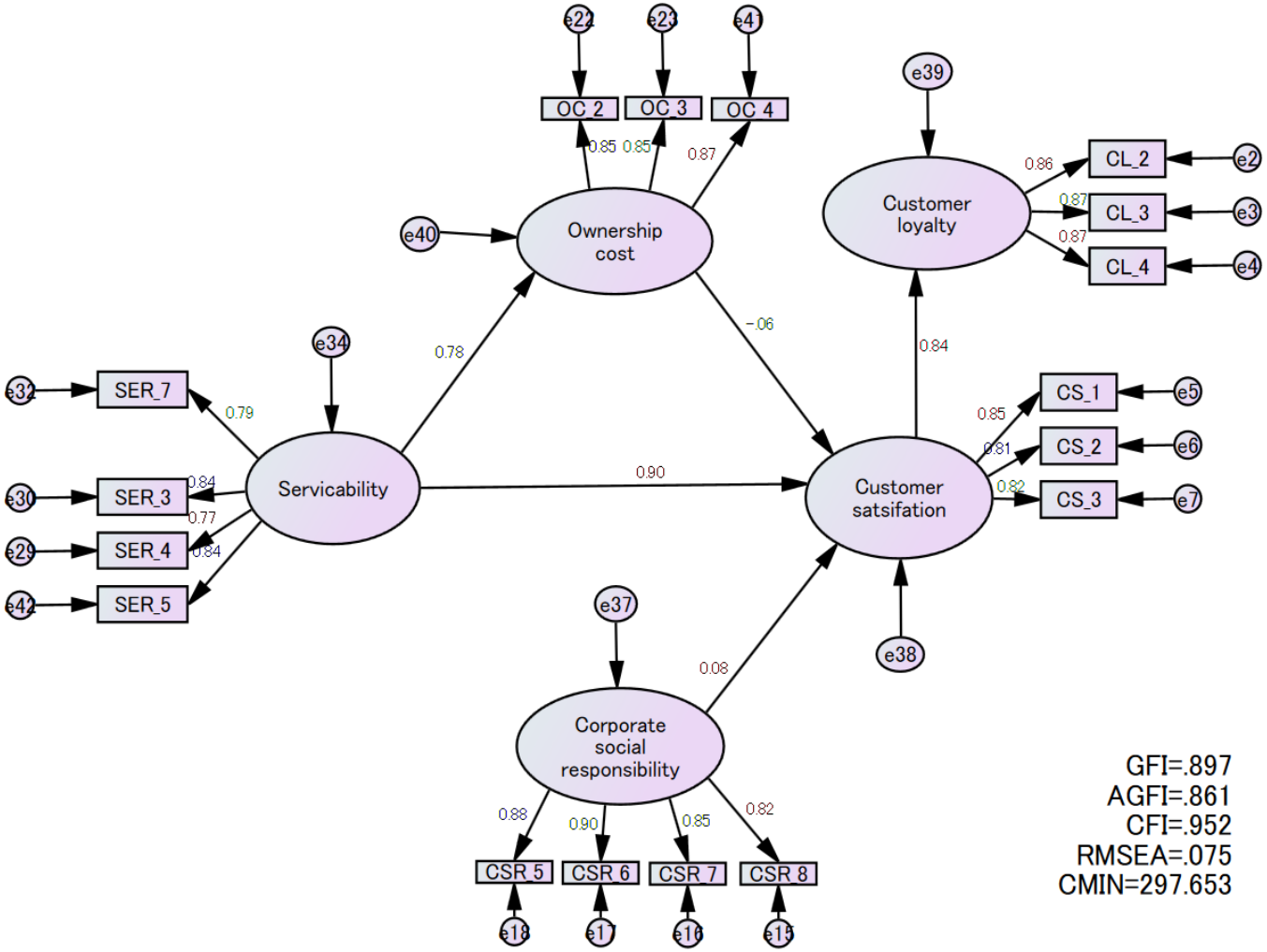


Figure 2.6: Structural model of France

Table 2.9: Result of SEM

Hypo-theses	Path	Standardized coefficients		Hypothesis supported?		Supported literature
		Japan	France	Japan	France	
H1	SER --> OC	0.788***	0.780***	Yes	Yes	Syahrial et al. (2018)
H2	SER --> CS	0.577***	0.898***	Yes	Yes	Devaraj, Matta and Conlon (2001)
H3	OC --> CS	0.109	-0.056	No	No	Syahrial et al. (2018)
H4	CSR --> CS	0.170***	0.081	Yes	No	Finding of this research
H5	CS --> CL	0.899***	0.842***	Yes	Yes	Devaraj, Matta and Conlon (2001) Suzuki (2010)

Path significant at: ***p<0.01

2.4 Discussion and managerial implication

This study reveals that the importance of practicing Garvin's quality dimensions for customer satisfaction and customer loyalty is established in both Japan and France. many studies by experts (Hazen et al., 2016; Yogi, 2016) have been conducted on Garvin's contribution. In particular, Syahrial et al. (2018) has shown that serviceability is an important quality dimension, and in this study, it was shown to have a significant impact on cost of ownership and customer satisfaction in both Japan and France. There are many studies on Garvin's contributions, this study adds new findings related to CSR. The 17 questions in the survey questionnaire proved to be easy to understand, with a high response rate in a short period of time from automobile users, and no ambiguous questions were pointed out by respondents.

In terms of serviceability, depending on the vehicle model, service personnel can now work quickly and efficiently at the service center. As a result, after-sales service, repair, and maintenance costs can be kept reasonable. In addition, easy access to spare parts for maintenance, service, and repair contributes to further cost savings, as customers can compare spare parts prices at various auto parts stores. And also, serviceability affected customer satisfaction in Japan and France. There is a concept that emphasizes the factors that make customers satisfied and loyal due to the various activities that provide after-sales service for the automobile company (Aris et al., 2019). The impact of cost of ownership on customer satisfaction could not be determined for both Japan and France. Similar results were obtained in Japan (Syharial et al., 2018). Similar results were obtained in the survey conducted for France in this study. CSR also has an impact on customer satisfaction in Japan. However, France is not determined. It is believed that the public is willing to pay a high price for something of value in France (Kuo et al., 2020). Compared to Japan, France has a different approach to consumption. Kuo et al. (2020) has shown that French consumer behavior places great importance on brands. Hence, we believe that differences in consumer behavior led to differences in the results. Japan has a high awareness of CSR. Japan has traditionally continued its efforts against the environment and global warming, including the Kyoto Protocol. In addition, Donald et al. (2017) confirmed that Japanese consumers are highly aware of CSR, which leads to trust in the company. Hence, Japan is considered to have established the hypothesis. Next, we will focus on the differences in cultural backgrounds between Japan and France due to their national origins. Japan is an island nation, surrounded by the sea. Japan has developed its own history and culture. Japan has a mindset of respecting its own culture and products. With regard to automobiles, many people are fond of domestically produced cars. Since Toyota and Nissan began producing domestically produced automobiles, aided by tariffs, Japan has matured with an increase in the number of people purchasing domestically produced automobiles. In addition, Japanese people have been educated about the damage caused by pollution in the past and are aware of the damage caused by industrialization and chemicals to the human body. Therefore, there is a tendency to unconsciously consider whether domestic automobiles themselves and the companies that produce them have a negative impact on the global environment and the human body. In fact, the Kyoto Protocol (1997) and the Summit on Global Environmental Protection are often reported in the news and are of great interest to the Japanese public. France, on the other hand, is a European country. In its long European history, France has numerous historical and cultural backgrounds. In particular, its citizens are characterized by a very strong sense of independence, and many of them have their own clear opinions. In terms

of environmental and social awareness, France has many historical buildings, so the emphasis is on preserving these buildings and protecting the landscape of the city. Regarding education on the environment and pollution, Germany is the leading country, while France does not emphasize it as much as Germany. This may be because Germany, which has experienced the Schadewald, is seen as a party to the problem, while France has no such experience. While Japan had the Kyoto Protocol as a milestone, France has signed the Paris Agreement (2015). The Paris Agreement on reducing greenhouse gas emissions was agreed to at COP21, and the French public is aware of the agreement. Godey et al., (2016) described that brands are a key factor in French consumers' spending behavior. The study stated that for French consumers, what they perceive to be of value leading to purchasing behavior is the brand. Brands are important to the French public. Although France plays a leading role in the world regarding fashion in the clothing industry, the perception of value by the public is the brand. In other words, it is thought that the national character does not lead to consumption behavior based on satisfaction with environmental and social initiatives, but rather to satisfaction with the brand in the end. Moreover, the differences in cross-cultural consumption behavior will be discussed. Having discussed the differences in environmental awareness above, we now turn to the perspective of employees. Japan has an extensive lifetime employment system and is characterized by long years of service. In recent years, the government has implemented measures to encourage people to change jobs in consideration of human resource mobility. The concept of the right person for the right job is spreading. In addition, some large companies have begun to adopt a job-based employment system, and awareness of the need to reform work styles and liquidity with respect to human resources is becoming more widespread. The reality is that this has led to a shift in focus toward employees in companies. When a company's business condition deteriorates, there are cases of nonpayment of wages, personnel cutbacks, and large-scale restructuring. Such cases are often reported in the media because they do not happen frequently in Japan. Since Japanese people often take in information from television, they recognize such reports as their impression of the company when they see them. It is also necessary for companies to guarantee the livelihood of their employees as part of their responsibility to fulfill. In recent years, wellbeing and happiness management have been the focus of much attention. Maeno (2016) described that if we use four factors of happiness as design parameters for products and services, we think that we can develop products and services that can make people happy. It is pointed out that there are four factors about happiness and that it is possible to enhance happiness by utilizing these factors. Happy employees are considered to have high engagement with the company and contribute very much to the company.

They also work more productively and diligently, with fewer mental disturbances and other insufficiencies. Hence, happiness management, which considers employee happiness in corporate management, has gained attention. Furthermore, well-being is being focused on from there. Well-being is a combination of the words well (good) and being (state), and is a concept that describes the state of being well, or being well, and being content both physically and mentally. On the other hand, the idea of lifetime employment itself has not existed in France for a long time. Employees do not remain loyal to a single company for many years. Restructuring also occurs frequently, so it does not make the headlines in France as it does in Japan. This suggests that the company may not be paying much attention compared to Japan. Then, corporate governance will be discussed. The central features of Japan's corporate governance environment are: (1) a main bank system in which banks voluntarily reorganize loans to some bad creditors; (3) unspoken promises of job security; (4) belief systems about the proper role and structure of the board of directors (Milhaupt, 2017). Corporate governance is of great managerial importance. In particular, in the SDG management theme addressed in this study, it is customary to establish a core organization such as a task force and create a governance structure as a company-wide effort. From there, create a system, explain it to employees, and ensure that they follow the rules. In addition, a summary of the efforts is often published outside the company as part of CSR. On the other hand, Martínez et al. (2020) state that from a corporate governance perspective, CEO nonduality and board independence function separately as determinants of a company's contribution to the 2030 Agenda. In other words, the decision-making structure of the board of directors has a significant impact on corporate governance. Japanese companies traditionally reflect the intentions of their boards of directors and general shareholders' meetings in their management, there have been scattered reports of this in the press. For these reasons, the Japanese public is likely to take an interest in the company. On the other hand, it explores how ownership concentrations, ownership patterns, and governance practices are related to CSPs. Capital geography is relevant, but there is little evidence of the importance of shareholder identity. In other words, neither family shareholders nor institutional shareholders have any influence on CSPs, suggesting that major shareholders do not seem to attach much importance to CSR, suggesting that they are reluctant to invest in CSR. Finally, while results regarding good governance practices are mixed, board independence is a cornerstone of good CSR (Ducassy et al., 2015). This is thought to be the difference between Japan and France in terms of cultural background.

From the above, similar trends were observed when comparing SEM results from Japan and France. In both countries, the impact of CSR on customer satisfaction and

loyalty is small, and it can be assumed that improving the serviceability the car itself will lead to product purchase behavior. And also, due to the difference in consumer behavior between Japan and France, it is important for marketing managers to build a brand strategy and promote product releases in France, because in Japan, consumers place more emphasis on price, whereas in France, consumers place more emphasis on their own culture and brand image of company.

2.5 Conclusion

This study investigates the impact of serviceability and ownership cost and CSR on customer satisfaction and customer loyalty in Japan and France, taking automobiles as a case study. shows summary of this research and previous literature. From the results of this study, Japanese customer demand remains one of the most important criteria, taking into account up-to-date serviceability and CSR. On the other hand, French customers value serviceability. Proactive manufacturers will be able to build strong relationships with their customers through prompt and courteous customer hospitality. Therefore, customer satisfaction should be monitored by manufacturers in order to increase the number of loyal customers and attract new customers.

This study also had its limitations. Limitations and managerial implications, and future research are stated. The reliability of this survey data was limited in two countries surveyed, Japan and France. In addition, we were able to obtain survey data from a wide range of citizen. In previous studies, we did not aim to detail by attribute, and we stand by the same concept in this study. It is also stated that even in surveys, the decision against asking questions separately by gender needs to be made based on whether there is a purpose in doing so and needs to be considered when integrating (Heidari et al., 2016). This study does not address differences by attribute as a limitation of the study, as it is not an objective in and of itself. Therefore, it is recommended that future studies examine more national contexts to further confirm the generalizability of these findings. In addition, this study focused on the managerial perspectives of firms regarding their performance with respect to service availability-related practices and cost of ownership and CSR. And this study analyzed only the customers' perspectives on vehicles that were not powertrain specific in both Japan and France. Since 85 to 90% of respondents owned gasoline engine vehicles, the results were primarily based on gasoline engine vehicles and represent how customers judged the cost of ownership and other product quality dimensions to be important. Future surveys targeting customers of EVs, HVs, and PHEVs, which are expected to be actively introduced in smart cities, are expected to

provide new insights that will contribute significantly to reducing the cost of ownership and protecting the environment. Future research on service quality may also yield new results on the quality of mobility required in smart cities, in terms of both product quality and service quality.

In the future, it is necessary to focus on the structure of service quality experienced by citizens living in the area, such as local mobility services and local community culture, to explore important factors that influence loyalty (Suzuki, 2010). Furthermore, it is desirable to clarify the existence and indirect effects of environmental and social influence factors on customer satisfaction. The results of this research show that CSR has an impact on customer satisfaction in Japan. It was shown that the level of awareness of the environment and social aspects of companies in Japan is different from that in France. Therefore, it is necessary to verify whether CSR in Japan influences customer awareness such as customer loyalty through other factors.

Table 2.10: Summary between research 1 and the existing literature

Literature	Key dimensions	Other dimensions	Findings
Sinclair, Hansen and Fern (1993)	Performance, Reliability, Conformance, Durability, Service/ Perceived Quality, Aesthetics	Economics	• Subsequent exploratory factor analysis supported the existence of most dimensions. Seven factors were specified rather than Garvin's eight.
Curkovic, Vickery, and Droge (2000)	Product quality and Service quality		• Service quality consisting of pre-sale customer service, product support (post-sale customer service), and responsiveness to customers.
Devaraj, Matta and Conlon (2001)	Service satisfaction, Product quality, Loyalty	Quality belief	• Examined product and service quality using a model that integrates it into the prediction of repurchase behavior.
Szwejczewski, Goffin & Anagnostopoulos (2015)	Serviceability		• After-sales is an important element of the business, service requirements are systematically evaluated during NPD through the involvement of after-sales personnel and the use of field service data to set design goals.
This study	Serviceability, Ownership cost, Customer satisfaction and Customer loyalty	CSR	• CSR affects to customer satisfaction in Japan. Notes: CSR->Customer satisfaction (Standardized coefficient= 0.170***(Japan), 0.081 (France)) Path significant at: ***p<0.01

Table 2.11: Anticipated future research of research 1

Classification	Contents	Future research
Findings	• CSR affects to customer satisfaction in Japan	• Investigate the impact of CSR on except customer satisfaction • Examine indirect effects of CSR on customer satisfaction and mediating factors
Supported hypothesis	• Serviceability affects to customer satisfaction in Japan	• Impact of Garvin's quality dimensions other than serviceability on customer satisfaction

Chapter 3 Customer perceptions of the role of perceived quality in mediating corporate social responsibility and social quality on customer satisfaction

3.1 Introduction

Japan has a high awareness of corporate social responsibility. It is necessary to verify whether CSR in Japan influences customer awareness such as customer loyalty through other factors (Shibuya et al., 2024). And also, it is necessary to examine indirect effects of CSR on customer satisfaction and mediating factors. Furthermore, changes in social conditions caused by COVID-19 are affecting business activities. It has been pointed out that the COVID-19 pandemic not only represents a massive global health crisis, but that the crisis requires massive behavioral changes (Bavel et al., 2020). Several reports have been published on how the COVID-19 pandemic affects the development of CSR and marketing. He et al. (2020) describes the COVID-19 pandemic presents a golden opportunity for companies to move to a more genuine and authentic CSR and contribute to addressing urgent global social and environmental challenges. It also states that the pandemic is changing consumer ethical decision-making. Companies engaged in a wide range of philanthropic activities during the pandemic, likely motivated by both utilitarian and deontological factors in responding to the needs of internal and external stakeholders (Manuel et al., 2020). Furthermore, Carroll (2021) states that the global pandemic has put CSR to the test, and many companies are trying to respond to this crisis and reset their CSR thinking and practices to meet society's expectations. From the above, it is considered necessary to pay attention to CSR and customer sentiment in the 2020s after COVID-19. On the other hand, consumer attitudes toward automobiles after COVID-19 are also noteworthy. It is the securing of individual space and privacy through mobility (Zhang et al., 2023). It is necessary to keep an eye on consumer attitudes toward the automobile industry in the future.

Therefore, the aim of this study is to clarify the relationship with the elements of social and environment activity of company, and automobile customer intention. That is, to explore the structure of the relationship between Garvin’s quality dimensions (Garvin, 1987), CSR, customer satisfaction, and customer loyalty with respect to quality and sociality by defining through structure equation modeling (SEM). This study focuses on

perceived quality, which has been changing in the social context since COVID-19, and CSR and social quality, which companies need to address in their SDGs and ESG integrated reports. And the purpose of this study is to clarify the causal structure of these factors on customer satisfaction and customer loyalty in order to contribute to the accumulation of knowledge on changes in customer perceptions after COVID-19. And also, from the result of Chapter 2, CSR affects customer satisfaction in Japan. Therefore, this study focuses on Japanese citizen's intention. Purpose of this study has two main objectives as follows. First one is to determine relevant variables of CSR, social quality, perceived quality, customer satisfaction and customer loyalty have to be determined through the factor analysis. Second one is to conduct the analysis and then verify the hypotheses for whole relationships between dimensions.

The remainder of this paper is organized as follows. Section 3.2 reviews previous studies, Section 3.3 presents the methodology of analysis and results, Section 3.4 presents the discussion and implications, and Section 3.5 concludes the paper and discusses future research topics.

3.2 Previous studies

Garvin (1987) attempted to bring together these and other definitions through eight aspects of quality to guide manufacturers in providing high-quality products. Most of the measurement scale items were aligned with the original description by Garvin (1987), adapted from Kianpour, Jusoh, and Asghari (2014), and then further enhanced with the associated field of study. In this study, serviceability and perceived quality are extracted due to the high impact on customer satisfaction in Syahrial et al (2018). Carroll (2021) states that COVID-19 changed corporate activities all over the world. Moreover, company should pay attention to CSR and social activities after COVID-19. In this study, hypotheses are developed from the following previous studies on perceived quality, CSR, social quality, customer satisfaction, and customer loyalty.

3.2.1 Perceived quality

Perceived quality indicates the degree to which customers are influenced by product image, advertising, brand name, and so on (Garvin 1987). Brand awareness, brand association, perceived quality, brand loyalty, and brand purchase intent are related to each other (Sebastianelli and Tamini 2008). Perceived quality is a subjective aspect of the customer based on product reputation and past customer experiences (Sebastianelli and

Tamini 2002). Customers may purchase products or encourage or discourage purchase behavior. These factors contribute to a customer's first impression and may influence product purchasing behavior (Sinclair, Hansen, and Fern 1993). In the future, you need to provide multiple angles of messaging to potential customers to consider purchasing the advertised or recommended product. Customer-perceived quality is determined by how well a product brand can satisfy its customers. Customer-perceived quality depends on the extent to which the product brand is successful in satisfying customers. From the above, it is considered that perceived quality influences customer satisfaction, so the hypothesis 1 (H1) was established.

Hypothesis 1 (H1): Perceived quality positively influences customer satisfaction.

3.2.2 CSR

Customer purchasing behavior is examined for the impact of philanthropic responsibility and ethical responsibility on customer loyalty. Businesses are encouraged to engage in strategic and relevant cause-related marketing and cause promotions in relation to their philanthropic responsibilities to increase customer buying behavior (Chrisjatmiko et al., 2017). Based on a longitudinal study of CSR reports of companies operating in the automotive industry, information disclosure practices are changing. First, in line with his CSR literature in the first place, the trend of increasing environmental and social responsibility is identified. Second, it adds evidence to the emerging debate on harmonization and standardization of reporting, with standards exerting some prescriptive pressure within the industry. Third, it provides evidence of specific connections that emerge between the problem and the actors (Russo-Spena et al., 2018). Automobiles are divided into multiple segments, such as popular passenger cars and luxury cars, and are shipped according to the market. In middle east market, regarding luxury car owners, Tahssili et al. (2023) state that both economic and ethical perceptions are indirectly related to purchasing behavior. And for mid-range car buyers, both philanthropy and economic perceptions have a direct relationship with buying behavior. In the automotive industry, there is a trend to focus on the impact of CSR on customer behavior. Furthermore, it has been shown that consumers have a positive perception of the quality of products and services when they see that an organization is actively engaged in CSR activities (Poolthong et al., 2009; Liu et al., 2014). From the above, it is considered that CSR efforts have a positive impact on perceived quality.

Based on the above, this study hypothesizes CSR affects the perceived quality

of customers, and the hypothesis Hypothesis 2a (H2a). It was also considered that that CSR influences customer loyalty and examines whether this is also the case in the automotive industry (Hypothesis 2b (H2b)).

Hypothesis 2a (H2a): Corporate social responsibility positively influences perceived quality.
Hypothesis 2b (H2b): Corporate social responsibility positively influences customer loyalty.

3.2.3 Social quality

Regarding Garvin's discussion on the quality dimension, Kianpour (2014) and Schvaneveldt (2000; 2005; 2011) argues that quality factors with environmental characteristics should be added to the framework of existing product quality factors. Kianpour (2014) explained the need to add an environmentally friendly factor to the existing eight quality factors. It is stated that product manufacturing from the customer's standpoint, consideration for the environment, and the life cycle of the product should be taken into account, and that safety assurance (safety) and environmental protection (environmental friendliness) should also be considered. It is defined one quality concept, "Socially Responsible Quality" as a quality objective that takes these three vectors of safety, environmental friendliness, and usability into consideration.

Hypothesis 3a (H3a): Social quality positively influences perceived quality.
Hypothesis 3b (H3b): Social quality positively influences customer satisfaction.

3.2.4 Customer satisfaction and customer loyalty

The importance of customer satisfaction has been investigated by many researchers. For example, Kotler (2000) defined satisfaction as: "perceived performance (or result) that meets his or her expectations in relation to feelings of joy or disappointment as a result of comparing products". Customer satisfaction refers to the evaluation of customer expectations based on the cumulative experience of the products and services used by customers. Customer satisfaction has a positive side and is believed to impact an organization's profitability. Hoyer and MacInnis (2001) argue that satisfied customers form the basis of everything, and that customer satisfaction leads to business success and repeat purchases. The reason why customer satisfaction is important is that while La

Barbera et al. (1983) found that satisfaction influences repurchase intentions, it also influences the major reasons for customer churn or discontinuation of purchases. Higher customer satisfaction results in fewer complaints from customers, which in turn increases customer loyalty to products (Fornell et al., 1987; Fornell, 1992). Here, customer loyalty refers to a customer's willingness to repurchase the same company or similar products or services in the future (Zeithaml et al., 1996). This view is consistent with Anton (1996), who states that satisfaction is positively associated with repurchase intent, likelihood of recommending a product or service, loyalty, and profitability". Positive word of mouth is made by customers in terms of referring other customers. Customer who has loyalty will buy from the firm over the long term (Evans et al., 1997). Positive word-of-mouth is a strong representation by customers, and is expected to enhance a manufacturer's image. From the above, it is considered that customer satisfaction influences customer loyalty, so the hypothesis 4 (H4) was established.

Hypothesis 4 (H4): Customer satisfaction positively influences customer loyalty.

3.2.5 Conceptual model

The aim of this study is to establish the relationship between CSR, social quality, perceived quality, customer satisfaction and customer loyalty.

Based on hypothesis 1 to 4, the conceptual model is illustrated in Figure 3.1.

3.2.6 Research limitation

In this chapter, we discuss the limitations of the research 2. We have constructed a hypothesis, which we detail here because it is a hypothesis under constraint. In this study we picked up automobile industries as well as research 1. In research 1, the hypothesis that CSR has a positive impact on customer satisfaction was supported in Japan. Therefore, in research 2, we conducted an impact study in Japan, targeting the automotive industry. In research 1, the hypothesis that CSR has a positive impact on customer satisfaction was supported in Japan. Therefore, in research 2, we conducted an impact study in Japan, targeting the automotive industry. While research1 addresses CSR as a dimension, research2 will address social quality as a new dimension. The definition of social quality is given above, but it is considered as a variable independent of CSR and each other. Therefore, both dimensions are incorporated into the same model. Carroll (2021) stated that after COVID-19, companies need to focus more on CSR activities, but

the social situation has changed with COVID-19, and perceived quality is also attracting attention. The pandemic restricted people from leaving their homes and declared a state of emergency, limiting the scope of their previous activities. Accordingly, more information was obtained from the Internet. Furthermore, because of the increased use of Internet services, it is necessary to take into account the impact of perceived quality on customer satisfaction and the impact of other latent factors on perceived quality.

Table 3.1: Summary of previous studies

	Subject	Quality dimensions	Social dimensions		Customer view		Impact/Effect	
	Automobile	Perceived quality	Social quality	CSR	Customer satisfaction	Customer loyalty	Direct	Mediation
Garvin (1987)		○			○	○		
Kianpour et al. (2014)		○	○					
Albuquerque et al. (2020)		○						
Carroll et al. (2021)				○				
Syahrial et al. (2018)	○	○			○	○	○	○
Suzuki et al. (2018)	○	○	○		○	○	○	
Schvaneveldt et al. (2011)			○		○	○		
This study	○	○	○	○	○	○	○	○

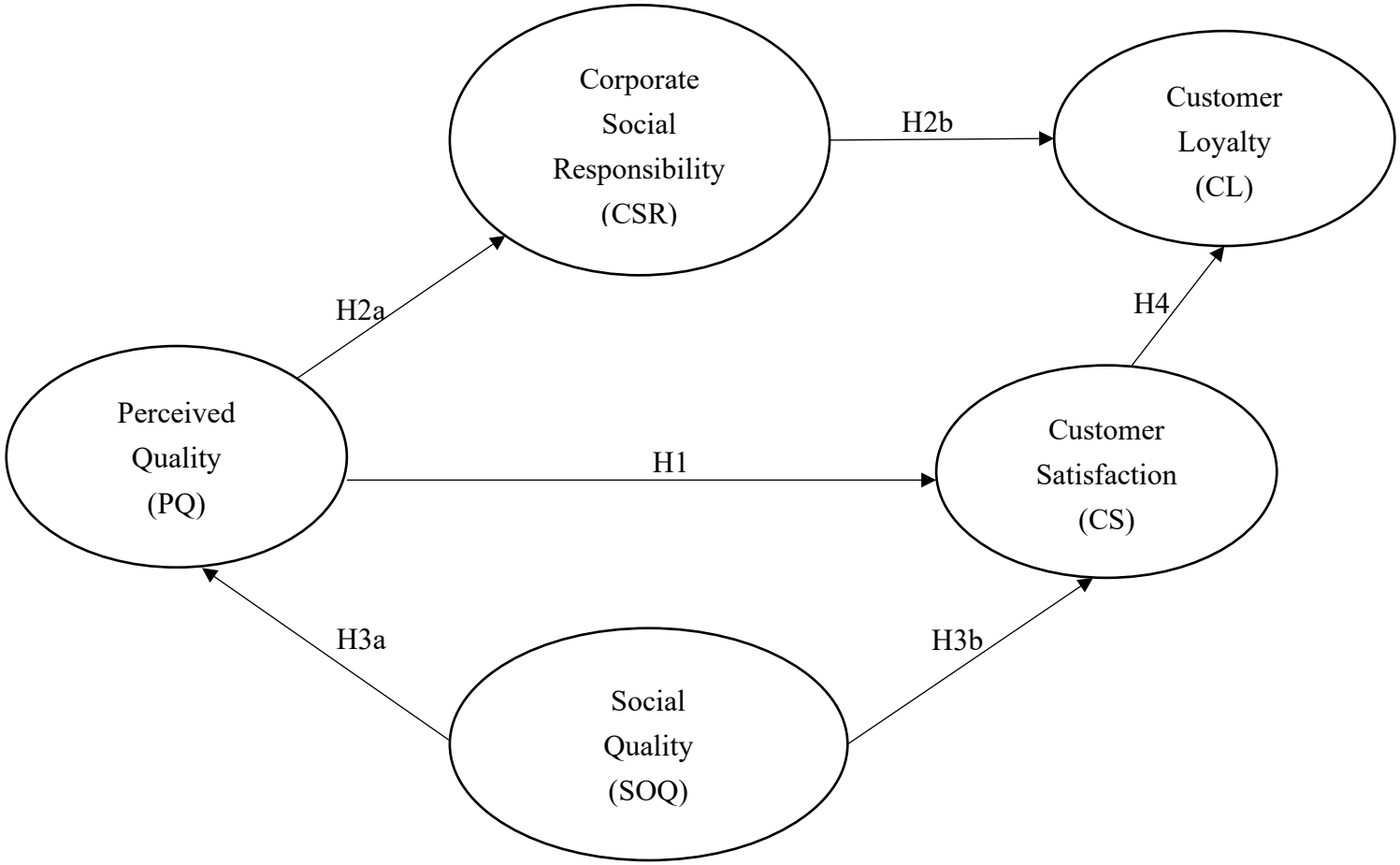


Figure 3.1: The conceptual model

3.3 Research methodology

A quantitative survey was conducted among Japanese mobility users to analyze their perspectives on quality dimensions and CSR. A quantitative research method using a questionnaire survey was used to achieve the research objectives (Hazen et al. 2016). For the online survey, the questions were developed and then outsourced to a research firm. IBM SPSS version 28 and IBM AMOS software 28 was used for the analysis.

3.3.1 Measurements and questionnaire

The measurement items were created by adopting most established measurement scales with a few modifications to adapt them further to this research area. We empirically tested each hypothesis using the items in the measurement scales. Prior to conducting this survey, we commissioned a research firm to conduct a questionnaire survey on Japanese mobility users. Attribute items included gender, age, frequency of driving, and experience of driving. See the Appendix B for the specific questions and questions asked in the survey. The questionnaire items were extracted and developed from previous studies and relevant literature.. Items were rated on a 7-point Likert scale ranging from 1 (not at all agree) to 7 (very much agree).

3.3.2 Data collection and demographic

A total of 314 online questionnaires were completed by July 2022. Data source is same as research 1 in Chapter 2. Finally, excluding 1 case where all the same answers were given, 313 Japanese responses were deemed useful for the analysis. This satisfies the sample size of 300 considered valid for the analysis (Comrey, et al., 1992). Survey respondents' attributes are listed in Table 1. A total of 71.3% of Japanese respondents were male, and 44.3% of Japanese respondents were middle-aged (40–59 years old). As this was an open survey covering all of Japan, driving frequency is moderate in their lives and they mainly drive gasoline-engine vehicle or hybrid vehicles.

Thus, they were assumed to have the knowledge to evaluate each scale used in this study. With regard to the mobility characteristics, a variety of mobility models were included. Given the diversity of customer backgrounds, makes, and models, this survey generalized the results of the mobility experience in Japan.

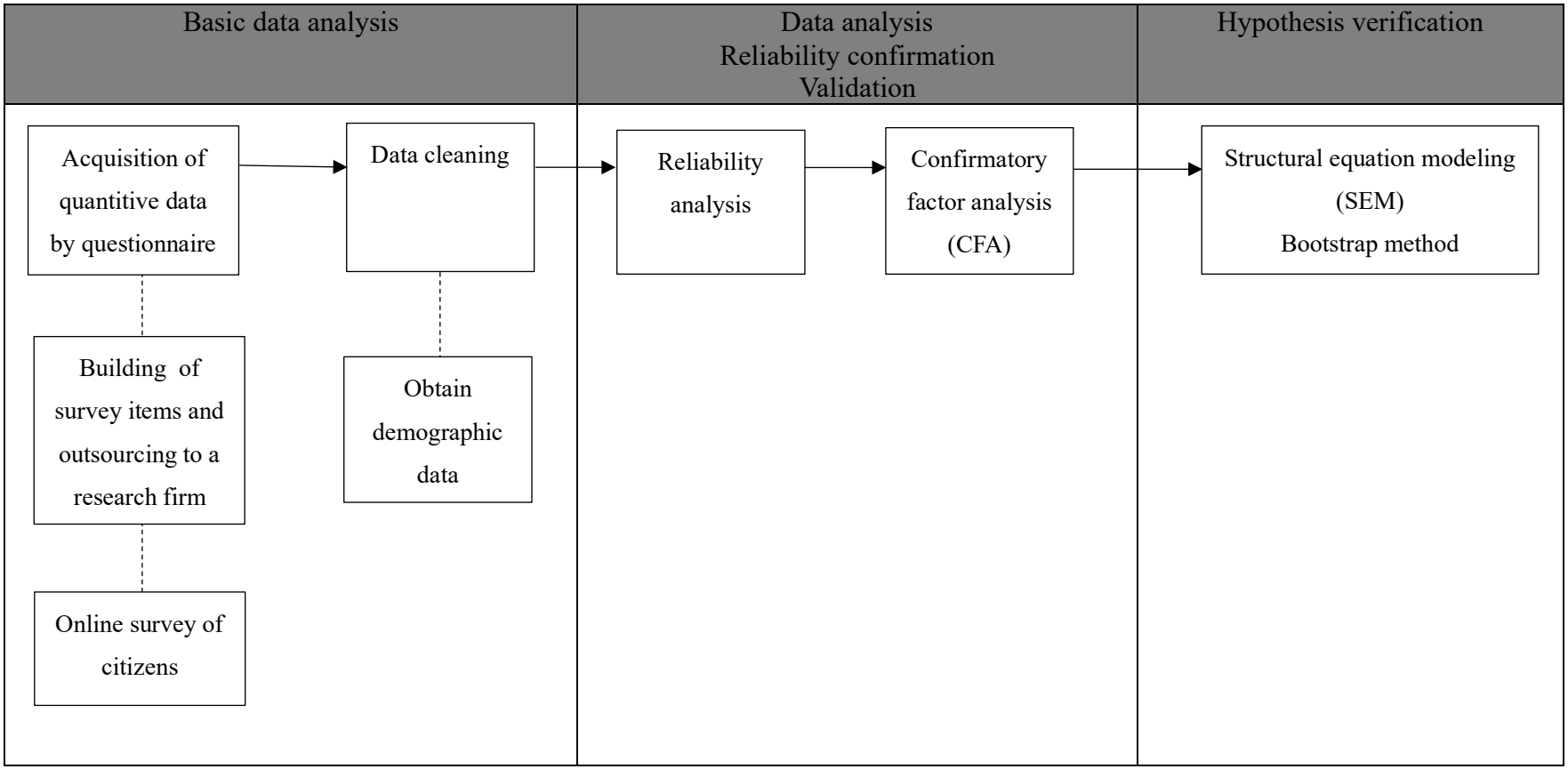


Figure 3.2: Analysis scheme of research2

Table 3.2: Demographic data of respondents

		Japan
Gender	Male	71.3%
	Female	28.7%
	Total	100.0%
Age	Twenties (20-29)	3.2%
	Thirties (30-39)	11.8%
	Forties (40-49)	18.5%
	Fifties (50-59)	25.8%
	Sixties (60-69)	25.5%
	Seventies (70-79)	15.2%
	Total	100.0%
Frequency of driving	Everyday	42.3%
	Several times a week	36.0%
	Once a week	15.0%
	Several times a month	6.7%
	Once a month	0.0%
	Total	100.0%
Powertrain Type	Gasoline	65.9%
	Hybrid	32.5%
	Diesel	0.3%
	Other (eg., EV, PHV, FCV)	1.4%
	Total	100.0%

3.3.3 Bias and sample reliability

In order to assess non-response bias, we selected the first and last 10% of respondents to compare early and late respondents (Armstrong and Overton 1977). Next, t-test was used to assess these two samples, which showed no significant differences. It is recognized that there is no nonresponse bias in this study. In the process of validation, common method bias is a possible problem in any survey (Tabacknick and Fidell 2007). In order to examine the normality and outliers, the Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity tests were applied. For sampling accuracy, a KMO value close to one represents a more accurate sample size. For the Bartlett's sphericity test, the p-value was used as a measure of the significance of the correlation between factors. The KMO value was 0.970, and the chi-square value for Bartlett's test was 14,054.230, with a p-value of <0.05. Thus, there was little concern regarding multicollinearity and all measurement scale items were highly appropriate for factor analysis (Tabacknick and Fidell 2007).

Reliability refers to the overall consistency of a test yielding a given measure. Table 3.3, Table 3.4, Table 3.5 presents the results of the tests discussed in this chapter. Cronbach's alpha was used to measure the reliability of each factor. Factors with an alpha of 0.7 or greater were deemed reliable (Nunnally 1978), indicating that the items on each measurement scale were appropriate for the survey.

3.3.4 Confirmatory factor analysis

A confirmatory factor analysis (CFA) was conducted to verify construct validity (Gerbing et al. 1988). A measurement model was applied to identify the relationship between the factors and their corresponding measurement scale items (observed variability), followed by a structural modeling method to verify the hypothesized relationships. The following subsections describe the CFA validation. Table 3.3, Table 3.4, Table 3.5 presents the factor correlation matrices for all the constructs.

3.3.4.1 Measurement model evaluation

The goodness-of-fit statistics were examined using a measurement model. The cut-off points for each goodness-of-fit index (GFI) were a ratio of chi-square to degrees of freedom (x2 /df) less than 5.0, a comparative fit index (CFI) between 0.9 and 1.0, and a root mean square error of approximation (RMSEA) value less than 0.080 (Hu et al., 1997). The model fit indices showed a relative chi-square value of 2.64, CFI = 0.953, GFI = 0.862, and RMSEA = 0.073. These results indicate that the measurement model had a

relatively good fit and established one-dimensionality. We examined the measurement model via CFA and identified several measurement scales that did not directly measure the factors, and were therefore excluded from subsequent analyses. Several measurement scales were excluded from subsequent analyses in the CFA. Thus, the 23 scale items included in the goodness-of-fit measurement model were perceived quality (five items), social quality (five items), corporate social responsibility (five items), customer satisfaction (four items), and customer loyalty (four items).

3.3.4.2 Verification of construct validity

The construct validity has both convergent and discriminant validities. Convergent validity is the extent to which an observed variable measures an inherited factor. The average variance extracted (AVE), which is the value of the variance introduced by a factor relative to the measurement error, is a well-known analytical tool for assessing convergent validity. The AVE is the value of the variance introduced by the factor for measurement error (Fornell and Larcker 1981). The criterion for AVE is 0.5 and that for CR is 0.7 (Bagozzi and Yi 1988; Byrne 1989). In this study, the AVE ranged from 0.683 to 0.823 and the CR ranged from 0.915 to 0.956 (Table 3.3 and Table 3.4). Hair et al. (2014) compared the square root values of the AVEs with the square correlations between factors and organized them in the same way as in our study. The diagonal values represent the square root of the AVE for each factor. Each diagonal value exceeded the respective correlation. The discriminant validity was supported (Table 3.6).

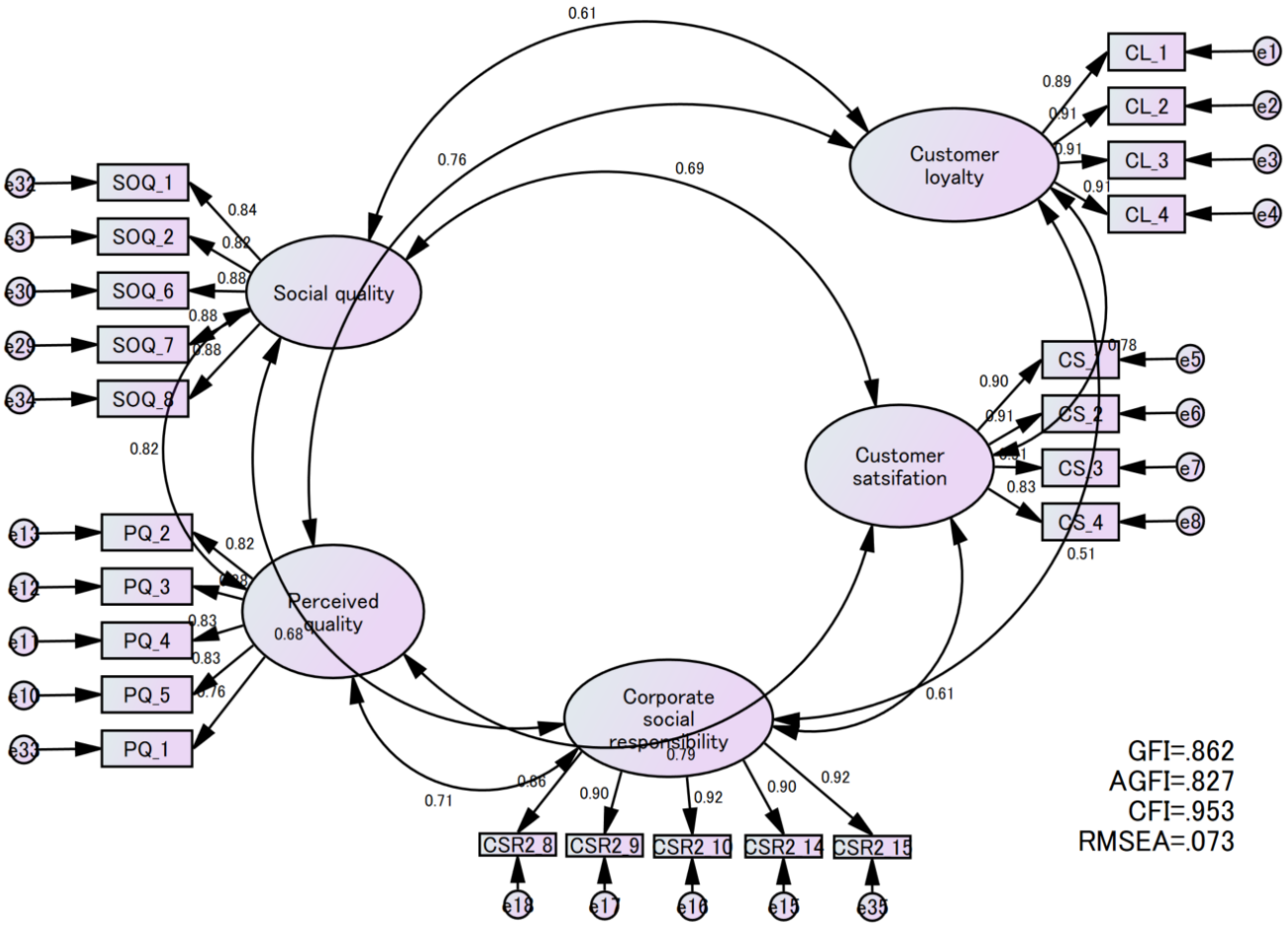


Figure 3.3: Measurement model

Table 3.3: Results of confirmatory factor analysis (Factor 1 – Factor2)

	Standardized loadings	CR	AVE	Reliability Coefficient (alpha)
Factor 1. Perceived quality (PQ)		0.915	0.682	0.913
This vehicle has a good reputation for environmental protection.	0.763			
The advertisement of this vehicle company gives a good impression.	0.819			
This vehicle generally has a good reputation.	0.880			
This automotive company's brand is well known worldwide as a quality brand.	0.833			
This automotive company generally has a good reputation for CSR.	0.831			
Factor 2. Social quality (SOQ)		0.933	0.736	0.933
This vehicle can depart quietly without disturbing people in the vicinity outside the vehicle.	0.836			
This vehicle makes little noise to people in the vicinity outside the vehicle.	0.821			
The smell of emission gas of this vehicle is not strong.	0.876			
This vehicle emits less gas and is environmentally friendly.	0.880			
This vehicle leaks less fuel and is environmentally friendly.	0.876			

Notes: KMO = 0.970 ($x2 = 14{,}054.230$, $p < 0.05$); n=313

Table 3.4: Results of confirmatory factor analysis (Factor 3 – Factor4)

	Standardized loadings	CR	AVE	Reliability Coefficient (alpha)
Factor 3. Customer loyalty (CL)		0.949	0.823	0.949
You would like to inform good point this automobile to someone who wants advice.	0.892			
You would like to recommend this automobile to someone who needs advice.	0.910			
You would like to tell a family member, acquaintance, or friend about this automobile.	0.914			
You would like to recommend to drive this automobile to a family member, acquaintance or friend.	0.913			
Factor 4. Corporate social responsibility (CSR)		0.956	0.813	0.955
This automobile company seeks to ensure long-term success.	0.860			
This automobile company will always respect the rules and regulations set forth by law.	0.901			
The automobile company is committed to social responsibility.	0.924			
The automobile company strictly manages its environmental impact.	0.905			
The automobile company invests in environmental protection activities.	0.918			

Notes: KMO = 0.970 ($x2 = 14{,}054.230$, $p < 0.05$); n=313

Table 3.5: Results of confirmatory factor analysis (Factor 5)

	Standardized loadings	CR	AVE	Reliability Coefficient (alpha)
Factor 5. Customer satisfaction (CS)		0.951	0.830	0.936
You are satisfied with the experience of being involved with this automobile.	0.899			
You are satisfied with my decision to purchase this vehicle.	0.912			
You are satisfied with the car.	0.915			
This car is close to your ideal.	0.827			

Notes: KMO = 0.970 ($x2 = 14{,}054.230$, $p < 0.05$); n=313

Table 3.6: Results of the factor correlation matrix

	PQ	SOQ	CL	CSR	CS
Perceived quality (PQ)	**0.826**				
Social quality (SOQ)	0.824	**0.858**			
Customer loyalty (CL)	0.761	0.613	**0.907**		
Customer social responsibility (CSR)	0.712	0.679	0.510	**0.902**	
Customer satisfaction (CS)	0.786	0.691	0.783	0.611	**0.889**

Note: All correlations are significant at the 0.01 level (two-tailed).

3.3.5 Structural equation modeling

Structural equation modeling (SEM) was carried out the proposed conceptual model. The 313 samples exceeded the minimum sample size, making them reliable (Hussey and Eagan, 2007). For mediation effect validation, the bootstrap method was used. The bootstrap sample size was 5000 times, with a bias-corrected confidence interval of 95% (Hair et al., 2017). Similar to the measurement model, the GFI was evaluated to prove the suitability of the structural model. The results were: CFI = 0.943, GFI = 0.851, and RMSEA = 0.080. The structural model was statistically significant at the 0.01 level because the fit index values were within the cutoff point (Hu and Bentler 1997). These indices indicate relatively good fit of the measurement model, and the model in this study is considered appropriate. Table 3.7 presents the results of this analysis. Hypothesis 1 indicates that perceived quality significantly affects customer satisfaction (standardized coefficient = 0.671, $p < 0.01$). Babakus, Bienstock, and Van Scotter (2004) supported this hypothesis., showing that perceived quality exerts significant influence on customer growth, and its impact is mediated by customer satisfaction. Perceived quality influences customer behavior, including reputation. Hypothesis 2a examines the impact of CSR on perceived quality. This hypothesis was supported (standardized coefficient = 0.376, $p < 0.01$). LACAP et al. (2021) states that CSR has a positive direct effect on perceived quality, and brand loyalty. And there were 557 surveys collected through an online survey panel that showed there is a significant relationship between CSR and perceived quality (Servert et al., 2022). These results are not only evident in the automotive industry, but also in other industries. CSR is incorporated into management policies by companies for the purpose of social symbiosis, and they always make their activities known outside the

company. Various methods are used by companies to make their activities known to the public. One of the most common is to prepare and publish a CSR report. Such corporate activities are considered to appeal to customers' perceived quality. The findings strongly supported the fact that particular cues, namely perceived financial performance and perceived quality of ethics statements, influence perceived CSR, which, in turn, impacts perceptions of corporate reputation, consumer trust, and loyalty. Hypothesis 2b examines the impact of CSR on customer loyalty. However, this hypothesis was not supported (standardized coefficient = 0.047, $p > 0.05$). This indicates that CSR does not directly affect customer loyalty; CSR is a corporate social responsibility activity that does not necessarily appeal to loyalty. The reason may be that it is an activity for society as a company, and not something that customers directly benefit from or perceive as beneficial. Hypothesis 3a indicates that social quality significantly affects perceived quality (standardized coefficient = 0.711, $p < 0.01$). This is finding of this study. Social quality involves environmentally friendly aspect. Customers are highly concerned about environmental friendliness, which is believed to be reflected in perceived quality. Recent corporate efforts to reduce GHG emissions, recycle waste, and other global environmental concerns are often covered in the media and are considered to be of high interest to customers (Ariffin et al., 2016). The same is also true for clean exhaust gases and odors. In response to consumers' demand for livable cities and quality of life, companies need to address air pollution and odors. Such efforts are likely to be reflected in perceived quality. Hypothesis 3b indicates that social quality does not impact customer satisfaction (standardized coefficient = 0.128, $p > 0.05$). It was shown that social quality does not necessarily directly affect customer satisfaction in the automotive industry. Hypothesis 4 indicates that customer satisfaction is highly significant for customer loyalty (standardized coefficients = 0.755, $p <0.01$). This result is as same as Syahrial et al. (2018). The hypotheses, paths, standardized coefficients, and results of the hypotheses (direct effect and mediation) are summarized in Table 3.7.

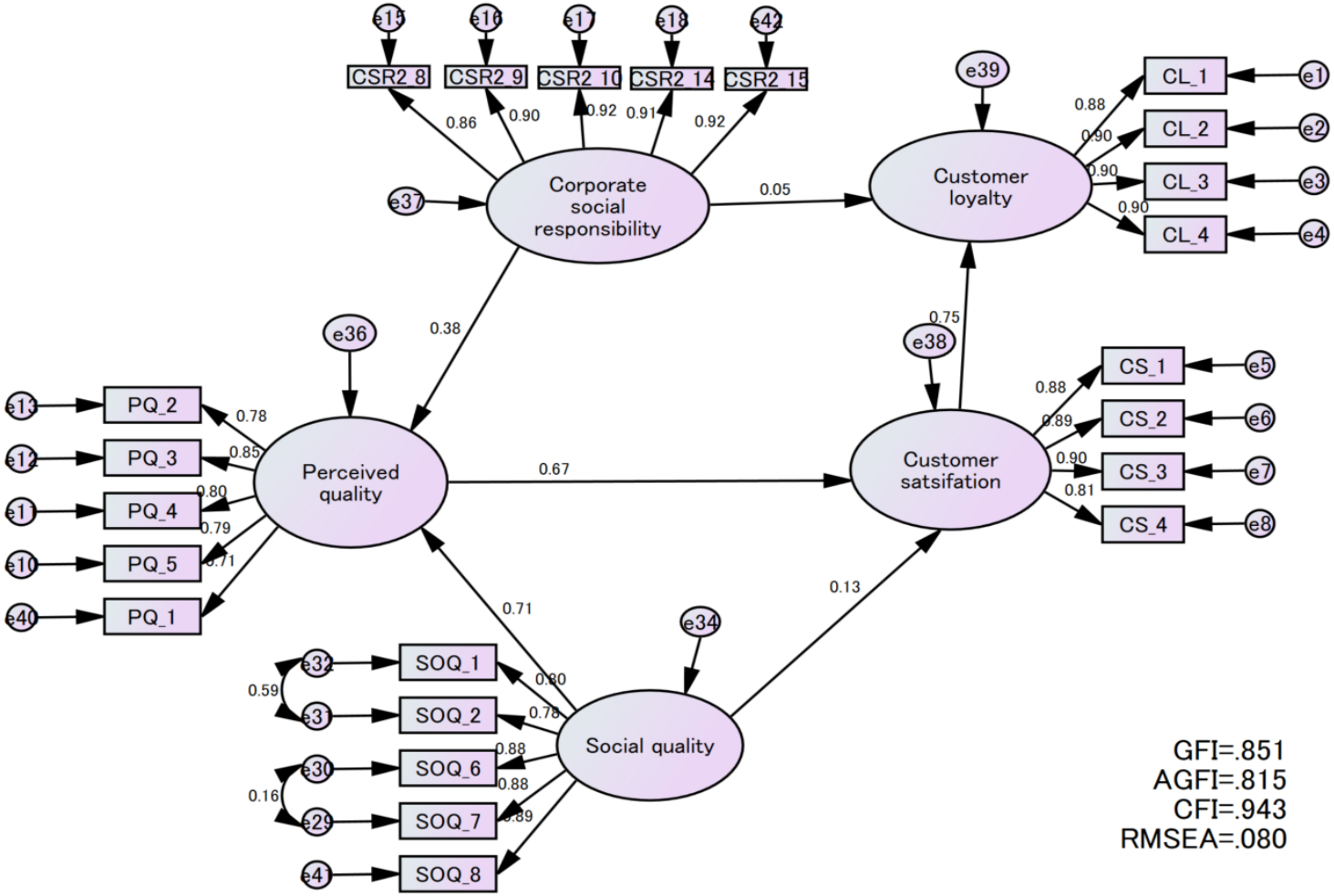


Figure 3.4: Structural model

Table 3.7: Summary of hypotheses test results for the structural model

Hypo-theses	Path	Standardized coefficient	Hypothesis supported?	Supported literature
H1	Perceived quality(PQ) -> Customer satisfaction(CS)	0.671***	Yes	Syahrial et al. (2018) Prasadh (2018)
H2a	Corporate social responsibility(CSR) -> Perceived quality(PQ)	0.376***	Yes	Tingchi et al. (2014) LACAP et al. (2021)
H2b	Corporate social responsibility(CSR) -> Customer loyalty(CL)	0.047	No	Latif et al. (2020)
H3a	Social quality(SOQ) -> Perceived quality(PQ)	0.711***	Yes	Finding of this research
H3b	Social quality(SOQ) -> Customer satisfaction(CS)	0.128	No	Suzuki et al. (2018)
H4	Customer satisfaction(CS) -> Customer loyalty(CL)	0.755***	Yes	Syahrial et al. (2018)

Path significant at ***p<0.01

Table 3.8: Summary of mediation test results for the structural model

Path	Path explained	Standardized coefficient	Significant	Supported literature
CSR ->PQ ->CS	PQ mediates the relationship between CSR and CS	0.252***	Yes	LACAP et al. (2021)
SOQ ->PQ ->CS	PQ mediates the relationship between SOQ and CS	0.477***	Yes	Finding of this research

Path significant at ***p<0.01

3.4 Discussion and managerial implications

In this section, we discuss the considerations and implications based on the survey results. First, as a result, we believe that this research has revealed the importance of practicing CSR, perceived quality, and social quality for customer satisfaction and loyalty. This study explores the impact of CSR, social quality and perceived quality on customer satisfaction and customer loyalty. The survey questionnaire's 23 questions were easy to understand, had a high response rate from mobility users in a short period of time, and were not ambiguous. Those who gave the same answer to all question items were first excluded from the analysis. The hypothesized results show that the most important quality dimension is perceived quality, which has a strong impact on customer satisfaction (standardized coefficient = 0.671, p-value < 0.01). Perceived quality consists of advertising and branding, and customers are highly interested. Customer perceptions of mobility manufacturers and mobility can include advertisements and billboards. Customer images of merchantability are often formed, for example, through television commercials. Chakraborty and Bhat (2018) revealed that source and review quality have a more significant effect on the credibility evaluation of online reviews than review consistency and receiver. Moreover, credible online reviews have a greater impact on hedonic brand image than functional brand image in the context of consumers. After COVID 19, people often moved on to advertisements on the Internet, followed by videos, to view products. El Naggar and Bendary (2017) stated that brands, experiences, and associations, as well as perceived quality, enhance brand loyalty through a reliable, trustful relationship from their analysis. For example, Dam (2020) found that customers value brand trust, so they are willing to buy, and brand trust has a large positive impact on brand preference, so brand trust has a positive effect on purchase intention. said to have an impact. Thus, perceived quality is considered to have a significant impact on customer behavior. On the other hand, CSR does not impact customer loyalty (standardized coefficient = 0.047, p > 0.05). CSR is considered a quality element that serves as a point of contact between the customer and the automaker’s sales channel. Typically, there is no direct contact between automobile manufacturers and their customers. Therefore, CSR does not directly affect customer loyalty. In addition, social quality does not affect on customer satisfaction. Although environmentally friendly element is considered to be an attractive quality of a product, its direct effect is considered to be small because it is not a must-be quality to obtain customer satisfaction. It is believed that whether or not customers perceive benefits to the environment, such as the conversion of benefits to money, will be an important factor. However, the relationship between CSR and customer satisfaction was supported by mediation tests (standardized

coefficient = 0.252, $p < 0.01$), which confirmed the partial mediation from CSR to customer satisfaction, mediated by perceived quality. CSR affects perceived quality (standardized coefficient = 0.376, $p < 0.01$). CSR is being implemented as one of the SDG activities. It is also part of a company's public relations activities, along with ESG integrated reporting. Jimenez et al. (2021) mentioned that CSR and ESG activity for SDGs connects to customer's trust and reliability. Moreover, Jimenez et al. (2021) mentioned that to achieve the SDGs companies need to shift found from the "business as usual" approach, which perceives sustainability as an externality, to incorporating sustainability factors in the company's underlying purpose. CSR activity leads corporate brand and reputation from customer and stakeholders. Other reason is culture background of Japan. In addition, Kumar et al. (2017) mentioned that comparing the cultures of USA, Italy, and Japan with respect to CSR, the authors describe the existence of different stakeholder cultures. They also found that the prevalence of the type of stakeholder culture in each country is influenced by the cultural values and institutional arrangements in that country. Japan is an advanced CSR country and is considered to have a high level of public awareness. Hence, hypothesis H2a was supported. Perceived quality played mediating role in the relationship between CSR and customer satisfaction (standardized coefficient = 0.162, $p < 0.01$). This is because the company's CSR is perceived as a quality by the customer, leading to satisfaction. Moreover, the relationship between social quality and customer satisfaction was supported by mediation tests (standardized coefficient = 0.477, $p < 0.01$), which confirmed the partial mediation from social quality to customer satisfaction, mediated by perceived quality. Social quality affects perceived quality (standardized coefficient = 0.711, $p < 0.01$). Similar trend is also observed in Chen et al. (2015). Environmental affinity had a significant positive impact on green satisfaction, green perceived quality, and green trust, indicating that the positive relationship between environmental affinity and green trust is partially mediated by green satisfaction and green perceived quality. This is thought that this may be due to a similar structure as in the present study, in which satisfaction with environmental affinity is mediated by perceived quality. Regarding firm and product quality, Syahrial et al. (2018) confirmed that customer satisfaction with Garvin's eight quality dimensions is high. Customers are satisfied with the merchantability of the product in terms of performance and functionality. On the other hand, if social quality corresponds to the attractiveness quality in the Kano model (Kano et al. 1984), consumers are likely to regard it as an added value in itself. Therefore, customers are considered to be satisfied with the environmental quality through the brand and trust. Customer satisfaction had a significant influence on customer loyalty (standardized coefficient = 0.795, $p < 0.01$). This result is supported by previous

studies (eg, Suzuki et al. 2010).

In terms of business implications, through marketing, management considers appropriate approaches from different angles and perspectives to ensure that the product is consistent with market trends. Since perceived quality has a significant impact on customer satisfaction, image enhancement through the media is considered to be effective. Since the number of people using SNS and video streaming services has been increasing after COVID-19. Because people need to stay their home and get information from internet. Moreover, Although the economy was temporarily in recession during COVID-19, it is also true that these Internet service industries drove the economy and continued to grow rapidly. It is considered effective to utilize internet service platforms and build up them. For example, company launches its owned media and regularly disseminates information, the algorithms of video distribution services make it easier for customers to play the videos and communicate the company's initiatives to customers. In Japan, Toyota Motor Corporation has been successful in acquiring fans through effective use of the owned media. From the above, it is considered necessary for marketing managers to grasp the media elements (e.g., entertainment) that the market is seeking and to communicate their company's CSR and environmental quality. Owning your own owned media is extremely valuable. The reason for this is that the video itself becomes an asset to the company. Videos posted on video distribution service platforms are viewed by viewers at their own convenience. Since the audience is diverse, some viewers may watch on the train during their commute to work, while others may watch in the evening after they return home. In addition, since the majority of viewers use their smartphones when watching, they watch at their own will, regardless of where and when they watch. Furthermore, many people watch the programs over and over again. The more people who watch a video and the more times they watch it, the more appealing it is to society. An additional reason is the high degree of freedom in creating videos. With television and newspapers, it is difficult for companies to communicate what they originally want to say and how they really are because of broadcast ethics and the right to broadcast. It is often practically difficult for employees of a company to go to a television station and voice their opinions. However, if it is the company's own owned media, the production can be done in-house. This makes it possible to deliver what the company originally wants to say and what is going on inside the company to people outside the company. The reality is that it is difficult for outside TV stations and newspapers to cover the internal affairs of a company without including arbitrary opinions due to the structure of the business. However, with their own owned media, it is possible to directly inform viewers of internal company affairs. In addition, the effectiveness of their own owned media lies in the fact

that they can be expected to increase the motivation of personnel within the company, thereby improving their productivity. Employees may enjoy the pleasure of disseminating information outside the company in order to increase their motivation. Therefore, we propose that company management actively promote to grow up the owned media.

3.5 Conclusion

This section describes the conclusions of Chapter 3. This study used the automotive industry as a case study to investigate the impact of social quality, perceived quality, and CSR on customer satisfaction and loyalty. Table 3.9 shows summary of this research and previous literature. By utilizing Garvin's quality dimensions, we were able to understand customer perspectives on the product quality and we also examined the impact of CSR. As each customer's opinion and comments are different (Brucks, Zeithmal, and Naylor 2000), we were able to show additional results in the manufacturing industry. Five dimensions were extracted as a result of EFA. The results of the hypothesized structural model were reported by CFA. Using a large sample of automobile users from all over Japan, the validated structural model was determined to be a good fitting. The model interprets the relationship between five extracted dimensions of social quality, perceived quality, CSR, customer satisfaction, and customer loyalty. Six hypotheses were tested, and five hypotheses showed significant relationships between the two constructs. Serviceability is a factor that influences customer satisfaction. CSR was considered as a new dimension in this study. For example, CSR is not a factor that directly influences customer loyalty, but it does influence customer satisfaction through the mediation of perceived quality. Therefore, CSR has been recognized as one of the effective factors in customer satisfaction and may become a consideration in future market investment and technology development strategies. From this research, it can be inferred that manufacturers who are proactive in CSR build strong relationships based on customer trust.

The limitations of this study are described. We conducted a questionnaire survey of Japanese citizens, but did not limit the demographic categories with regard to the sample size. In previous studies, we did not aim to detail by attribute, and we stand by the same concept in this study. It is also stated that even in surveys, the decision against asking questions separately by gender needs to be made based on whether there is a purpose in doing so and needs to be considered when integrating (Heidari et al., 2016). This study does not address differences by attribute as a limitation of the study, as it is not an objective in and of itself. In order to better reflect the actual situation, the questionnaire

survey was designed to take into account the recent social conditions, such as gender differences, taking into account the progress of a genderless society. In addition, the survey was not limited by residential area attribute, although the sample size was more than 300. In the case of automobiles, those who live in urban areas own cars but do not use them frequently, while those who live in rural areas have cars as a necessity. Limiting the size of such cities as an attribute is one option. It should be noted here, however, that the data in this study were obtained in the same manner as in previous studies to ensure universality and are reliable data.

Table 3.9: Summary between research 2 and the existing literature

Literature	Key dimensions	Other dimensions	Findings
Devaraj et al. (2001)	Service satisfaction, Product quality, Loyalty	Quality belief	• Examined product and service quality using a model that integrates it into the prediction of repurchase behavior.
Schvaneveldt (2011)	Garvin quality dimensions	Social quality	• Proposed societal quality as another dimension of quality which extends Garvin's original set of eight dimensions.
Kianpour, Jusoh and Asghari (2014)	Garvin quality dimensions and environmental friendly		• Explored consumers' opinions on the demand side to examine environmentally friendly capability as a new dimension of product quality. • Customer responded that environmentally friendly is an important part of a product along with other dimensions of product quality.
Erialdi Syahrial, Hideo Suzuki and Shane J. Schvaneveldt (2017)	Ownership cost, Customer satisfaction and Customer loyalty	Garvin quality dimensions	• This research investigated the influence of ownership cost on automobiles customers' perspective through maintenance, service and repair. • This research also found benefit in utilizing Garvin's quality dimensions for understanding customer perspectives of product quality for Japanese automobiles and examined the impact of ownership cost in after-sales service.
Suzuki et al. (2018)	Garvin quality dimensions	Social quality	• With respect to automobiles for Japanese citizens, social quality was shown to have a negative effect on customer satisfaction. However, this is a study of direct effects.
This study	Perceived quality, Customer satisfaction and Customer loyalty	CSR, Social quality	• Social quality positively influences customer satisfaction not through a direct effect but through an indirect effect mediated by perceived quality. Notes: Social quality->Perceived quality->Customer satisfaction (Standardized coefficient= 0.477***(Japan)) Path significant at: ***p<0.01

Table 3.10: Anticipated future research of research 2

Classification	Contents	Future research
Findings	• Social quality positively influences customer satisfaction not through a direct effect but through an indirect effect mediated by perceived quality	• Verification of specific corporate measures regarding social quality and the effectiveness of their implementation • Establishing a system for implementing corporate measures to ensure social quality
Supported hypothesis	• CSR positively influences customer satisfaction not through a direct effect but through an indirect effect mediated by perceived quality	• Implementation of effective measures to perceive CSR and verification of their effectiveness

Chapter 4 Visualizing the project of design for environment to improve the feasibility for corporate social responsibility

4.1 Introduction

One of the social responsibilities of a company is to manufacture and develop environmentally friendly products. To achieve this, design for environment (DfE) is required, and the Ministry of Economy, Trade and Industry (METI) has set guidelines (Ministry of Economy, Trade and Industry, 2019). In addition, companies need to actively engage in DfE because the social quality of a product, mediated by perceived quality, affects customer satisfaction. However, in order to execute DfE, project management must be effective and improve feasibility. In project management, gantt charts and flow charts are used to manage projects, however it is pointed out that these methods do not contain accurate information for decision making (Browning, 2010). Individual designers involved in product development may be aware of the design process for which they are responsible, however may not be fully aware of the design process outside their responsibilities. As a result, an improper design process causes a major design rework, and as a result of accumulating component designs, it is difficult to meet product requirements simply by matching existing technologies (Koga et al., 2009). The reason is that 80% of all life-cycle costs of the product is decided at the initial design stage (Fabrycky, 1991). Therefore, in order to meet product requirements, it is necessary for the project manager to have each individual designer involved in product development understand the design process outside the scope of their responsibility at the initial design stage.

The view of this study is to have each individual designer involved in product development to understand the design process outside the scope of their responsibility in the DfE process from the requirement definition to the prototyping at the phase of feasibility study stage based on V model approach (Harold, 2014) of system engineering. As an approach to environmental, social, and governance investments and sustainable development goals (SDGs), the design for environment (DfE) needs to be implemented based on the guidelines of United Nations (United Nations, 2019) and METI (Ministry of Economy, Trade and Industry, 2019). These guidelines recommend choosing DfE as a means of developing SDG initiatives from the product and service category. However, the specific process depends on the ingenuity of each company or organization and they

did not describe the connection between the overall project and the tasks in DfE.

The proposal of this study is the assurance case description method which is in order to visualize the DfE process. As for the evaluation method in this study, a questionnaire survey is conducted before and after seeing an assurance case whether the designer be able to understand the processes outside the scope of his/her responsibility. Next, we describe the novelty of this study. From the viewpoint of project management, Levardy et al. (2009) proposed a modeling framework for process models that support product development. At the view point of project visualization and planning, Browning described that process models can support ongoing project management by helping the project manager monitor interim results (Browning et al., 2007). Browning et al. (2001) pointed out that the design development process is complicated by the independent design activities and the design information flow with many starting points, and proposed to analyze the complicated process using DSM (Design Structure Matrix). Browning et al. (2006) showed that it is possible to support restructuring from the viewpoint of "As Is" and "To Be" by using the model of the product design process and the development organization for which DSM is applied. Nakazawa et al. (2006) pointed out that the main part of the product development process is an indigenous person, and an RDC model was proposed as a methodology for explicitly describing the implicit design process. However, these studies do not refer the dependability and operation guarantee of the methodology. Focus on the methodology, assurance case (ISO15026-2-2011) description method was proposed for solving communication challenges in business (Kobayashi et al.,2016). Kobayashi et al. (2018a, 2018b) also showed that using assurance cases increases the feasibility of accomplishing management vision and management strategy. However, these previous studies do not mention the communication and consensus in DfE process. Scoping to DfE process and consensus building, Ameknassi et al. (2016) showed that multi stage methodology for defining, modeling, and solving DfE problems. This integrated approach includes Life Cycle Assessment (LCA) checklist and Quality Functional Deployment (QFD) in order to support designers in implementing DfE activities effectively. Ramanujan et al (2019) indicated the visual analytics system which is called VESPER, for generating contextual DfE principles in sustainable manufacturing. The tasks involved can be divided into following steps (i) data gathering and preprocessing, (ii) interactive visual exploration, and (iii) DfE principle(s) generation. In order to carry out design cooperatively, Takechi et al. (2000) proposed a method for linking process information to resolve inconsistencies and a method for changing process information to resolve conflicts, based on the modeling of the product and the design process. Ignacio et al. (2014) proposed the consensus model for heterogeneous group

decision making problems guided also by the heterogeneity criterion. However, these studies do not refer these studies do not satisfy both of consensus and accountability. Therefore, the novelty of this study is to propose the assurance case description method which is applied for the DfE process of automobile interior development, in order to visualize the DfE process and also assure the dependability and accountability. From above, this study aims to make project members recognize their tasks by visualizing the entire project process based on the Spiral model (Boehm, 1988) and V-model approaches (Harold et al., 2014) of system engineering. Accordingly, a method for visualizing the entire DfE process is proposed by applying an assurance case. Furthermore, a survey was conducted before and after applying the method of combining a Spiral model and an assurance case to evaluate whether the member can understand the entire process and the corresponding task importance. Research objective of this study is to ensure the feasibility of the DfE by making person in charge understand DfE process task and outputs.

This paper is organized as follows. We explain the research objectives in 4.2, previous studies of this proposal in 4.3. We show the proposed assurance case description method for DfE in 4.4. Then, we show evaluation method, results of evaluation, and discussion in 4.5 and 4.6. Finally, we conclude this paper and state the future research topics in 4.7.

4.2 Previous studies

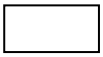
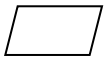
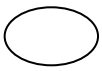
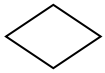
4.2.1 Definition of assurance case

The safety case was proposed by Kelly (1998) as a means of making clear, complete, and valid arguments. The safety case was proposed by Kelly as a means to ensure clear, complete, and valid discussions. The use of a safety case allows stakeholders to confirm that the system can be operated at an acceptable level of safety. The safety case allows stakeholders to confirm that the system can be operated at an acceptable level of safety. The assurance case (GSN Community, 2011) is a discussion of quality as a whole, including "safety" as covered in the safety case. The assurance case extends the scope of the discussion to include "safety" covered by the safety case and to quality as a whole. This study uses Dependability Case as a description method, which is an extension of the description method called Goal Structuring Notation (GSN Community, 2011) proposed by Kelly (1998). In this study, D Case is used instead of GSN because it is assumed to be used in the actual business operation phase. The reason for using D Case instead of GSN is to employ the monitor node, which is available only in D Case. The reason is that the monitor enables the expression of items to be checked at the time of operation, not at the

time of designing the business. The reason is that the monitor enables the expression of items to be checked at the time of operation, not at the time of designing the business.

The six main nodes of D Case used in this study are indicated by " ", which is the basic rule for the description method. “Goal" describes what is to be guaranteed. “Context" describes the state, environment, and conditions of the system, and is connected to "Goal" and "Strategy". “Strategy" describes the concept of dividing the system into subgoals, and connects the "Goal" to the subordinate goals. “Evidence" is the final guarantee that the "Goal" will be realized, and is connected to the "Goal" to be guaranteed. The "Monitor" proposes data and documents obtained from the system in operation. The "Monitor" proposes data and documents obtained from the system in operation, and connects them to the "Goal" that has the function to guarantee that the “Goal” will be satisfied. “Undeveloped" is used when there is no "Evidence" or argument to support the "Goal" and indicates an undecided state. Table 4.1: Six nodes in assurance cases shows six nodes in assurance cases.

Table 4.1: Six nodes in assurance cases

Node	Figure	Explanation
Goal		“Goal” describes what to assure, with a combination of a subject and a predicate.
Strategy		“Strategy” describes how to break down the Goal into sub-goals, thus leading to the lower layer.
Context		“Context” describes the state, or environment and conditions, of the system, and shows ways to lead to the “Goal” and “Strategy”.
Evidence		“Evidence” eventually assures that we can reach the “Goal”, and shows the ways that lead to it.
Monitoring		“Monitoring” is intended to represent “Evidence” available at runtime, corresponding to the target values within the in-operation ranges.
Undeveloped		“Undeveloped” indicates the status that there is no “Evidence” or “Monitoring”, or discussion supporting the “Goal”.

A requirement quality function development table can be utilized as a method for describing a business process (Kobayashi et al., 2019). The framework is organized by role and function. Compared with D-Case and GSN, both D-Case and GSN have dependability and accountability features. Therefore, project managers cannot reliably confirm implementation. Herein, D-Case is used instead of GSN because it assumes the

operation stage and adopts a node called “Monitor,” which is prepared only for D-Case. Considering the three elements in this study, the field of application is the quality assurance field of business. The other two elements are discussed in the following sections. In order to separate the hierarchy, we propose the conventional assurance case description method. In order to divide the hierarchy, there are two types of proposals: one is a proposal for only an argument decomposition pattern to divide the nodes, and the other is a proposal for both an argument decomposition pattern and a description rule. In this study, we use the proposal of argument decomposition patterns and description rules. It should be noted that the drawbacks and points to keep in mind when using the argument decomposition pattern are pointed out (Yamamoto et al., 2013). Architectural decomposition is a decomposition according to system structure Functional decomposition is a decomposition of a claim according to functional structure Attribute decomposition is a decomposition of a property into multiple attributes Inductive decomposition is a decomposition by dividing an explanatory object into cases. Given the above issues, we propose the assurance case description method in this study as a description method that takes these factors into account.

4.2.2 Issue of assurance case and novelty of this study

In this chapter, we discuss the issue of the assurance case description method in particular. Yamamoto et al. (2012) point out that the following seven questions often arise as known issues regarding assurance case. The following are seven items; i) what to write as "Goal" and how to write it, ii) what to write in the "Strategy”, iii) how much to expand the range of decomposition in the “Strategy”, iv) what to write in "Context”, v) what to write in "evidence”, vi) how deep should the tree structure go, vii) how to analyze the relationship between "context" and "evidence”. In addition, Yamamoto et al. (2012) point out that the following three elements are effective in resolving these questions. First element is “limitations of applicable fields”, and second element is “hierarchical structure of assurance case”, and finally, third element is “description rules for nodes”. Considering the three elements in this study, the applicable field is the quality assurance field of the Design for Environment process. The setting of the other two elements is discussed. In order to separate the hierarchy, there are two types of proposals for conventional assurance case description methods: one is a proposal for only argument decomposition patterns to separate nodes, and the other is a proposal for both argument decomposition patterns and description rules. In this study, we use the proposal of argument decomposition patterns and description rules. Furthermore, in a previous study, Yamamoto et al. (2013) pointed out that there are "four mistakes beginners tend to make"

when creating assurance cases due to a lack of understanding of assurance cases. First one is to mistake “strategy” for “goal”. Second one is to content that should be written as "Goal" is not a proposition but an executable or functional statement. Third one is to misinterpret "strategy" as a decision branch. Forth one is that we break down the functions in the order of their execution, rather than by argument by using “Strategy”. Given the above issues, we propose the assurance case description method in this study as a description method that takes these issues into account.

Novelty of this study is that we clarified the steps to apply to the DfE process, and after describing the content of the use case description in the context node as a premise, aggregate the evidence of the decomposed process and put it in the context of another process. It is at the point that connects to the node. In DfE, there are a number of items that must be confirmed at the initial design stage. Using that content, it is essential to move on to the next step. Since the description method developed in this research can express this process, it is thought that it contributes to the purpose of improving the feasibility of DfE. The details of the notation itself are given in the next chapter.

Table 4.2: Summary of previous studies (Related definitions and business model)

	Proposed methodology	Applicable subjects	Business process			Quality item
		Automobile	Visualization of the entire business process	Visualization of the work flow	Visualization of outputs and evidences	Perspectives on quality assurance
Kano et al. (1984)	Definition of quality	○				○
Akao (1974)	Quality functional deployment	○	○	○		○
Ohtomi (2005)	Product design methodology map	○	○			○
Srikar (2003)	Application of the Ashby Approach	○		○		○
Osterwalder (2004)	Business model ontology	○	○	○		
Hoque (2014)	Modified balanced scorecard	○				
This study	Assurance case	○	○	○	○	○

Table 4.3: Summary of previous studies (Related assurance methodology)

	Proposed methodology	Initial Project Phase			Section end of project phases		Before beginning project
		Assurance			Evaluation		Feasibility
		Visualization of the entire business process	Responding to requests clarification of response procedures	Hierarchical structure representation	Evaluation of assurance structure	Quantitative evaluation from the perspective of business improvement	Representation of DfE process
Seki et al. (2011)	Design structure matrix	○				○	
Kaneko et al. (2014)	Common Criteria-Case			○		○	
Tokoro (2013, 2014)	Accountability procedures		○				
Tim Kelly (2007)	Six attributes to tree structure				○		
Kobayashi (2018a)	Assurance case	○	○	○		○	
This study	Assurance case (Additional new description method)	○	○	○		○	○

4.3 Method of combined spiral model and the assurance case based on V-model in value engineering

4.3.1 Methodology

In this section, we visualize the combined method by using the assurance case. This methodology is applied to value engineering in the development of automobile interiors. Figure 4.1 shows the phases of the project life cycle and the total expenditure profile (Forsberg et al., 2005; Fabrycky et al., 1991) based on the systems engineering handbook (INCOSE, 2015). In this study, the schedule fitted to the project life cycle shown in Figure 4.1 was planned for the development of an automobile interiors. DfE initiatives promoted in CSR are implemented in the initial development phase for front loading (Ohtomi, 2005). According to Figure 4.1, We tried to apply the methodology in this study to the Concept Stage (INCOSE, 2015), which has a large effect of investment (Fabrycky et al., 1991). However, differences in the common language and understanding of development among the project members involved cause rework (Seki et al., 2011). Therefore, the novelty of this study is to improve the feasibility of DfE by simultaneously having dependability, accountability and implementation confirmation, which are the feature of the assurance case (Matsuno, 2010). We visualized the entire DfE process using a biaxial diagram in the system design, as illustrated in Figure 4.1. This model is applied in Concept Stage (INCOSE, 2015). This diagram is related to the Spiral model (Boehm, 1988) in the project cycle. The horizontal axis represents the value and function required by the customer, and the vertical axis represents the planning and development, which is one of the phases of the process. The curved arrow in Figure 4.2 represents building the process counterclockwise from Area1 to Area4, whereas the double-headed arrows indicate mutual confirmation. Herein, we propose to apply the assurance case in product development corresponding to Areas 3 and 4 in Figure 4.2. This assurance case is applied based on the V-model. Furthermore, the description method of this assurance case uses the argument decomposition pattern (Bloomfield et al., 2010; Masumoto et al., 2013). Assuming that it is confirmed by all members involved in DfE, the D-Case of the DfE process is described based on the V-model in system engineering. In the requirement definition, based on IEEE1220 (IEEE, 2005), the process was shortened by considering time constraints (Yamamoto et al., 2013).

4.3.2 Scope of applying the assurance case

The assurance case scope of reference was proposed by the GSN Community (2011) as a means to have a clear, complete and valid discussion. The use of assurance cases allows

stakeholders to confirm that the system can be operated at an acceptable level of safety (Figure 4.3). Some reasons for applying the defined assurance case coverage.

The first reason is for confidentiality. In automotive product development, information on drawings and development schedules are top secret. The automotive industry is characterized by a large market, but at the same time there are many competitors, and they invariably avoid leaking information about their developments to other companies. Most automobile companies take strict measures when technical development information or specifications regarding the appearance and performance of vehicles under development are leaked. It applies not only to employees of finished vehicle manufacturers, but also to related suppliers and steelmakers, who are required to maintain strict confidentiality, and if they leak information, their contracts will be terminated or they will be required to pay large amounts of compensation. For this purpose, any person directly or indirectly involved in the project or any generalized content that is permitted to be disclosed within the company shall be treated as available for reference. However, the scope of disclosure is in line with the definition in Figure 4.3, as it is necessary to share business processes as core knowledge to an organization with a high degree of liquidity.

The second reason is the scope of assurance in assurance cases. This study applies the assurance case to the DfE process, but has limitations in the scope of disclosure. Project-specific budgets and structures are often established, and there are restrictions on objects such as those applicable to automobile interiors but not to chassis components. For example, in the case of interior components, eco-materials are being increasingly introduced, and materials with high environmental friendliness are being used in an increasing number of cases. As part of corporate CSR activities, sustainability reports and LCA reports are published annually by automobile companies. The use of eco-plastics for automotive interior parts is a major topic of discussion, and GHG emissions over the life cycle are calculated and environmental protection benefits are quantitatively calculated. On the other hand, there is a pessimistic aspect to introducing environmentally friendly design to the parts that make up the white body and chassis of an automobile. White bodies require total section plastic moments to ensure crashworthiness in order to comply with regulations and NCAP. Since the total cross-sectional plastic moment depends on the tensile strength and thickness of the steel, material selection is prudent. The same is true for chassis components. For example, fatigue endurance strength and deformation strength of chassis components are of paramount importance for large commercial vehicles with a ladder frame structure in which the cabin is mounted. In particular, since these commercial vehicles are often

designed to be driven off-road in foreign countries, concerns about strength performance must be avoided by introducing eco-materials. The same is also true for rubber used in engine mounts and bound stoppers. Since these components are set up to dampen the vibrations caused by vehicle driving, the risk of weight loss due to thermal deformation or deterioration must always be avoided. In view of the above, the scope of the assurance case shall be set in accordance with the definition of GSN Community actually utilized in the development of automobiles.

4.3.3 Proposed assurance case description method for DfE

In this chapter, we propose the method for describing the AC which is applies the argument decomposition pattern (Bloomfield, 2010; Yamamoto et al., 2013) for DfE. On the assumption that it will be confirmed by all members involved in DfE, D-Case of the DfE process is described based on the V model (Harold, 2014) in system engineering. In the requirement definition, based on IEEE1220 (IEEE, 2005), the process was shortened in consideration of time constraints. Including the product design including UI/UX, the customer's requirements and related laws and regulations are clarified, product planning is performed, and it is defined as a requirement specification by combining with the requirement quality development table by QFD (Akao, 1972). In concept design, it is divided into the selection of environmentally friendly parts and the creation of the concept design document incorporating the parts. When selecting environmentally friendly parts, HAZOP analysis was used to extract hazards from the user's perspective (external analysis), and FTA was used to extract hazard factors from the developer's perspective (internal analysis). FMEA is applied to the function of parts, weighting is applied by the degree of risks, and then, environmentally friendly parts and application destinations are selected from the viewpoint of 3R (Reduce, Reuse, Recycle). Finally, the concept design specifications is comprehensively created. In the detailed design, the structural design of the automobile interior parts is performed based on the concept design specifications which is created in the concept design. It is required that physical property values are obtained from parts manufacturers and also refer Ashby maps (Srikar, 2003). Next, in layout design, functional parts and structural members are laid out in view of interference of parts and design tolerances according to production equipment and quality standards, and finally 3D CAD is presented. At this stage, the feasibility is confirmed to be consistent with the required specifications and concept design documents. Finally, we describe the description method of assurance case by D-Case (Matsuno, 2013) for system dependability. In addition, the present study provides a limitation to the description

method for solving the known problem regarding the description method of the assurance case. First, we set the business system that you want to achieve the top goal, and then, we divide it into “Attractive quality system” and “Must be quality system” in the strategy node. In this study, the requirement definition and the concept design are defined as "Attractive quality system", and the detailed design is defined as "Must be quality system". (Berger et al., 1993; Ohtomi, 2015). In “Attractive quality system”, the work for the purpose of value co-creation is the center, and it is described by the evidence node. On the other hand, in “Must be quality system”, the monitoring node is applied to the goal node. The reason for this is to confirm “Attractive quality system” as the implementation of the customer satisfaction value. Therefore, the evidence node is not used for the goal node in “Must be quality system”. As shown in Figure 4.4, 3D CAD data refers to the requirement specifications and concept specifications in “Attractive quality system”. The monitoring node in “Must be quality system” is connected to the evidence node in “Attractive quality system” (Figure 4.4 dotted arrow). The reason is to judge whether to achieve the top goal based on the monitoring results. However, this description method has the limitation described later. First, design tolerances are not constant because they vary depending on production equipment and quality standards required. Second, the subject being monitored is not always constant. Third, the monitored results are not always necessary for evidence in “Attractive quality system”. Proposed assurance case in this study has these limitations. Additionally, proposed assurance case in this study is guaranteed by the agreement of the project member participants. Next, the procedure applied to the description method of the DfE process is described. Proposed method of assurance case description is showed in Table 4.4. Figure 4.6 and Figure 4.7 depict the assurance case for whole DfE process. Figure 4.6 shows left-hand side of the V-model, whereas Figure 4.7 shows its right-hand side. From the requirement definition viewpoint, the roadmap inside/outside of the company and its regulations were clarified, UI/UX design of the product was performed, and it was defined as a requirement specification. At this stage, the feasibility was confirmed to be consistent with the required specifications. In the architecture design, the process is divided into the adaption of eco-friendly materials and the detailed design document incorporating the parts. When adapting eco-friendly parts, fault tree analysis (FTA) was used to extract hazard factors from the developer's perspective. Moreover, failure mode and effect analysis (FMEA) was applied to the function of parts, weighting was applied considering the degree of risks, and finally, ecology materials are selected from the viewpoint of Reduce, Reuse, and Recycle. Finally, a detailed design was performed. In layout design, functional and structural parts were laid out considering interference of parts and design tolerances

according to production equipment and quality standards, and finally, 3D CAD was presented. At this stage, the feasibility was confirmed to be consistent with 3D CAD data. Finally, we describe the description method of assurance case by D-Case for system reliability.

Herein, we first set the business system to achieve the top goal. We then divide it into “Left-hand side of the V-model (V-model LHS)” to define the requirement definition and the architecture design and “Right-hand side of the V-model (V-model RHS)” to define the verification and the validation in the strategy node. In “Left-hand side of the V-model,” specification definition is the purpose of this work. Finally, the output of the work is described by an evidence node. Conversely, in “V-model RHS”, the monitoring node is applied to the goal node. This is because we need to confirm “V-model LHS” as the implementation of the feasibility of customer requirements. Therefore, the evidence node was not used for the goal node in the validation for “V-model RHS”. As shown in Figure 4.6 and Figure 4.7, the requirement specifications refer to the validation report, and the 3D CAD data refer to the verification results on “V-model LHS”. Moreover, the monitoring node in “Right-hand side of the V-model” is connected to the evidence node in “V-model LHS” (Figure 4.6 and Figure 4.7 dotted arrow). This was done to judge whether to achieve the top goal based on the monitoring results. However, this description method has a limitation (Yamamoto, 2014) described as follows. First, we checked whether the required function was acquirable from the verification results. In addition, we confirmed whether the products matched the customer requirements in the validation process. The validation results were not constant because customer requirements were fluid. Second, the subject being monitored was not always constant. Third, the monitored results were not always necessary for evidence in “V-model LHS”. Additionally, the proposed assurance case in this study was guaranteed by the agreement of the project member participants. The assurance case description procedure is presented in Table 4.4. Consequently, the monitoring results in the verification measure the architecture design achievement of a product using 3D CAD data. Additionally, they also measure the requirement definition achievement of a product using the requirement specifications.

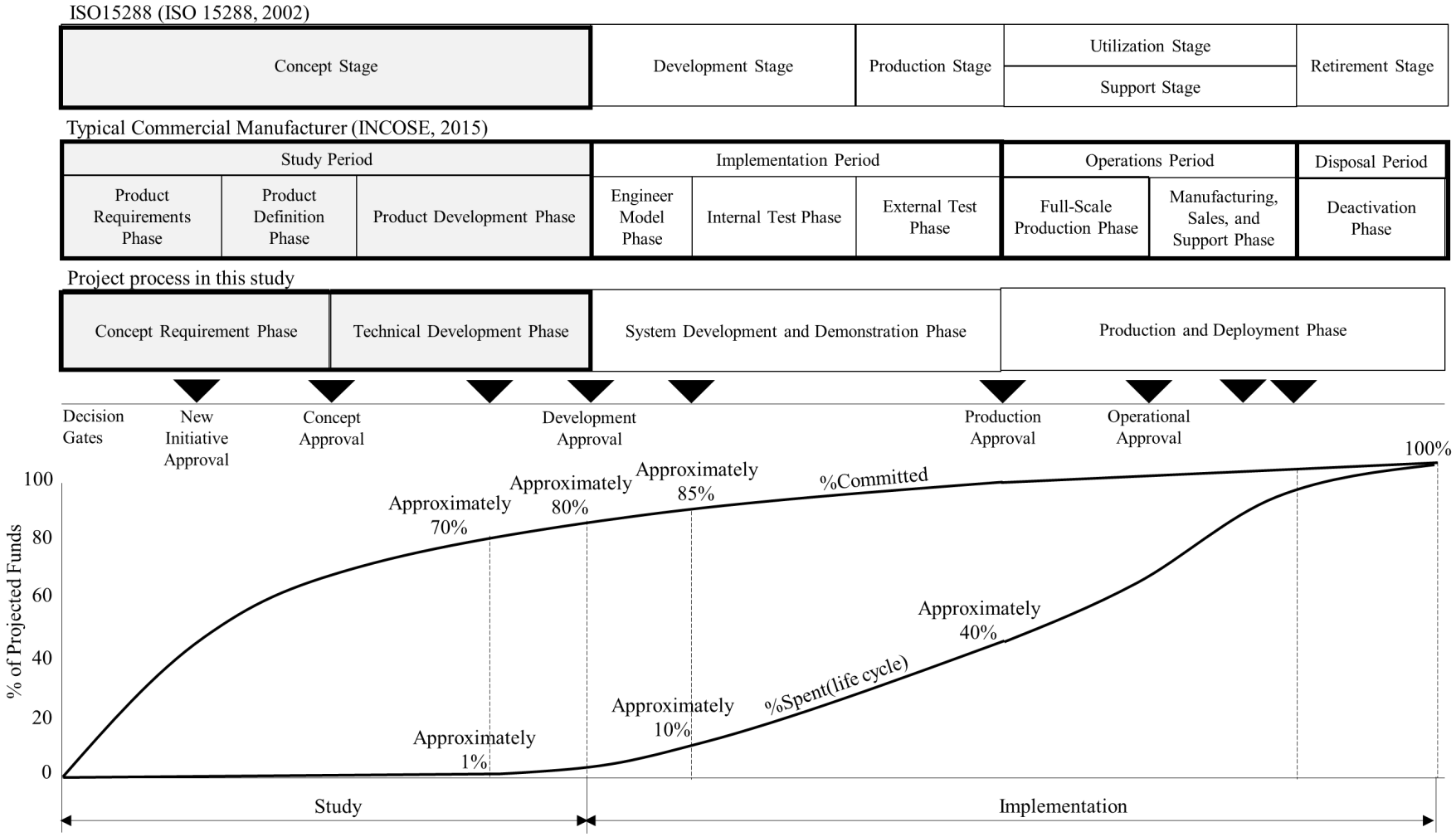


Figure 4.1: Project life cycle and typical expenditure profile (INCOSE, 2015), added project process in this study by the author

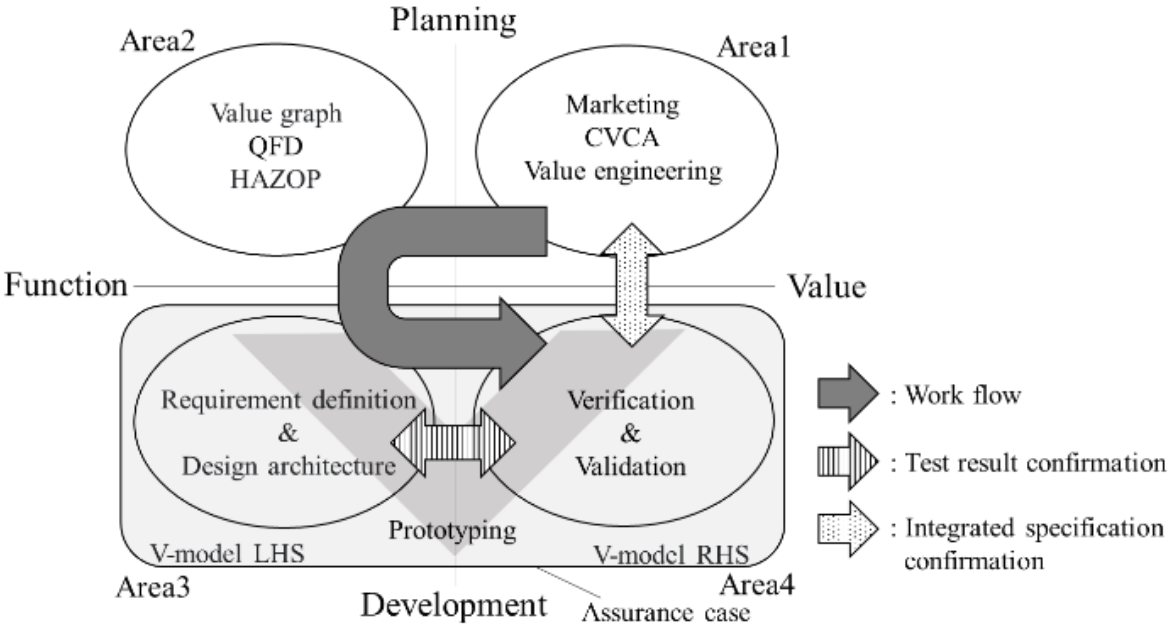


Figure 4.2: Combined Model

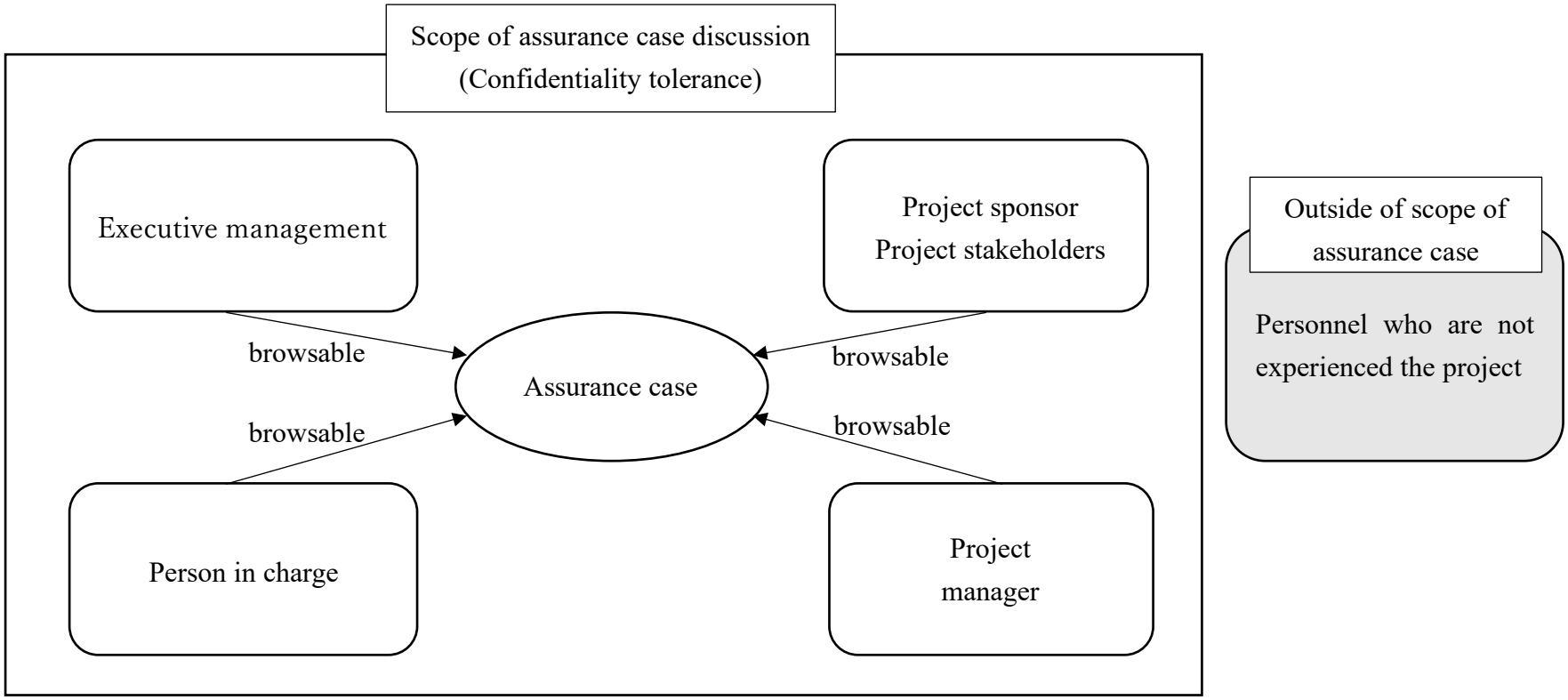


Figure 4.3: Definition of assurance case browsing scope

Table 4.4: Method of assurance case description

Step 1	Set Goal node.
Step 2	Set Context node as sub-goals by dividing the Goal into sub-goals. In addition, set priorities, if any, in the Context node when the priority of sub-goals is important.
Step 3	For Strategy node, divide the Goal into sub-goals (in prioritized order, if any).
Step 4	Set the sub-goals (in prioritized order if any) underneath the Strategy node. In addition, set Evidence nodes if the sub-goals need to be prioritized.
Step 5	Assume Step 4 to be Step 1, and repeat this process until sub-goal nodes are completely deconstructed.
Step 6	Set Evidence node or Monitoring node until you cannot divide.
Step 7	Link multiple Evidence nodes to Context nodes, and Context nodes are linked to Goal nodes, in order to express the procedure to be executed on the premise of the output of multiple procedures.
Step 8	Summarize Evidence node with Context node of the next procedure, in order to synthesize the result of multiple procedures.
Step 9	Confirm the relationship between the monitoring node and the evidence node.
Step 10	Connect the dotted arrow from the monitoring node to the evidence node according to the result of Step 9.

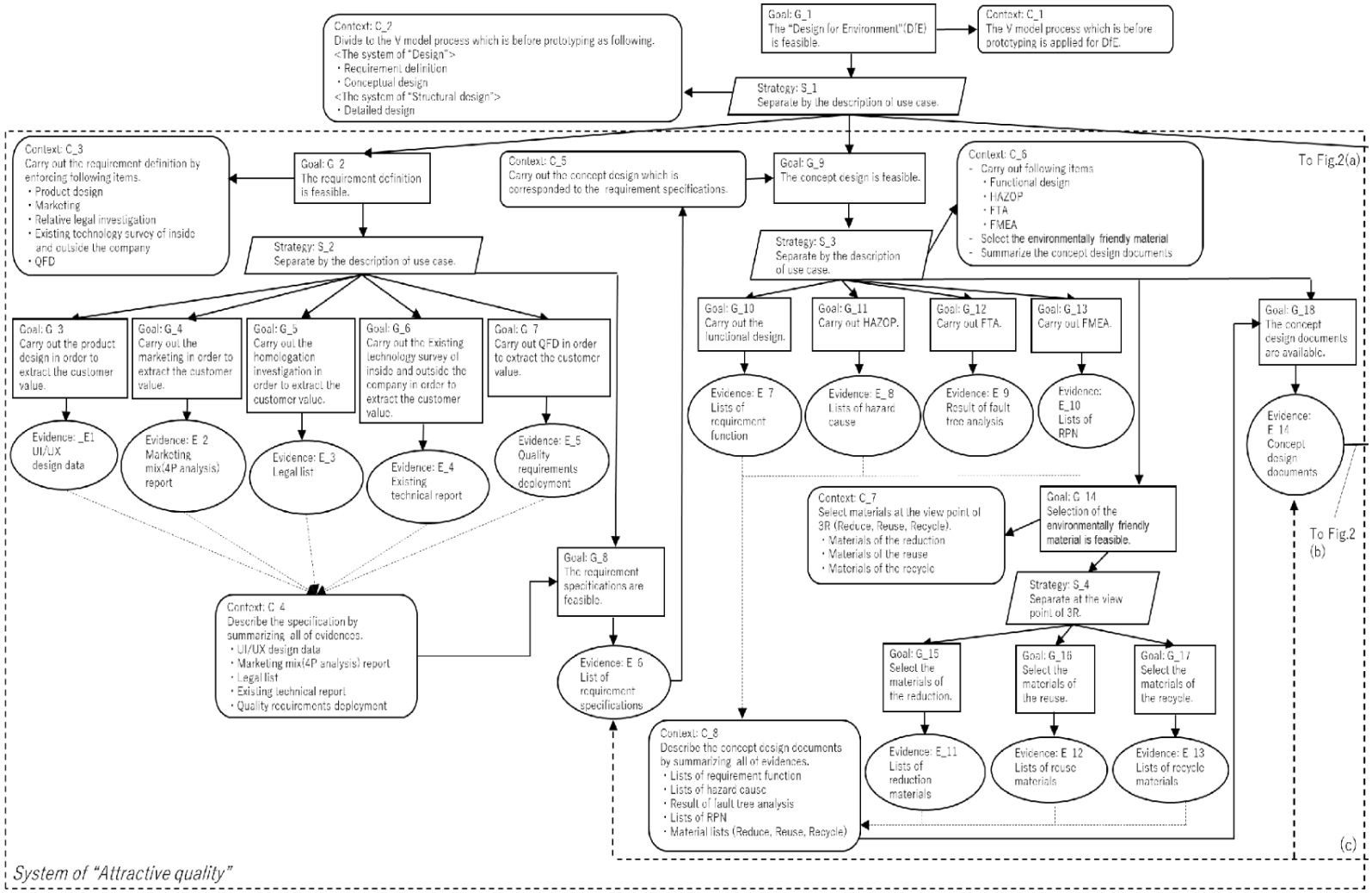


Figure 4.4: DfE assurance case 1 in "Attractive quality system"

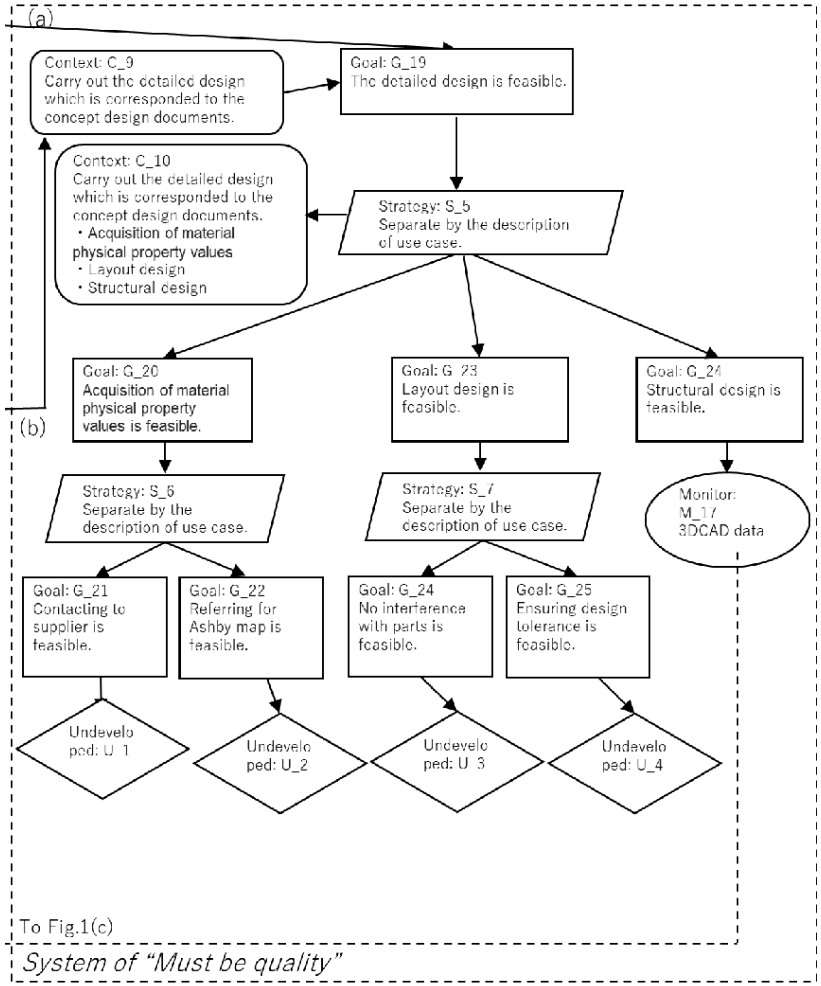


Figure 4.5: DfE assurance case 1 in "Must be quality system"

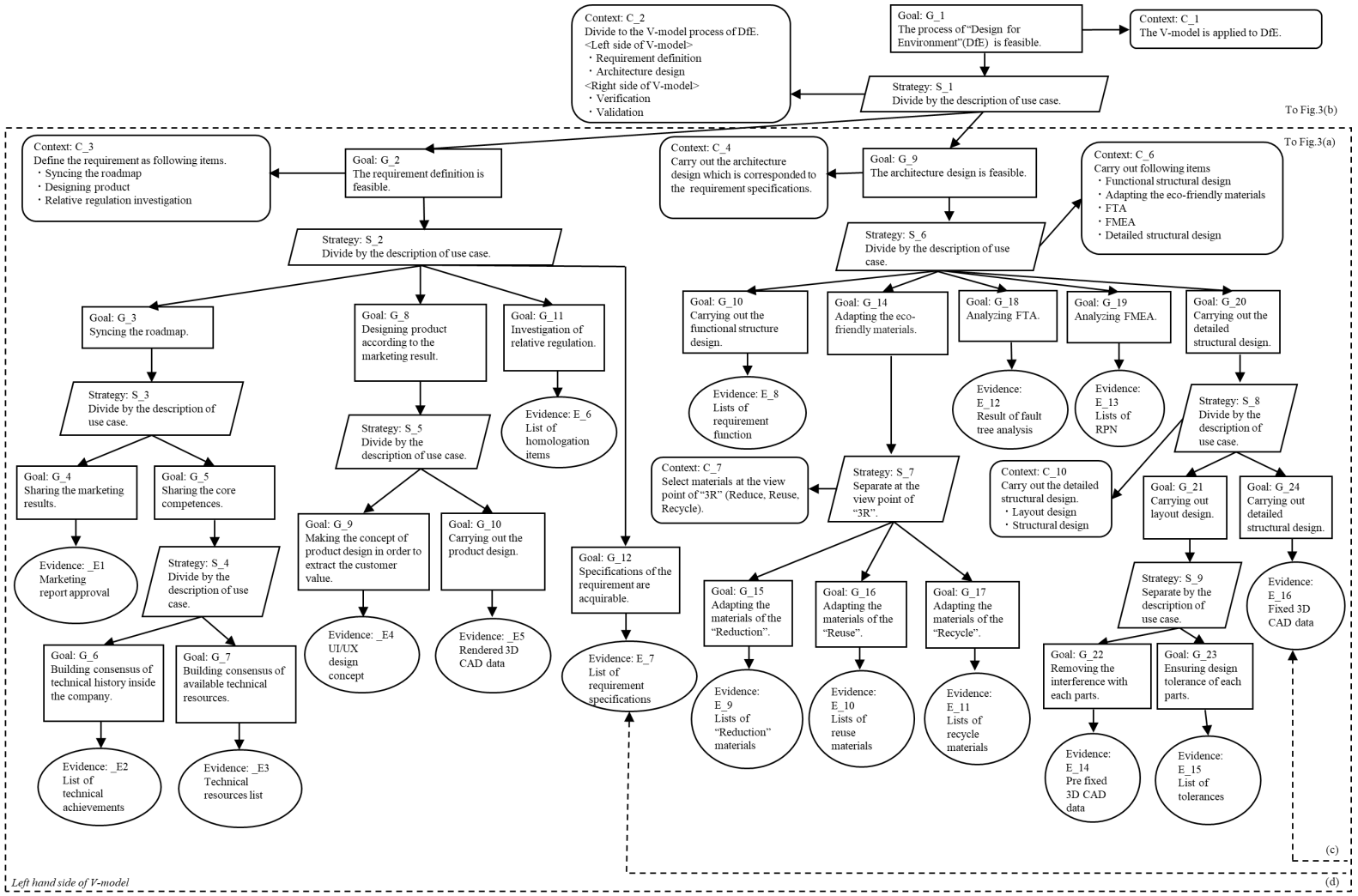


Figure 4.6: DfE Assurance Case 2 in "Left-hand side of the V-model"

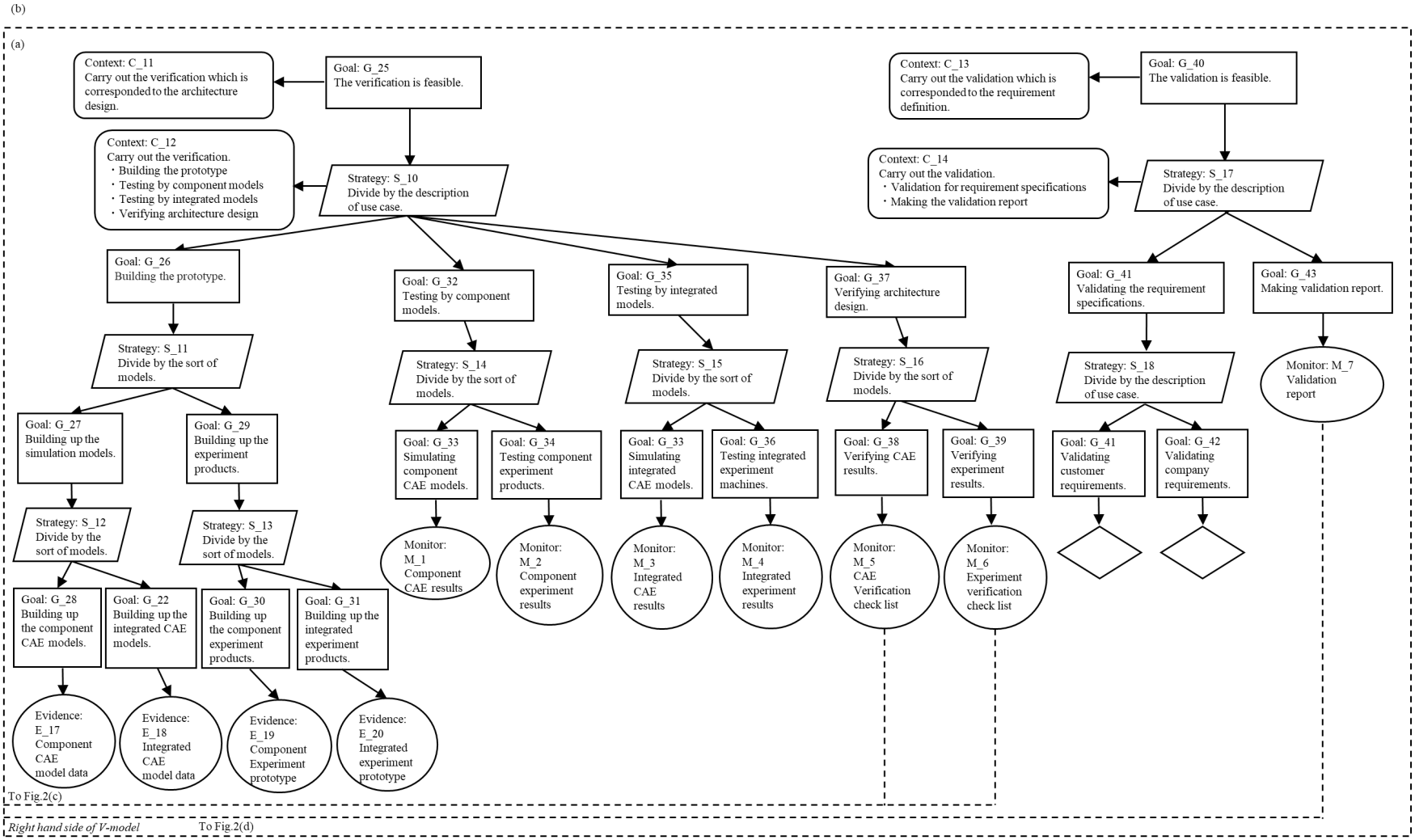


Figure 4.7: DfE Assurance Case 2 in “Right-hand side of the V-model”

4.4 Evaluation

4.4.1 Evaluation method

We surveyed DfE project members to verify this effect herein. Then, the target persons were designers, software engineers, structural design engineers, product planners, and quality control engineers. Herein, the evaluation methods were paired-samples t-test and open coding for each questionnaire, before and after applying the method of this study. This was done to confirm whether each member in charge is aware of the entire DfE process from the viewpoints of quantitative and qualitative analysis. Table 4.5 lists the questionnaire for the project members in this study. In this study, the relevance of tasks to the overall project and the evidence required is recognized as a issues because it is tacit knowledge that is not clearly stated. Therefore, the questionnaires are designed to ensure that the issues are addressed by the features of the assurance case. With regard to qualitative analysis, responses were given on a five-point ordinal scale, ranging from -2-"disagree," to +2-"agree," with 0 representing "neither agree nor disagree." Scores from +1 to +2 were assumed to be valid for business improvement. Moreover, we confirmed whether respondents could repeat and point after applying the proposed method to respondents (Kobayashi et al., 2018a).

Table 4.5: Questionnaires for the Project Members

No.	Questionnaires
Q1	Do you understand the entire DfE process?
Q2	Do you understand the positioning of your task in this process?
Q3	Do you understand the relationship between the task connections and the evidences in this process?

Table 4.6: Open coding procedure

Step 1	The free description of the questionnaire survey and the verbatim comments are extracted, and the viewpoint of categorizing the Affinity Diagram is determined by using the KJ method (Scupin, R., 1997).
Step 2	Based on the viewpoint set in Step 1, the comments of the respondents are sorted according to the Affinity Diagram.
Step 3	Using the results sorted in Step 2, the participants are asked to summarize the main points of the group and describe the title of each group.
Step 4	The number of descriptions related to the open coding results is counted.

Conversely, with regard to the qualitative data analysis, free descriptive answers were used as data. Further, these data were analyzed using the procedure provided in Table 4.6 utilizing the qualitative coding methods provided in Strauss et al. (2008) . Lastly, to confirm the purpose of this study, which is described in Section 1, we set the viewpoint to understand the entire DfE project.

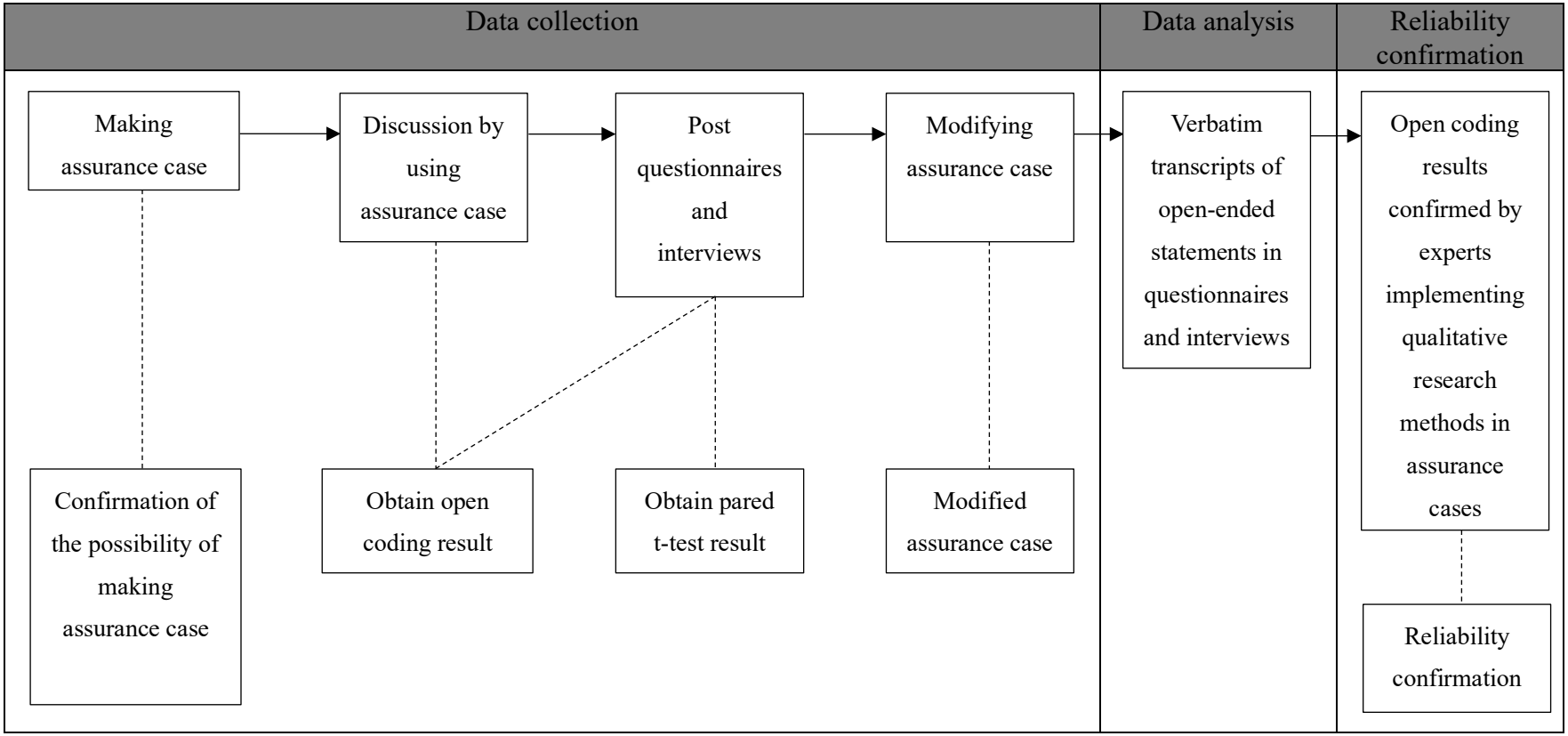


Figure 4.8: Overview of business process descriptions of assurance case

4.5 Evaluation Results

We surveyed before and after applying the method used in this study. A total of 20 individuals participated in our survey. In this study, the members who had participated in the DfE project as a person in charge were the target. Table 4.8 presents the results of the paired t-test. Accordingly, before and after applying the method proposed herein, p-values were 0.000, 0.001, and 0.000 for each questionnaire, all of which are smaller than 0.05. Therefore, we rejected the null hypothesis, which means that there is a difference between before and after applying this method. In other words, by applying this method, the person in charge can understand the entire DfE process, positioning of their tasks, and the relationship between their tasks and other related divisions. Table 4.9 provides the results of open coding. The results show the purpose of this study described in Section 1, "project members recognize their task by visualizing entire DfE process" is achieved. To ensure the reliability of the open coding results, we confirmed the analysis results in Table 4.9 with the respondents; all of them agreed with the analysis results (Kobayashi et al., 2019; Kobayashi et al., 2018b). In addition, the reliability of the analysis results was confirmed by an expert researcher who had verification experience in using qualitative surveys (Golafshani, 2003). Furthermore, we confirmed whether respondents could repeat and point after applying the proposed method (Kobayashi et al., 2018a). Consequently, all respondents were able to repeat and point. This result shows that the method proposed in this study enables the recognition of the entire DfE process. Hence, we concluded that this method is effective in making project members recognize the entire DfE process and their tasks.

Table 4.7: The work experience years of respondents

The work experience years	Number of respondents
1-5	7
6-10	6
11-20	4
21-	3
Total	20

Table 4.8: Result of Paired t-test

	Q1		Q2		Q3	
No.	Before	After	Before	After	Before	After
1	-2	1	-1	0	-1	0
2	-1	0	-1	0	-1	0
3	0	1	1	1	0	1
4	-2	2	1	1	0	1
5	-1	1	0	1	0	1
6	-1	1	-1	0	-1	0
7	0	1	0	1	0	1
8	0	1	-1	1	-1	1
9	1	2	0	1	0	2
10	-1	2	-1	2	-2	1
11	-1	2	-2	1	-2	1
12	-2	1	-2	2	-1	2
13	-2	-1	-2	-2	-2	-2
14	-1	-1	-1	-1	-1	-1
15	-2	-1	-2	-2	-2	-2
16	-2	-1	-2	-2	-2	-2
17	-2	-1	-2	-2	-2	-1
18	-1	0	-1	0	-1	0
19	-1	1	0	0	0	0
20	-1	1	-1	0	-1	0
Sample number	20					
Degree of freedom	19					
Standard deviation	0.73	1.20	0.94	1.67	0.63	1.50
P-values (Both side)	0.000 (≤0.05)		0.001 (≤0.05)		0.000 (≤0.05)	

Table 4.9: Results of Open Coding

No.	Open cording results	Counts
1	Since project process and work flow is visualized, the person in charge can understand the whole outline and schedule.	23
2	Since personal work is based on a written framework, the person in charge can understand needed evidences and carry it out.	15
3	The person in charge can understand and discuss business processes and output timing required for DfE.	12
4	Be aware of the positioning of own work in the DfE process.	5

4.6 Discussion and managerial implication

From the results of the paired t-test in Table 4.8, it can be seen that the proposed method accomplished the following goals: “person in charge can understand the entire DfE process,” “person in charge can understand the positioning of their tasks,” and “individual designers can understand the relationship between the task connections and evidences.” The results are as follows: Kobayashi et al. (2017) indicated that the person in charge recognizes the task importance proposed by Hackman et al. (1980) by applying the assurance case. In fact, herein, from the open coding first result in Table 4.9, the respondents answered, “Since DfE process is visualized, we can understand the complete outline of the DfE.” To recognize the entire DfE process, the proposed method is effective as a tool for grasping the complete process, which is considered to contribute to the recognition of task importance. In addition, the open coding second result in Table 4.9 indicates that the tacit knowledge, which is the personalized experience in the DfE, is converted into formal knowledge. Specifically, the open coding third result in Table 4.9 shows that the persons in charge can reconcile the recognition of tasks in the DfE. In other words, we consider that this contributes to the recognition of task importance. Finally, the open coding forth result in Table 4.9 indicates that the persons in charge were aware of each phase, and thus had the consciousness of positioning in the development process. This was because each designer understood the phase of overall development and the position of each person’s work. Therefore, each person in charge can understand the entire DfE process by grasping the tailored process and outputs and the awareness of the work positioning of each phase. That is because each individual designer understands the phase of overall development and the position of each person's work. It contributes the consciousness for the schedule driver in order to success the project management

(Yaghootkar et al, 2012) and also the task importance. The result which project members understand the position of their work in the design phase indicates that they are aware of the development time schedule which the project manager controls. In addition, the visualization of the entire DfE process and the clarification of the workflow made it easier for those in charge to visualize the sequence of business execution. In the QFD, functions were developed in a list and connected by arrows to make it easier for the person in charge to understand the importance of tasks. The QFD is designed to make it easier for the person in charge to understand the importance of tasks by developing functions in a list and connecting them with arrows. On the other hand, the assurance case is tailored so that the divergence of workflow by strategy can be visually understood. At the same time, it has a point of accountability. The person in charge stored the deliverables described in the evidence node, and when they were finally aligned, the project itself could be completed, and it was easy for the person in charge to realize the effectiveness of the project. Furthermore, it is also effective in that it is a base configuration when looking at systemization. The described assurance case can be easily systematized by programming. Since the algorithm is not complex, it is suitable for standardization; it is assumed to be a DEOS process, and the highly personalized know-how can be shared among the parties concerned as a standardized business process. In workplaces where human resources are highly fluid, such as in transfers, the ability to implement standardized processes even with inexperienced engineers is highly advantageous in the development field. Human capital and standardization of business processes are considered to be closely related. In a workplace with a high degree of human resource mobility, knowledge that has become gentrified can cause a significant loss of development speed and reliability when that person is no longer available. Knowledge sharing is a factor that accelerates development. On the other hand, it also leads to a loss of identity and motivation in the workplace for those who possess the know-how. With the emphasis on clarifying positions and structures, teams and roles within a company while conducting business, a decrease in employee motivation is detrimental in the workplace. Therefore, standardization should be done with caution, but assurance cases have shown results that are highly acceptable to those in charge. This is not only because accountability is clear, but also because the output produced by the person in charge is clear, and thus individual motivation is not reduced. From this perspective, assurance cases are an effective tool.

From the above, it is important for each individual person to understand the DfE process for the purpose of grasping the design process outside the scope of responsibility and to share the purpose and the awareness of the time schedule of the design phase among the stakeholders. Visualization of the DfE process using proposed assurance case

is effective for the realization of DfE. The reason is that proposed assurance case is used for the consciousness of the members for the task importance and the time schedule. In conclusion, visualization of the DfE process using the proposed method is effective for DfE feasibility.

4.7 Conclusion

Herein, we proposed a combined method for the DfE process to make project members recognize the task to visualize the DfE process, which assures that they will perform that task. The result of the paired t-test shows that there is a significant difference between before and after applying the proposed method; in other words, the persons in charge can understand the entire DfE process, positioning of their tasks, and the relationship between the task connections and evidence by applying the proposed method. Furthermore, based on the open coding results, it was observed that the proposed method is effective. From the foregoing, the method of this study is effective in addressing the issues described in Section 4.1. Therefore, we applied this method to the concept stage (INCOSE, 2015) and totally incorporated it into the development schedule.

The limitations of this study are described. In this study, the content was limited to universal content in accordance with METI guidelines, ISO and other international standards, and previous studies. The reason is confidentiality. In actual product development, company-specific processes are often followed. For example, there are applications based on unique workflows and systems to be referenced, so in actual operations, it is necessary to pass the specific process through internal approval procedures. However, one of the objectives of this study is to create shared knowledge of geriatric know-how in a fluid organization, and company-specific processes are out of scope. In future research, first, the development of a method for analyzing value creation linked to the proposed method is desired. This is because project managers and leaders perform their roles to succeed in the project. Second, future research needs to link ways to encourage innovation. A desirable method is a framework for finding “meaningful multi-viewpoints” that work reliably and guide insights. In other words, it should be a method that helps understand the characteristics of each option by quantitatively comparing multiple candidate ideas. Such methods would guide the insights and make it possible to innovate in a project. Third, future research needs to be conducted to drive the project smoothly. In other words, a method of converting ideas and concepts into concrete stories, telling them, and sharing them with project members and audiences is desired because persons in charge must share ideas, culture, and knowledge.

Table 4.10: Summary between research 3 and the existing literature

Literature	Methodology	Industry/ Applied project	Findings
Hoque (2014)	Modified balanced scorecard	Accounting/ Any	• It has been used in decision making in business organizations to visualize operations and concepts. It is effectively used in the decision-making process in projects.
Kaneko et al. (2014)	Common Criteria-Case	Telecommunications/ Information security	• The proposed scheme is robust against such irregularities in the real world scenes since it is based on matching gradient information around each pixel, computed in the form of orientation codes, rather than the gray levels directly.
Tim Kelly (2007)	Six attributes to tree structure	Aeronautics/ System developing	• As with the previous report, the authors focus in addressing safety cases for advanced control systems is to concentrate on the class of adaptive systems. A system can be considered adaptive if its behavior cannot be predicted solely from knowledge of its initial software design and state.
Kobayashi (2018a)	Assurance case	Construction machinery/ Product shipping process	• The study compared a total of eight models which were described in an assurance case of ISO15026-2-2011: models were examined feasible implementation of management strategy, as well as the most effective timing of evaluating assurance cases, were identified.
This study	Assurance case	Automobile/ DfE of automobile interior developing	• The method was applied, and the results of a survey of personnel confirmed the effectiveness of the assurance case.

Chapter 5 Conclusion

In conclusion, this study identifies relevant elements of corporate commitment to CSR, social and environmentally friendly, and reveals important contributions to the existing academic literature. In this study, based on previous research, we constructed a hypothesis a priori and examined it by an approach of inductively verifying it from the facts obtained by an online questionnaire survey. Furthermore, by implementing the framework of research 1 to 3 in this research, we have shown an example of building and modeling a system that allows companies to focus on social and environmental initiatives. Table 5.1 and Table 5.2 are summary of findings and managerial implications of this study. Indeed, the study results will provide insights for researchers and practitioners to weave CSR and social and environmental requirements into corporate strategic planning and product planning to provide pro-environmental practices. We believe that this study largely covers the entire product life cycle. This study focuses on the phases related to strategic planning that takes CSR into account, including social and environmental characteristics and public relations activities, in the planning and review phase upstream of the project and in the task force activities that examine QMS and EMS mechanisms. According to the findings of this study, the automotive industry is concerned with environmental and social concerns, which are mediated by perceived quality and lead to customer satisfaction. In addition, a country-by-country comparison between Japan and France shows that Japan has an impact on customer satisfaction with respect to CSR. It is clear that serviceability is relatively well taken into account and that customers have a serious interest in efficient service, maintenance in dealer shop. Therefore, manufacturers pursuing CSR, social quality, and serviceability strategies are encouraged to adopt the set of frameworks applied in this study. This study also demonstrates the necessary for management strategy and planning and corporate activities that coexist with society by taking into account CSR, social quality and serviceability of products. This is large impact for company strategies such as product development, service quality and service systems for sustainability. Thus, the results of this study provides a real scenario in Japan. While the need for quality factors that take into account society and third parties has been advocated, we believe that we have made a certain contribution to this research field in that we have created a social quality scale and clarified the relationship between social quality and customer satisfaction. Based on the results of this study, we propose measures to companies and governments to encourage consumers to perceive social quality as an

attractive factor.

For companies, We should implement public relations strategies such as advertisements to make consumers aware of the contribution to society of products that meet social quality standards. Corporate efforts are needed to change the image of this segment. If consumers are made aware of such corporate efforts, they will be aware of the company's fulfillment of its social responsibility, and the perceived quality of the product will be improved. Having one's own owned media or information dissemination platform is also very effective. after COVID-19, the number of users of video streaming services and social networking services has increased rapidly. It is important to continue to provide useful information to these smartphone-accessible information sources. Information that is also beneficial to consumers, CSR activities, and brand image enhancement could bring a leap forward in corporate activities.

For governments, financial incentives, such as subsidies for the purchase of products that meet social quality standards, should be strengthened. In Western countries, large subsidies are planned for the purchase of electric and fuel cell vehicles. In the future, it is expected that more and more local governments will enact policies to provide additional subsidies. The Japanese government should also strengthen its policies to remove cost concerns from consumers. As for policy guidance, it is hoped that it will continue to be promoted in cooperation with companies. Japan is dominated by the private sector, which supports the country's growth, and CSR and social activities are too costly to be undertaken solely through corporate efforts. This is because companies also need to maintain a profitable structure in order to grow. Subsidies and grant programs should continue to be expanded, and a system is needed to enable private companies to actively conduct corporate activities in line with the direction of national policy.

For society, Japan remains the world's second largest country in terms of GDP, but at the same time, the reality is that in recent years, Japan has become a leading country in terms of low prices. Japan's aging society is in full swing, but Western countries have overcome this challenge by improving social welfare. One very significant effect has been the increase in IT literacy and the acquisition of a wide range of information. Businesses and governments are continuing their efforts to improve the societies in which their citizens live. It is recommended to participate in society as much as possible, not only through TV commercials, but also by taking an interest in the companies that manufacture the products you use and their initiatives through their websites. In Western countries, such as France, citizens have a strong independent spirit and often acquire information and opinions on their own. Japan, too, would like to foster a culture in which each citizen actively participates in social life.

Table 5.1: Summary of findings of this thesis and managerial implication (Research1-2)

Research	Results of hypothesis (Findings)	Managerial implication
1 (Chapter 2)	H4: CSR->Customer satisfaction (Standardized coefficient= 0.170***(Japan), 0.081 (France))	• Companies communicate their contributions to society through CSR activities and disseminate measures to increase social acceptance through the media in Japan. • France is more interested in the serviceability of the product itself than in the direct appeal of CSR activities to customers, so branding is done by enhancing the serviceability of the product.
2 (Chapter 3)	Mediation effect: CSR->Perceived quality->Customer satisfaction (Standardized coefficient= 0.252***(Japan)) Social quality->Perceived quality-> Customer satisfaction (Standardized coefficient= 0.477***(Japan))	• Since a company's environmental and social activities do not directly affect customer satisfaction, but affect it through the medium of perceived quality, the company's own owned media and other platforms to reach customers are used to disseminate the information.

Notes: Path significant at ***p<0.01

Table 5.2: Summary of findings of this thesis and managerial implication (Research 3)

Research	Results of hypothesis (Findings)	Managerial implication
3 (Chapter 4)	Assurance case is effective following perspectives, • Assurance case is helpful for person in charge to understand whole DfE process. • Assurance case makes person in charge to understand work flow of DfE • Assurance case helps for person in charge to make sure the needed outputs and evidences	• Since the assurance case has been recognized as an effective way to carry out the DfE process, it is important for project managers to visualize the entire process in assurance cases to facilitate the understanding of their staff. It is also important to explain the assurance case and its description to those in charge and encourage them to think about it so that they can carry out their work independently and autonomously.

Notes: Path significant at ***p<0.01

The future research in this study is described below. First, we discuss the issues. The number of samples for each attribute was not adjusted in this analysis. Since there is a possibility that the model may be partially influenced by attributes with a large number of samples, it may be possible to ensure higher prediction accuracy by adjusting the number of samples for each attribute. When conducting the next survey, the number of samples for each attribute should be considered more carefully when designing the questionnaire. It would also be interesting to conduct a survey that focuses on a single attribute. There is also a need to test the hypothesis model using a different hypothesis model. In this study, based on the study by Syahrial et al. (2018), there are many examples of causal testing using different hypothetical models from this study in past studies. It would be interesting to treat extensions of hypothetical models as a subject of future research. Finally, three issues for the future are discussed. In this study, social quality was found to have no effect on customer satisfaction, but there is a possibility that this will turn out to be positive in the future. In fact, hybrid vehicles that emit almost no exhaust gas are now very popular in Japan, and electric vehicles that use gasoline as an energy source to generate electricity are also expected to shift in the future. After 2020, the shift to EVs for automobiles is further accelerating. Until now, automobile companies have been conservative in their approach to EVs, partly to secure employment and partly to avoid wasting special technologies and assets owned by complete vehicle manufacturers. However, the successful development of all solid-state batteries, which are compact, lightweight, and have a long cruising range, is expected to usher in an era of significant growth for EVs. As a result, the shift from hybrid vehicles to plug-in hybrid vehicles may also progress. Therefore, this study should be continued, and the value of the study will be further enhanced by looking at changes over time. The second point is that the number of products to be studied should be increased. More findings could be obtained by increasing the number of product types. Since it is suggested that consumer’s potential attractiveness to social quality differs depending on the product, conducting a survey not only on automobiles but also on many other products would make a greater contribution to the field. For example, new electronic devices, such as wearable devices, could become more closely connected to people's lives. In the quest for a life of well-being, there is potential for market expansion, as wearable devices will enable a life of daily monitoring of health maintenance scores. Finally, we believe that purchase intention surveys also need to be further developed: as mentioned above, social quality does not have a direct impact on customer satisfaction at this time, but only with regard to currently owned products. As a further consideration, We discuss future prospects by taking the change in social conditions as a starting point. consumer behavior toward purchasing has changed

dramatically since COVID-19. In particular, it is clear that the implementation of entry restrictions and operations to avoid density at car dealerships has led to a significant increase in the number of consumers looking at websites before acting on them when purchasing a car. Therefore, it is also expected that the number of consumers obtaining information about CSR and social quality from websites, which were surveyed in this study, will also increase. We would like to attempt to measure this effect by actually obtaining cooperation from dealers. We believe that this would be a good opportunity for consumers to become better informed about corporate activities. In addition, we believe it is important to survey consumers to determine whether they are satisfied with the car and would consider repurchasing it, whether they are satisfied with the car company and its brand, or whether they are satisfied with the dealership and its sales representatives when they make a consumption decision. In this study, we did not conduct a survey from that cut-off point because we built our hypotheses based on previous research. However, we believe that clarifying the pathways from where consumers' impressions come from will provide insight into planning more effective measures. Trends obtained there could be combined with recommendation systems through machine learning and AI to become effective measures. By conducting a future purchase intention survey as well, it will be possible to understand the gap between the present and the future, and more meaningful discussions will be possible.

Next, We discuss the business model research. A business model is considered to be a logical description of the way value is created and supplied to customers. It is addressed customer value proposition, profit equation, key management resources, and key business processes as elements. There are constraints that sustainability places on business models. They can be categorized into environmental, social, and economic issues. For environmental issues, there are decarbonization, energy conservation, and waste-free. For social issues, there is child labor, work-life balance, cultural promotion, etc. For economic issues, trends include the sharing economy. Under such constraints, it is necessary to examine the nature of business models. Bode et al. (2019) cites the pursuit of social impact. They states that traditionally, productivity and cost reduction have been heavily emphasized with an emphasis on lumbering indicators, but the trend of the times is to pursue food loss reduction, decarbonization, and well-being. Bansal (2019) believes that a composite KPI that simultaneously optimizes social, environmental friendliness and economic efficiency will be necessary. Green finance, green marketing, and the relationship between employee happiness and productivity will be the starting points. As sustainable development unfolds across economic, social and environmental domains, non-traditional research methodologies are required. It is stated that we should emphasize

the research perspective of business administration and organizational theory, which focus on analyzing the workings of corporate organizations, which have not been fully elucidated in the past, neither as individuals nor as macro-ecosystems (Wakabayashi, 2022). In the future research of this study, it is desirable to accumulate knowledge on corporate organization in implementing SDG management in relation to the recommendations of Wakabayashi (2022).

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Appendices

Appendix A. Measurement scale items and supporting for research 1 survey (Chapter 2)

	References
Factor 1. Serviceability (S)	
Your car has easy access to spare parts.	(Hazen et al., 2016) (Yogi, 2016) (Brucks et al., 2000) (Larson, 1993)
Your car needs fewer self-inspections.	
Your car is easy to self-inspect.	
Your car is eligible for repairs and other maintenance services.	
Factor 2. Ownership cost (OC)	
Your car's fuel consumption is reasonable.	(Sweeney et al., 2001) (Kuo et al., 2009)
Your car's maintenance cost is reasonable.	
Your car's service or repair cost is reasonable.	
Factor 3. Corporate social responsibility (CSR)	
You think that the environmental aspect of CSR is very important.	(Waller, 2016) (Dočekalová, 2016) (Rahdari et al., 2015)
You think that the social aspect of CSR is very important.	
You think that the employee aspect of CSR is very important.	
You think that the governance aspect of CSR is very important.	
Factor 4. Customer satisfaction (CS)	
You think that it is nice to use this company's services or products.	(Crosby et al., 1990) (Rust et al., 1994) (Suzuki, 2010) (Syahrial et al. 2018)
You do not regret using this company.	
You think that this company offers exactly what you need.	
Factor 5. Customer loyalty (CL)	
You would not change for another company.	(Zeithaml et al., 1996) (Flint et al., 2011) (Suzuki, 2010) (Syahrial et al. 2018)
You use this company as your first choice.	
You intend to use this company's products again.	
You would recommend this company's automobiles (in general) to others.	

Appendix B. Measurement scale items and supporting for research 2 survey (Chapter 3)

	References
Factor 1. Perceived quality (PQ)	
This vehicle has a good reputation for environmental protection. The advertisement of this vehicle company gives a good impression. This vehicle generally has a good reputation. This automotive company's brand is well known worldwide as a quality brand. This automotive company generally has a good reputation for CSR.	(Hansen and Bush, 1999) (Sinclair et al., 1993) (Kianpour et al., 2014) (Shaharudin et al., 2011)
Factor 2. Social quality (SOQ)	
This vehicle can depart quietly without disturbing people in the vicinity outside the vehicle. This vehicle makes little noise to people in the vicinity outside the vehicle. The smell of emission gas of this vehicle is not strong. This vehicle emits less gas and is environmentally friendly. This vehicle leaks less fuel and is environmentally friendly.	(Garvin, 1987) (Lin, 2013) (Yogi, 2015) (Hazen, 2016)
Factor 3. Customer loyalty (CL)	
You would like to inform good point this automobile to someone who wants advice. You would like to recommend this automobile to someone who needs advice. You would like to tell a family member, acquaintance, or friend about this automobile. You would like to recommend to drive this automobile to a family member, acquaintance or friend.	(Zeithaml et al., 1996) (Flint et al., 2011) (Suzuki, 2010) (Syahrial et al. 2018)

	References
Factor 4. Corporate social responsibility (CSR)	
This automobile company seeks to ensure long-term success.	
This automobile company will always respect the rules and regulations set forth by law.	
respect the rules and regulations always set by law.	(Waller, 2016)
The automobile company is committed to social responsibility.	(Dočekalová, 2016) (Rahdari et al., 2015)
The automobile company strictly manages its environmental impact.	
The automobile company invests in environmental protection activities.	
Factor 5. Customer satisfaction (CS)	
You are satisfied with the experience of being involved with this automobile.	
You are satisfied with my decision to purchase this vehicle.	(Crosby et al., 1990) (Rust et al., 1994) (Suzuki, 2010) (Syahrial et al. 2018)
You are satisfied with the car.	
This car is close to your ideal.	

Appendix C. Estimation of structural equation model

	Equations	
Multivariate normal distribution	$f(\boldsymbol{x}\|\boldsymbol{\mu}\,\boldsymbol{\theta}) = (2\pi)^{-\frac{n}{2}}\|\sum(\boldsymbol{\theta})\|exp\left[\frac{-1}{2}(\boldsymbol{x}-\boldsymbol{\mu})'\sum(\boldsymbol{\theta})^{-1}(\boldsymbol{x}-\boldsymbol{\mu})\right]$	(1)
Likelihood function	$f(\boldsymbol{X}\|\boldsymbol{\mu}\,\boldsymbol{\theta}) = f(\boldsymbol{x_1}\|\boldsymbol{\mu}\,\boldsymbol{\theta}) \times \cdots \times f(\boldsymbol{x_i}\|\boldsymbol{\mu}\,\boldsymbol{\theta}) \times \cdots \times f(\boldsymbol{x_N}\|\boldsymbol{\mu}\,\boldsymbol{\theta})$	(2)
logarithmic likelihood function	$\log\big(f(\boldsymbol{X}\|\boldsymbol{\mu}\,\boldsymbol{\theta})\big) = \sum_{i=1}^{N}\log(f(\boldsymbol{x_i}\|\boldsymbol{\mu}\,\boldsymbol{\theta}))$	(3)
Objective variable	$f_{ML} = tr(\sum(\boldsymbol{\theta})^{-1}\boldsymbol{S}) - \log\|\sum(\boldsymbol{\theta})^{-1}\| - \log\|\boldsymbol{S}\| - n$ $= tr(\sum(\boldsymbol{\theta})^{-1}\boldsymbol{S}) - \log\|\sum(\boldsymbol{\theta})^{-1}\boldsymbol{S}\| - n$	(4)
Sample covariance matrix	$\boldsymbol{S} = \boldsymbol{\frac{1}{n}}\sum_{\boldsymbol{i=1}}^{\boldsymbol{n}}(\boldsymbol{x_i}-\boldsymbol{\bar{x}})(\boldsymbol{x_i}-\boldsymbol{\bar{x}})'$	(5)

x:Observed variable

n:Number of observation variables

μ: expectation vector of $(n \times 1)$

f_{ML}: Objective variable

θ: parameter vector

N:Number of samples

$X = (x_1, x_2, \cdots, x_N)$: Sample vector

S: Sample covariance matrix

$\bar{x}$: Sample mean vector

Appendix D. List of model fitting indexes

Index	Equations	
chi-square goodness of fit	$\chi^2 = (N-1)f_{ML}$	(6)
	$df = \frac{1}{2}n(n+1) - p$	(7)
Root Mean Square Error of Approximation (RMSEA)	$RMSEA = \sqrt{Max\left(\frac{\chi^2 - df}{df(N-1)}, 0\right)}$	(8)
Goodness of Fit Index (GFI)	$GFI = 1 - \frac{tr\left(\left(\sum(\hat{\boldsymbol{\theta}})^{-1}\left(\boldsymbol{S} - \sum(\hat{\boldsymbol{\theta}})\right)\right)^2\right)}{tr\left(\left(\sum(\hat{\boldsymbol{\theta}})^{-1}\boldsymbol{S}\right)^2\right)}$ $= 1 - \frac{tr\left(\left(\sum(\hat{\boldsymbol{\theta}})^{-1}\boldsymbol{S} - \boldsymbol{I}\right)^2\right)}{tr\left(\left(\sum(\hat{\boldsymbol{\theta}})^{-1}\boldsymbol{S}\right)^2\right)}$	(9)
Adjusted GFI (AGFI)	$AGFI = 1 - \frac{n(n+1)}{2df}(1 - GFI)$	(10)
Comparative Fit Index (CFI)	$CFI = 1 - \frac{max\left((N-1)f_{ML} - df, 0\right)}{\max\left((N-1)f_0 - df_0\right)}$	(11)
	$df_0 = \frac{1}{2}n(n-1)$	(12)
	$f_0 = tr\left(\left(diag(\boldsymbol{S})\right)^{-1}\boldsymbol{S}\right) - \log\lvert(diag(\boldsymbol{S})^{-1}\boldsymbol{S})\rvert - n$ $= n - \log\left\lvert\left(diag(\boldsymbol{S})\right)^{-1}\boldsymbol{S}\right\rvert - n$ $= -\log\left\lvert\left(diag(\boldsymbol{S})\right)^{-1}\boldsymbol{S}\right\rvert$	(13)

χ^2: chi-square, N:Number of samples, n:Number of observation variables,
p:Number of parameters, $\hat{\theta}$: Maximum likelihood estimate,
S: Sample covariance matrix

Appendix E: Reliability coefficient

	Equations	
Cronbach α coeficient	$\alpha = \frac{p}{p-1}\left(1 - \frac{\sum_{j=1}^{p} s_{jj}}{s_T^2}\right) = \frac{p}{p-1}\left(\frac{\sum_{i1,i\neq j}^{p}\sum_{j=1}^{p} s_{ij}}{s_T^2}\right)$	(14)

p: Number of parameters

s_{jj}: Sample covariance of item i, j

s_T^2: Variance of the overall scores for the items of the target concept

Index	Criteria	Citation
Cronbach α	>0.7	(Nummally, 1978)

Appendix F. List of construct validity indexes

	Equations	
Construct reliability	$CR = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + (\sum \varepsilon_i)}$ $\varepsilon_i = 1 - {\lambda_i}^2$	(15)
Average variance extracted	$AVE = \frac{\sum {\lambda_i}^2}{(\sum {\lambda_i}^2) + \sum(1 - {\lambda_i}^2)}$	(16)

λ: standardized factor loading for item i

ε: respective error variance for item j

Appendix G: List of evaluation index and criteria

Index	Criteria	Citation
Chi-square/df	<5.0	(Hu et al., 1997)
CFI	>0.9	(Hu et al., 1997)
AGFI	>0.8	(Hu et al., 1997)
GFI	>0.8	(Hu et al., 1997)
RMSEA	<0.08	(Hu et al., 1997)
Composite Reliability (CR)	>0.70	(Fornel et al., 1981)
Average Variance Extracted (AVE)	>0.50	(Fornel et al., 1981)
Factor loading	>0.50	(Hair et al., 2016)

List of achievements

Articles in publications (peer reviewed)

1. Shibuya, K, Hu, E, Kobayashi, N., Suzuki, H. (2023). Visualizing the Project of Design for Environment to Improve the Feasibility for Corporate Social Responsibility. Review of Integrative Business and Economics Research, Vol. 12(1), 56-70.

2. Shibuya, K., Jean-Baptiste Blet, Suzuki, H. (2024). Evaluation on the Impact of Quality Dimensions for Social Perception. Review of Integrative Business and Economics Research, Vol. 13(1), 1-19. *RIBER Best Paper Prize

Articles in review stage (journal peer review)

1. Shibuya, K., Jean-Baptiste Blet, Suzuki, H. (2023). Customer perceptions of social quality in Garvin's quality dimensions

Presentation at international conference (peer reviewed)

1. Shibuya K.*., Kobayashi N., Shirasaka S. (2021). Proposal of Assurance Case Description Method in Design for Environment (DfE) Process, Proceedings of the 4th International Conference on Complex Systems Design and Management Asia and of the 12th Conference on Complex Systems Design and Management, CSD & M 2021, pp. 357-369.

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1. Shibuya, K.*, Jean-Baptiste Blet, Suzuki, H. (2022). Comparison of the relationship between CSR and customer loyalty between Japan and France using the case of automobiles, The Japanese society for quality control, 52nd annual conference.

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Others

- Presentation at international conference (peer reviewed)

1. Shibuya, K.*, Suzuki, H. (2022). Citizen Perceptions of Intention to Live in a Smart Cities Based on its Characteristics. IIAI Letters on Business and Decision Science, Vol. 001, LBDS002 DOI: https://doi.org/10.52731/lbds.001.002.

- Articles in review stage (journal peer review)

2. Shibuya, K., Suzuki, H. (2022). A study on intention to live in a smart cities based on perceived usefulness of citizen