

## Article

# Servitization and Sustainable Value Creation Strategy for China's Manufacturing Industry: A Multiple Case Study in the Belt and Road Initiative

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**Citation:** Chang, Y.; Ming, X.; Zhang, X.; Zhou, T.; Liao, X.; Cao, S. Servitization and Sustainable Value Creation Strategy for China's Manufacturing Industry: A Multiple Case Study in the Belt and Road Initiative. *Sustainability* **2021**, *13*, 11334. <https://doi.org/10.3390/su132011334>

Academic Editors: Barbara Motyl and Yoshiaki Shimomura

Received: 12 August 2021

Accepted: 12 October 2021

Published: 14 October 2021

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**Abstract:** Manufacturers are adding service offerings to satisfy customers' needs in various markets. Effective strategies for servitization can improve the competitiveness of manufacturers during cooperation. The Belt and Road Initiative (BRI) established by China offers opportunities for economic cooperation and regional integration for the involved countries. Now, many manufacturing firms are expanding their businesses into Belt and Road countries, most firms are facing the "how to do" problems in improving sustainability during their cooperation. They urgently require methodical assistance on both improving competitiveness through servitization and addressing sustainability challenges. This necessitates the firms to develop successful service models for their industrial initiatives and investigate ways to produce long-term sustainable value through services. In addition to the firm's economic worth, it also entails lowering the project's negative environmental impact. The results provided effective strategies for manufacturers from two perspectives. The first perspective is the study discovered innovative service models at both the product and project levels. Project-service systems are critical, and manufacturing firms should use innovative service models to deliver projects. The operation method of holistic solution and localization integration project service was addressed in particular in this study. In the second perspective, there are suggestions for achieving sustainability through innovative service models. The methods for preserving sustainable value on the industrial project level were the subject of our study, which included significant criteria and detailed descriptions. The effective project service system should bring sustainable value to the lifespan of an industrial project. This study has determined four major paths to improving sustainable value creation through servitization: improving resource allocation capabilities, reduce carbon emissions through energy project service, technological outputs, and standards exportation. Useful recommendations are provided for manufacturing firms planning to develop their business overseas, especially in BRI countries.

**Keywords:** manufacturing industry; sustainability; strategy; servitization; sustainable value creation; the Belt and Road Initiative; project management; multiple case study



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## 1. Introduction

The Belt and Road Initiative (BRI) was proposed by China in 2013 to build a regional cooperative platform for all the relevant countries, promote international cooperation, and improve the global economic governance system. Statistics from China's Ministry of Commerce showed that investments in Belt and Road countries from Chinese firms had reached \$ 15.04 billion in 2019. China is now the largest industrial country and firms are considering new paths toward advancing their levels of manufacturing [1]. Services, which are invisible and intangible, can bring significant benefits, such as higher revenues and business sustainability [2]. The markets in the BRI are extensive and therefore the drive for

manufacturers to implement servitization is becoming urgent. The BRI can also provide opportunities for sustainable development [3,4]. Manufacturing firms can gain significant benefits and achieve win-win outcomes by expanding their businesses in the Belt and Road Region (BRR) properly [5].

The BRI brings both exciting opportunities and challenges to manufacturers, so effective servitization strategies are important to keep them competitive [2,6]. Servitization, including the development of an embedded product-service culture and the delivery of integrated offerings, can be considered a bottom-up and iterative process in business model contestation, [7]. The servitization has been used widely to reflect the transformation from product to the integrated product-service system [8]. Fabien Ma. et al. [9] clarified the application of product-service systems in the automotive industry, their result illustrated the automobile manufacturers should improve awareness of product-service system-related concepts and principles. Offer digitalized product-service systems in life cycle dimension can let the manufacturers offer resource-efficient and sustainable solutions [10,11].

Finding effective strategies for servitization can improve the competitiveness of manufacturing firms and enhance sustainable value creation [12]. Previous researchers have discovered strategies for guiding the expansion of manufacturing firms in several industries. Huandong J. et al. [13] focused on the opportunities and challenges in cooperative ventures of Chinese and foreign oil firms, showing that oil and gas resources were rich in the BRR. Petroleum exporting countries require project upgrading services to transform oilfields and improve cooperation. Yi et al. [14] mentioned possible development strategies for the Chinese textile and clothing industry, suggesting that the relevant firms should emphasize the development of enterprise brands while engaging in new technology and management services. Yijun X. et al. [15] revealed a typology of servitization strategies for manufacturers entering the advanced economies through mergers and acquisitions. Creating sustainable value was also inspired by cooperation in the BRR [16,17]. Although the literature on the advancing manufacturing industry in the BRR has been increasing, more studies on how the manufacturing firms could improve their servitization through service model innovation and what strategies for sustainable value creation could be formulated are needed.

Manufacturers are now facing many challenges while expanding their businesses overseas. Both Chinese and foreign manufacturing firms aim to seize the opportunities brought by the BRI. Previous studies had focused on analyzing specific industries in the BRR, so their conclusions are somewhat limited to those industries. Feasible models of servitization for manufacturing firms in the BRR and pathways for enhancing sustainable value creation are essential. This study aimed to provide useful answers to the following research questions (RQs).

RQ1: What opportunities can BRI bring to manufacturing firms? RQ2: What are the topics of focus by current research on manufacturing businesses that are expanding overseas (especially in the BRR) and what are the gaps in the research on discoveries of service models? RQ3: What research methodology and processes should be applied to discover service models and strategies? RQ4: What are effective service models that manufacturers could apply to improve their businesses? (Are traditional product-service systems sufficient and are there any methods for applying project delivery services?) RQ5: How can service model innovation facilitates sustainable value creation? These research questions have a gradually progressive relationship as follows. The reply to RQ1 explains the aim of BRI in detail, and RQ2 proposes the motivation for this study using a literature review to show the current research limitations. The RQ2 discovery can reveal the current requirements for manufacturing firms interested in joining the BRR. RQ3 is discussed as a research methodology explanation. The purpose of RQ3 is to explain why the multiple case study method is used to find effective strategies for manufacturers. The response to RQ4 and RQ5, which includes a description of project level service models discovered and how sustainable value might be generated, is the main context of this multiple case study.

This study discovered two systematic servitization strategies for manufacturing firms participating in the BRI so that they could achieve win-win outcomes. The first strategy is the discovery of effective service models that can be applied by manufacturing firms. The second strategy is to promote sustainable value creation through service model innovation. This paper is organized as follows. Section 1 provides the background of the research topic and explains RQ1. Section 2 answers RQ2 by providing an analysis of recent studies on the research topic and summarizes the gaps in the current research. Section 3 answers RQ3 by explaining this study's research methodology, data collection methods, and data analysis. Section 4 answers RQ4 and RQ5 by presenting an in-depth multiple case study and describing the findings on service model innovation. This section also discusses the enhancing of sustainable value by service models that could be effective paths for improving manufacturing. Finally, Section 5 examines the major contributions and limitations of this study.

## 2. Literature Review and Rationale for the Study

This study explored effective service strategies for manufacturing firms that planned to expand their businesses in the BRR. This section discusses the relevant research on cooperation in the BRR and service strategies (corresponding to RQ2). Using the keywords, "Belt and Road", "manufacturing industry", "service model", and "servitization strategies", we searched Google Scholar and Science Direct, then chose a total of 40 papers especially relevant to the overseas business expansion of manufacturing firms in the BRR.

### 2.1. Cooperation of Manufacturing Firms in the BRR

The advent of the BRI has had positive effects on the world's economy, as most of the participating countries have experienced increases in economic growth, welfare, and foreign trade [18]. Most countries are still developing and dependent on foreign resources and technology to realize advanced manufacturing and sustainability [19,20]. For manufacturers, the product-service system is considered one of the most effective value propositions toward a resource-efficient business [21]. Wenyan S. et al. [22] mentioned the importance of notice sustainability issues for the product-service system in the design stage. When manufacturers provide product-related service they should be capable of fulfilling specific customer requirements in both economical and sustainable manner [23]. Lingdi L. et al. [24] proposed a framework for product-service system sustainability level evaluation, the sustainable criteria on technology support and energy use efficiency are highlighted. As more and more firms develop construction business in the BRR, some scholars examined the region's carbon emissions due to industrial activities as environmental concerns. Some studies [25,26] emphasized the importance of low-carbon development index and provided suggestions for a greener transportation industry. Huaping Sun et al. [27] studied greenhouse gas emissions and demonstrated that factors such as trade liberalization, urbanization, and industrial energy usage have been responsible for the recent increases in global carbon emissions. These studies [28,29] have provided important insights into the environmental issues of the BRI but not much into effective strategies that would be essential to manufacturing firms willing to enter the BRR.

Some studies focused on cooperative strategies and have analyzed certain types of manufacturing firms. Huandong, J. et al. [13] quantitatively analyzed oil and gas consumption in the BRR and discovered the significant potential for Chinese firms in oil and gas exploration, pipeline construction, and engineering and technical services. Studying China's export growth for 2001–2018, Kun, Z. et al. [30] used data envelopment analysis to estimate the extent and quantity margins, as well as to measure the efficiency, of new energy exports. Chi, Z. et al. [31] focused on the energy trade network in the BRR and found that neighboring countries tended to establish closer trade relations between their energy industries. The upgrading of the automobile manufacturing industry in China has also attracted attention. One study [32] conducted a multiple regression analysis using panel data and the results emphasized the importance of improving internal capabilities

for technological innovation and external linkages for automobile firms. Wen, J. et al. [33] designed a competitiveness evaluation system for the opportunities and challenges brought by the BRI to the automobile manufacturing industry in a southwestern Chinese province. With the gradual progress in BRI cooperation, infrastructure projects, including electricity grids and information technology industries, have also become important. The requirements for electricity in the BRI have markedly increased [34], but there is great potential for cooperation in electricity generation [35]. Cooperation between energy industries now plays an important role in the BRI [36]. Fossil-fuel industries, such as oil and gas, have also gained development opportunities. Sarker et al. [37] suggested that governments should implement effective strategies for creating favorable investment opportunities between China and Middle Eastern countries in the BRI.

The major manufacturing industries, such as high-end equipment, automobile, information technology, and energy, have become a very important part of the BRI, whose significant potential has been attracting various Chinese and foreign manufacturing. Hence, effective servitization strategies for overseas industrial project investments are becoming more important. Moreover, manufacturing firms should play more important roles in global value chains [38], so creating sustainable value is important to cooperation in the BRI.

## 2.2. Methods Applied to Discovering Strategies for the Manufacturing Industry

The BRI brings significant opportunities to manufacturers but firms need to discover and implement effective strategies to stay competitive [2,39]. Table 1 summarizes the main topics covered by the literature on discovering strategies for BRI cooperation. There are three main types of studies on discovering strategies: literature reviews, mathematical analyses, and case studies. Literature reviews usually focus on how the manufacturing industries in the BRI are portrayed by studies on topics such as trade problems, transportation, and supply chain management [40–42]. Such reviews are effective at discovering future directions for research but provide little on discovering strategies.

**Table 1.** Topics of representative studies on discovering strategies for manufacturers.

| Research Methods                                      | Focus                                                                                                                          | References | Results                                                                                                                 | Discoveries Made of Detailed Strategies for Manufacturers? |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|------------|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| Literature reviews                                    | Systematic classification of the literature on management and economics                                                        | [40]       | Future research should consider geopolitical differences and trade blocks in addition to firms and countries.           | No                                                         |
|                                                       | Comprehensive reviews of the effects of the BRI on transportation and logistics.                                               | [41]       | Several research opportunities found for transportation.                                                                | No                                                         |
|                                                       | Broad systematic reviews of the literature on how the BRI would affect global supply chain management.                         | [42]       | Summaries of several issues in supply chain management                                                                  | Partially                                                  |
| Mathematical analyses based on database or statistics | Estimations on China's new energy exports to other BRI nations and development of an input-output mechanism for export growth. | [43]       | Institutional distance is an important factor in energy exports. Implications for the energy industry's sustainability. | Partially                                                  |
|                                                       | Estimations of losses in capacity on both environmental and equipment inefficiencies.                                          | [44]       | Overall capacity losses in BRI countries increased because of environmental inefficiency.                               | No                                                         |

Table 1. Cont.

| Research Methods | Focus                                                                                   | References | Results                                                                                                                            | Discoveries Made of Detailed Strategies for Manufacturers? |
|------------------|-----------------------------------------------------------------------------------------|------------|------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| Case study       | Multiple case studies for the Sweden and Australia manufacturing firms                  | [45]       | The manufacturing firms should have a good awareness of all the elements of the market environment for their competitive strategy. | Yes                                                        |
|                  | Multiple case studies available on transport infrastructure projects in the BRI.        | [46]       | Summary of an Architecture & Supplier Identification Tool (ASIT) model for supplier management.                                    | Yes                                                        |
|                  | Facilitation of cross-border transport infrastructure project services in other nations | [47]       | Proposal of several cooperative models for the strategic promotion of energy firms.                                                | Yes                                                        |

Mathematical models using statistical databases provide more realistic insights. Zhenling, C. et al. [43] calculated capacity use losses and their impacts on China's outward foreign direct investments. Wang L. et al. [44] developed a globally and environmentally extended multiregional input-output analysis using the self-developed multiregional input-output model. The results of mathematical analyses are usually descriptions of conclusions based on calculations. Although such studies are quite useful to governments, they are limited in their answers to the "how to do" questions asked by manufacturers.

The case study is considered one of the most appropriate means for discovering realistic and effective strategies or business models that could answer "how" and "why" questions. After multiple comparative case studies of firms in Australia and Sweden, Soosay, C. et al. [45] formulated several effective strategies for enhancing manufacturing competitiveness. By three case studies, Jixian, W. et al. [46] discovered strategies for facilitating the capabilities of transnational transport infrastructure projects in garnering the required resources and support. Feng, T.-T. et al. [47] also applied a multiple case study to formulate several strategies for multilateral platforms to facilitate cross-border transport infrastructure projects. The multiple case study approach is useful for discovering effective strategies that improve manufacturing competitiveness.

### 2.3. Achieving Sustainable Value Creation through Effective Servitization Strategies

Studies have shown that international cooperation in the BRI has brought both opportunities and challenges for manufacturing firms [40]. The potential of the BRI requires deeper research into strategic management [48–50]. Many researchers conducted mathematical analyses using data from government databases to investigate environmental issues and problems related to carbon emissions and water resources [26,47].

Such studies can be effective resources for government officials and scholars but have been somewhat limited in providing novel suggestions on servitization strategies for manufacturers. This is because although the mathematical analyses on databases or statistics can bring very quantitative and specific results, their reference value is major in theoretical implications. The results obtained usually have limitations in guiding the manufacturing firms in "how and what to do" questions in their business. For example, Zhenling, C. et al. [43] estimated the capacity use loss in countries along the BRI through the data envelopment analysis method. Their results were based on calculating the statistics of energy consumption/labor force and can provide a valuable reference for environmentalists. However, the theoretical implications do have limitations in offer strategies for manufacturing firms in BRR. Studies that have focused on strategic management tools [51–53] have been effective in evaluating and comparing existing strategies and can provide managerial and policy

implications. These methods are suitable for assessing whether the strategy applied is applicable, but still rather limited in suggesting novel strategies and models.

Manufacturing firms planning to enter the BRR's markets need proper innovative service strategies to guide their business and investment activities. The strategies should systematically concern the competitiveness of the firms and social-environment influence. As the BRI also calls environmental pollution control and social responsibility in project construction. However, few studies focused on developing comprehensive strategies for both service models and sustainable value creation for manufacturers in BRR. With the increasing number of countries entering the BRI, more overseas manufacturing firms are planning to invest in this region. Successful service strategy outcomes and value positioning are important to competitive performance [54]. As the situation in the BRR is complex, managers in the manufacturing firms would like to know how to apply service transformation to keep their firms competitive. The situations of the manufacturing firms differ according to product, size, industry, and technology. Classic servitization strategies, such as product-service systems, may not be sufficient for manufacturing firms [2,55], whose managers require innovations in their service models for the servitization of their industrial and larger construction projects. With the gradual deepening of cooperation, manufacturers are also aiming at sustainable development.

This study fills the gaps in the current research in two ways: (1) applying a multiple case study method to discover effective service models, as well as their characteristics and advantages; (2) combining the characteristics of sustainability with these service models to formulate proposals for how service model innovation could facilitate sustainable value creation.

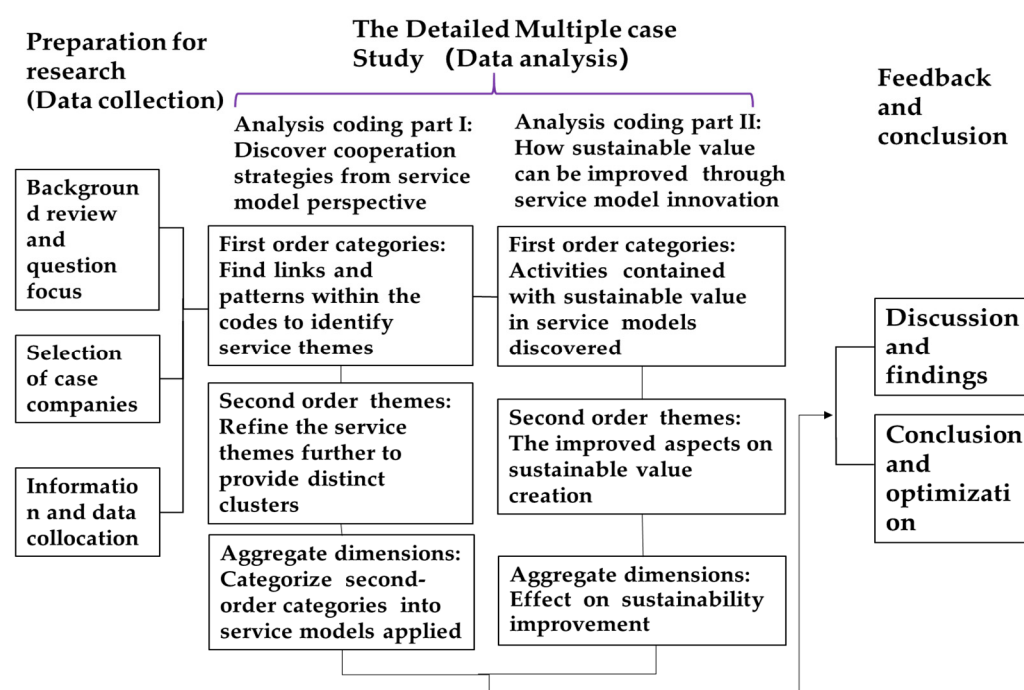
### 3. Research Methodology

#### 3.1. Methodology and Research Framework

Discovering effective service strategies for product/project delivery and sustainable development requires exploratory case studies in the manufacturing industry. Statistical and mathematical methods may restrict the generation of new knowledge and strategies [56,57]. Therefore, it is important to investigate how manufacturers understand their reality. The case study is the proper method for examining procedural and strategic issues [58,59], especially when evaluated interventions cannot provide a clear and single set of outcomes [60].

Case studies can be divided into two major types: single and multiple [61]. The latter has been applied to this study because it could be more convincing, suitable, and robust for obtaining effective strategies [61–63]. Cross-case comparisons can provide better explanations and a more relevant understanding of the effects of the contextual variables [64,65]. Paiva, et al. [66] applied a multiple case study to analyze the strategic choices and operational strategies of the Brazilian manufacturing industry. Marri, et al. [67] proposed strategies regarding computer-integrated manufacturing by small and medium-sized enterprises.

The multiple case study also has greater flexibility in adapting the circumstances and terminologies of different industries [68,69]; hence, it can provide a means for analyzing the differences and similarities between cases, which is especially useful for discovering common characteristics and exploring strategies [70,71]. Our study explored cases from different representative industries to find useful service models that could encourage sustainable value creation. To answer RQ3, we collected primary data by means of a questionnaire and secondary data from annual reports and the official websites of the chosen firms. Figure 1 presents a flowchart illustrating the various procedures involved in our study.



**Figure 1.** Research framework of this study.

### 3.2. Data Collection

We chose the case firms according to two criteria. First, the firms should be manufacturing firms headquartered in China with overseas businesses in the BRR. Second, they should be representative of key industries that have already developed effective methods of cooperation. Of the fourteen firms we contacted, eleven of them agreed to participate in our study (see Appendix A). The respondents occupied a wide range of roles and job positions related to the servitization business with at least ten years of working experience. The Chinese Academy of Engineering commissioned several experts to design a detailed questionnaire (see Appendix B), which was sent to the respondents before we interviewed them. Primary data were collected by face-to-face interviews with professionals in manufacturing-related businesses and/or servitization transformation. Then, secondary data were collected from additional documents provided by the selected firms, which described their successful experiences, discussed related questions, and provided future suggestions. We examined the feedback from the firms carefully and expressed it in refined linguistic terms.

### 3.3. Data Analysis

To analyze case data effectively the explanation-building interpretative technique was applied in this study [69,72]. Then to conclude the findings this article applied two parts in the multiple case study corresponding to servitization and sustainable value creation strategy.

Part I of the data analysis involved the identification of the service models. The first step consisted of in-depth readings of each firm's case before a cross-case comparison was conducted [73,74]. The feedback is summarized in Section 4. We familiarized ourselves with the interview transcripts by reading them several times and marking the phrases and passages that mentioned servitization. In the second step, we applied thematic analysis to supplement the multiple case study and used two coding schemes for the identification of the service models used. We coded the common phrases and sentences into first-order categories. In the third step, we analyzed the second-order categories to discover links and patterns to find relevant service themes. To decide whether or not a theme was an effective service model in product or project delivery service (categorization), we followed these principles [75]: (1) the service was applicable in the context of one participating firm,

(2) several firms mentioned the theme in their feedback, and (3) the theme provided useful conclusions for theory formulation. Among the six service models we discovered, four could be seen as improvements of the traditional service model while the other two novel service models proved to be effective for cooperation.

Part II of the data analysis focused on how the service models could contribute to sustainable value creation. The first-order categories were formed by new characteristics found among the service models from the collected data, then analyzed for links and patterns to be placed into the second-order categories [76]. We returned to the literature as a reference for grouping our first-order into second-order categories, which described the improved aspects of cooperation in terms of sustainable value creation. Finally, through thematic analysis, we grouped the three second-order categories into two perspectives that could contribute to sustainability as aggregate dimensions. To guarantee the quality of the data analysis, a coding team consisting of two doctorate students, three master's degree students, and two professors was established. Each member was an independent coder of the textual information and subsequently compared to ensure the reliability of the case study [77].

#### 4. Processes and Results

Our research process starts with explaining the service characteristics and methods of each firm, with emphasis on the service models and how these models could promote sustainable value. This study summarized the effective service models of manufacturing firms by means of a detailed multiple case study. We focused on how sustainable value creation could be improved through service model innovation.

##### 4.1. Service Models Applied by Case Firms

This section describes the current conditions of Chinese manufacturing firms in the BRR. The selected firms operate in major manufacturing areas such as high-end equipment, automobile, information technology, energy, and petrochemicals. All the respondents were familiar with the servitization business and understood the importance of sustainable development. Each response to the questionnaire was read carefully. Figure 2 shows the coding scheme used to identify the service models.

##### 4.1.1. Product-Service Delivery: Digital Industrial Product-Service System Model

Industrial product-service system can provide service offerings on industrial applications that support the integration of products and services [78,79]. Our results indicated that the three selected firms focused on providing service offerings with their industrial products and explored effective methods for product-service delivery by developing a digital product-service system.

The marketing and service center manager of Firm 1 stated: *"Our quayside crane equipment has occupied more than 70% of the global market share. In the BRI countries, customers are requiring systematic services. To solve this problem, the firm applied smart sensors on monitoring points with IoT or Industrial Ethernet to collect operating data effectively, which successfully realized the remote centralized monitoring of quay crane equipment throughout the BRI countries."* This feedback helped us to discover that industrial product-service systems could also incorporate the digitalized management of spare parts.

The respondent from Firm 2 stated: *"The service networks in the major countries were developed and an e-commerce platform was built for the collaborative management of spare parts. The layout of the spare parts outlets and the service training were improved."* For supporting after-sales maintenance and upgrading, a digitalized supply chain collaboration platform for product accessories is essential. The respondent from Firm 7 stated: *"Our major industrial products are automotive spare parts. During our business dealings with BRI countries, we found that it was important to ensure real-time interactions of information, spare parts logistics, and capital flows among the stakeholders, including government departments and suppliers. Our firm consolidated the digitalization of automotive parts logistics and developed an intelligent*

information management system for the automotive parts service. " With these measures Firm 7 achieved warehousing automation, share information upstream and downstream, cut communication costs, and shorten the delivery cycle.

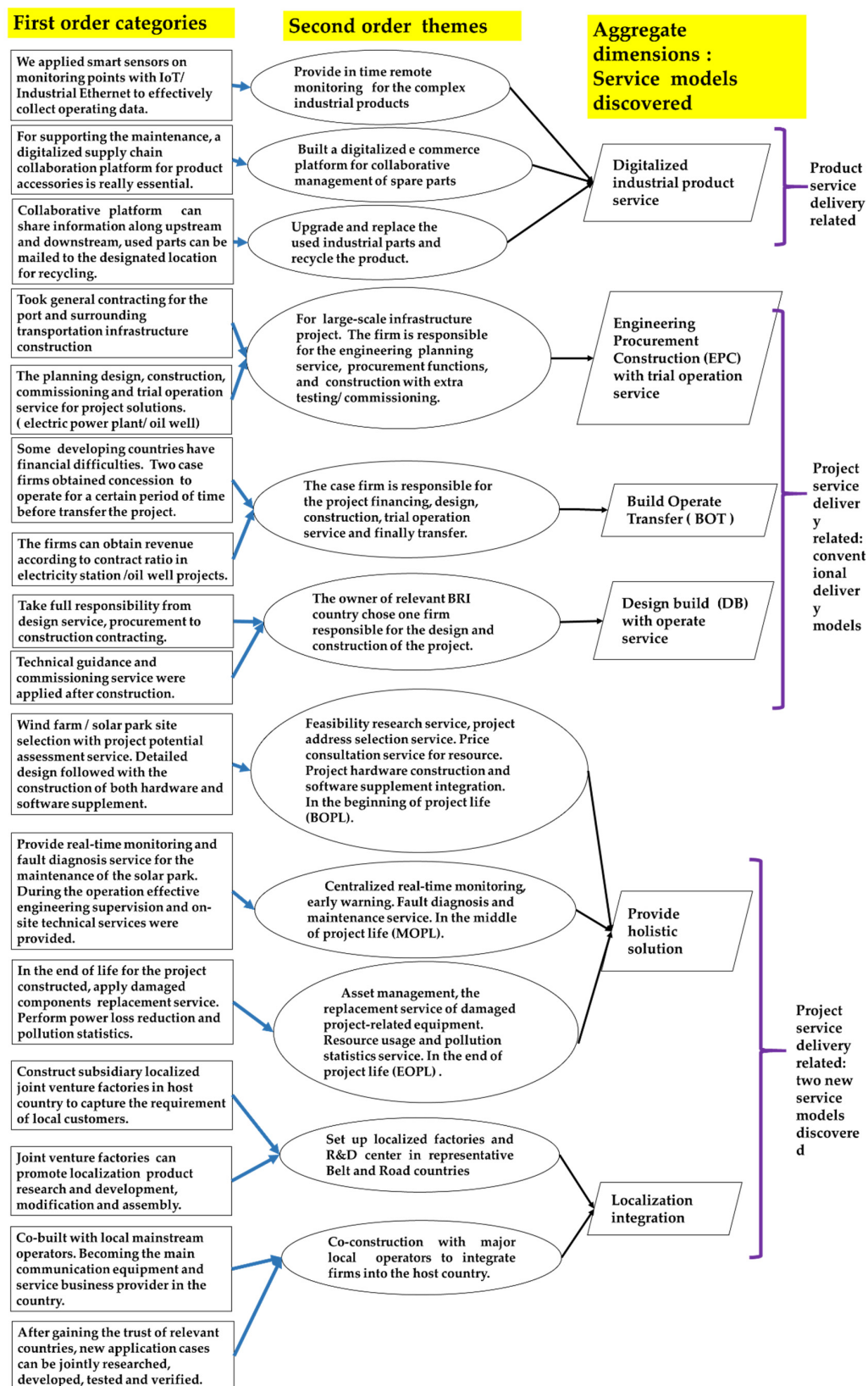


Figure 2. Coding scheme for identification of service models applied in BRI.

These firms benefit from applying digital industrial product-service systems, which should include: (1) remote monitoring of complex industrial products by the use of emerging technologies such as the Internet of Things (IoT), Industrial Ethernet, and smart sensors, which help to extend the lifecycles of the products; (2) digitalized e-commerce platforms for the collaborative management of spare parts, improved layouts of spare parts outlets, and high-quality service training so that the real-time interactions of customer order, work, and information flows with upstream and downstream business partners can be realized; (3) upgrading, replacing, and recycling of used industrial products. This service model is an effective way for BRI countries where the firms have just started their service businesses. Their services are mainly the extensions of products sold to customers, which can be seen as an effective method in the initial stage [80].

#### 4.1.2. Project-Service Delivery: Conventional Public-Private Partnership (PPP) and Engineering Procurement Construction (EPC) Delivery Models

We identified nine firms that have started providing project delivery services with clear objectives rather than simply servicing sold products and have explored methods of providing project-based services. A project can be considered to be any undertaking that is carefully planned to achieve a particular aim and comprises a unique, complex set of tasks, which can be divided into work packages and subtasks, with a defined duration [81,82].

Two of the firms deliver their project services by applying the EPC model. Firm 1's respondent stated: *"When we expanded our business overseas, the services provided were no limit to our port machinery products. The firm applied the EPC model to its general contracting service for the constructions of ports and their surrounding transport infrastructures."* Thus, Firm 1 transformed itself from a single-product seller into a general contractor. The service manager of Firm 3 stated: *"In the past, our firm's major products were electricity transmission and transformation equipment. During our cooperation in BRI countries, we discovered that electric power grid construction was usually a complex project with a long duration that required complex technical engineering. We applied EPC to multiple businesses, such as power plant planning, design, construction, commissioning, and trial operations, to meet local needs."* Firm 11 was in the oil industry and its respondent mentioned that the EPC model was applicable to oil well construction and related services: *"Our firm applied a high-quality EPC model to our integrated project services, which covered oil exploration, as well as oil well engineering design and construction. Relevant research and extended services for the petroleum industry were provided by the project."*

Two project delivery methods, design-build (DB) and Build-Operate-Transfer (BOT), were widely applied. The respondent from Firm 5 stated: *"During our cooperation, we provided project construction services, including design, relevant equipment selection, and transportation installation services, to electric power transformation grids. To satisfy the customers, we also provided installation technical guidance and commissioning services after construction."* The respondent from Firm 9 stated: *"Our firm applied an improved DB model for project services. For an ICT construction project, we took full responsibility for design, procurement, construction, contracting, technical guidance, and commissioning before accepting it."*

We found that the DB model was widely used in projects related to the energy industry. The respondent from Firm 10 pointed out: *"For a liquefied natural gas project in Russia, the firm was fully involved from design to construction. It obtained permission from the local government and adopted the DB to achieve the contracting of the entire project for the drilling and production of natural gas. The application of the DB model updated the service business from the product level to the level of entire natural gas drilling and production."* We discovered that firms in less developed countries tended to choose the BOT model, as project financing could be covered by the private sector. This model requires the concession firm to shoulder the financial and managerial responsibilities and has been applied to many power plants in China. The respondent from Firm 5 stated: *"Our firm has sufficient experience in electricity transformer substation construction and operations. We completed several 500-kV substation projects in central Asia. The firm was responsible for construction, installation, and commissioning. We earned part of the profits from the power plant operations after the design and building stages."* Firm 10 also

adopted the BOT model to provide project delivery and related service. Its respondent stated: *“We were granted several concessions by the relevant government departments of the oil-producing countries along the BRI and obtained the right to use oil wells for limited periods. Our firm provided oil and gas field construction, engineering construction operations, and business operations.”* The BOT model can deliver projects as successfully as the EPC or DB models and does not require direct funds from the host country. Relevant firms can deliver services through the operational and transfer steps in the BOT model and can reduce the financial difficulties for developing countries in the BRR.

Several other firms mentioned that increased familiarity with the BRI countries into which they entered had extended their servitization through project delivery services delivered mainly in the engineering/design step or the installation and commissioning before project transfers.

#### 4.1.3. Project-Service Delivery: Two New Service Models Discovered

With the deepening of cooperation, some firms mentioned novel ways of providing project services to their customers. From the data analysis described in Section 3.3 [75], we thus discovered two novel service models: a holistic project solution and localization integration.

The respondent from Firm 4 stated: *“Many BRI countries are interested in wind power projects as important ways of realizing clean energy. To satisfy the various requirements of different stakeholders, our firm applied the relevant services during the project lifecycles.”* This service model was developed through an in-depth understanding of the entire lifecycles of wind power-related projects and relevant financial businesses. This respondent also stated: *“At the beginning of project planning, we provided wind resource forecasts and wind farm site selection services with GPS and base station positioning technology. During the construction, both the hardware (wind turbine equipment) and supplementary software (software version management platforms for wind turbines) were provided. In the middle of a project’s life, we applied centralized real-time monitoring and fault diagnostic services to the wind power stations. The relevant fault information was recorded into a big-data platform to guide wind plant component maintenance, thus helping the wind farms achieve higher power generation and life extension. Our project team provided replacement services for damaged wind plant components and statistics for power loss reduction at the end of the lives of the wind power farms.”* The holistic solution service model was found applicable to complex industrial parks, such as wind and solar parks. The respondent from Firm 8 stated: *“Germany is the country where we had relatively close cooperation in the BRI. We explored a more holistic way of providing project-related services. For example, the firm applied a holistic solution to a 7.8-MW smart photovoltaic solar park in Germany. At the beginning of the project, we were responsible for the project address selection and the solar energy potential assessment. During construction, relevant smart photovoltaic controllers, communication optical fiber hardware, and related ICT software support services were offered. After the construction, we provided real-time monitoring and fault diagnostic services for the maintenance of the solar park. To achieve more sustainable cooperation, the firm applied project-related equipment recycling services, resource usage, and statistics on pollution episodes.”*

A holistic solution model focuses on providing services during the entire lifecycle of a project and contains more service choices than do traditional PPP/EPC models. The respondent from Firm 8 stated: *“The holistic service model can be considered as the upgrading and improvement of conventional PPP project delivery models while including the initial idea/feasibility study, construction, maintenance, and final recycling. This model may be a bit more expensive, but the service offerings provided are more diversified and comprehensive.”* The holistic solution service model aims at providing the relevant services during the start, middle, and end of a project’s life. These services cover the pre-project, project operational, and post-project delivery phases, which are described as follows.

**Birth of project life (BOPL):** This stage corresponds to the site selection and construction phases. It includes feasibility research and project address selection services, price consultation services for raw materials and resources, project hardware construction, and supplementary software integration.

Middle of project life (MOPL): This stage includes centralized real-time monitoring, early warning systems, and fault diagnostic and classification services.

End of project life (EOPL): This stage includes asset management, maintenance and replacement services for damaged equipment and resource usage, and relevant pollution statistical services.

The conventional PPP and EPC models usually focus on providing services with fixed modes, whereas the holistic project solution service model aims to provide comprehensive services over the entire lifecycle of a project and has a more flexible service configuration that includes subsequent adjustments to feedback until customer requirements are fully satisfied.

Another novel effective service model we discovered is localization integration. With the deepening of economic cooperation, Chinese manufacturing firms should improve localization and build their industrial bases in the BRR [5]. This service model can be considered a more systematic way of providing customized service. Firm 2's respondent stated: *"Our firm shifted from exporting products overseas to on-site manufacturing in the host country, so we named the model, the localization integration model. This cooperative method can produce win-win outcomes from the firm's perspective. The localized manufacturing factory can produce crane equipment to suit the needs of the local market, thus increasing profits. From the host country's perspective, localization integration can accelerate the technological transformation and provide access to standard outputs."* The respondent of Firm 6 stated: *"Our firm promoted localized integration to develop specific products for different countries. We established several subsidiaries and production factories in Indonesia. These localized manufacturing factories were able to capture the requirements of local customers and launch automobile types that met the country's conditions. Special requirements for products in the BRR are collected to strengthen personalized customized services and expand profitability."*

Localization integration was also implemented by firms in the information technology industry, where we found the second path for localized services, which requires that firms be very familiar with the host countries before co-building with local major operators. The respondent from Firm 8 stated: *"Our firm successfully combined the localization integration service model with the customer-centric firm culture. In important Belt and Road countries such as Kazakhstan and Saudi Arabia, we co-built with local mainstream operators in cooperation, thus successfully becoming the main communication equipment provider and service business provider in these countries."* Similarly, the respondent from Firm 9 reported: *"Our service business started with providing after-sales services for telecommunications equipment. After gaining trust, we proposed a joint operation with ArmenTel, the largest telecom operator in Armenia. Our firm promotes unified equipment and data-sharing agreements. With this localization model, the firm became the IPTV Service Provider in 2019 and several digital subscriber line broadband networks were built and operated successfully in the major cities."* A systematic localized integration model does not provide only locally customized products for the relevant country. There are two specific paths for achieving localized integration service.

- (1) For firms in conventional equipment manufacturing industries: Establishing localized joint venture factories in representative Belt and Road countries, which should be major regional powers, such as India in southern Asia and Poland in eastern Europe that can successfully radiate to neighboring nations. Developing specific products for different countries and launching models that are compatible with each country's level of economic development and conditions.
- (2) For firms in emerging information technology industries: As a result of the characteristics of information technology services, localization cooperation can be an effective supplement for improving PPP models. Co-building with major local operators can promote firms with equipment and data-sharing access, thus helping them to become the main communication equipment and service business providers in the host countries. After gaining trust, new applications can be jointly researched, developed, tested, and verified.

#### 4.1.4. Summary of the Trends of the Discovered Service Models

We found that the selected firms had applied effective service models and servitization for project delivery, such as the EPC model for design/operational services for electric transformation stations and the PPP model for oil and gas field construction, engineering construction operations, and business operations. We also discovered new types of project-service trends such as the holistic solution and localized integration models. A project-service system can be seen as an extension and completion of conventional project management services [82]. Achieving a project-service system is important, as a project is usually more complicated than a single product and contains various mechanical structures. A comparison between a product-service system and a project-service system is shown in Table 2. The latter system tends to provide the customer with unique solutions, as well as complex project construction and knowledge-intensive services [83]. Classic project delivery methods such as EPC and PPP can provide additional service offerings but the holistic solution model is more comprehensive because it can provide systematic services during the BOPL, MOPL, and EOPL stages. The localization integration model is an effective tool for gaining an understanding of a host country and for successfully radiating to neighboring nations. Both these novel service models are effective types of project-service systems.

**Table 2.** Comparison of product-service system and project-service system.

|                                                        | Product-Service System                                                                                                                                                                                                                 | Project-Service System                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Definition                                             | Usually defined as an extended market proposition that extends product functionality by applying additional services [84].<br>The industrial product plus digital service applied in this study is one type of product-service system. | Projects have defined objectives. The project-service system provides services as additional offerings for projects. The service offering is progressively applied during the project lifecycle.                                                                                                             |
| Drivers                                                | Extends existing offers for products to satisfy and fulfill customer requirements. Achieves a more sustainable environment.                                                                                                            | Firms tend to provide unique solutions to their customers and their business performance differs according to their industries.                                                                                                                                                                              |
| Components/elements                                    | One or several products plus the additional services and sometimes with supporting networks.                                                                                                                                           | With a clearly defined aim as the output, a project could contain various mechanical structures with demands for the construction of complex systems and knowledge-intensive services.                                                                                                                       |
| The role of the service provider                       | The provider aims to increase its competitiveness and profitability through product and service provision [85].                                                                                                                        | The provider aims to achieve a specific objective, so they need to study carefully what services to include during the different phases of the project lifecycle [86].                                                                                                                                       |
| The role of the customer (and other service consumers) | Customers can provide requirements and join the value co-creation. Product/service ratio can vary according to different customers [87].                                                                                               | Customers can receive both project and related service offerings. As a business project is usually more complicated, the customer can receive more service offerings in various industrial schemes.                                                                                                          |
| Delivery paths                                         | Satisfy customer needs by delivering combinations of products and services to provide the desired functions.                                                                                                                           | The project-service system can be delivered through conventional PPP and EPC models. The level of localization can be improved and more services can be offered during the project lifecycle to create more value. The delivery is usually for achieving a valuable service result/solution to the customer. |

Table 3 summarizes the six effective service models that we discovered the selected firms to have applied in different servitization stages, of which Lütjen, et al. [88] identified three transitional stages: service initiation, service anchoring, and service extension. The initiation stage applies and delivers the services from products sold to BRI countries.

Digitalized industrial product-service systems are applicable by firms as they enter BRI countries. Their service offerings are applied mainly for the products they provide. We found that ten firms, which accounted for 90% of related cases, had applied project delivery services. Promoting project-service delivery is appropriate for firms that have accumulated a certain basis for cooperation. These service models require manufacturers to be familiar with a country's market and customer needs. Project-service delivery through conventional EPC or PPP delivery models can be seen as the service anchoring stage and some firms may apply multiple models for better results [89]. We identified several firms that had discovered novel models for project services in cooperation. These two models contain integrated service activities and solutions for customer-specific problems, which can be seen as features of the service extension stage. Both holistic solution service and localization integration models require deeper value co-creation with relevant stakeholders in BRI countries, so firms in this stage seek to provide value-added services during a project's entire lifecycle.

**Table 3.** Applications of service models.

|         | Product-Service Delivery                                          |                                                                              | Project-Service Delivery (EPC and PPP Models) |                                                  | Project-Service Delivery (Two Novel Models) |                          |
|---------|-------------------------------------------------------------------|------------------------------------------------------------------------------|-----------------------------------------------|--------------------------------------------------|---------------------------------------------|--------------------------|
|         | Provides Additional Real-Time Remote Monitoring for Products Sold | Digitalized e-Commerce Platforms for Collaborative Management of Spare Parts | EPC Model                                     | PPP Models Including DB/BOT and Related Services | Holistic Solution                           | Localization Integration |
| Firm 1  | ✓                                                                 |                                                                              | ✓                                             |                                                  |                                             |                          |
| Firm 2  |                                                                   | ✓                                                                            |                                               |                                                  |                                             | ✓                        |
| Firm 3  |                                                                   |                                                                              | ✓                                             |                                                  |                                             |                          |
| Firm 4  |                                                                   |                                                                              |                                               |                                                  | ✓                                           |                          |
| Firm 5  |                                                                   |                                                                              |                                               | ✓                                                |                                             |                          |
| Firm 6  |                                                                   |                                                                              |                                               |                                                  |                                             | ✓                        |
| Firm 7  |                                                                   | ✓                                                                            |                                               |                                                  |                                             |                          |
| Firm 8  |                                                                   |                                                                              |                                               |                                                  | ✓                                           | ✓                        |
| Firm 9  |                                                                   |                                                                              |                                               | ✓                                                | ✓                                           | ✓                        |
| Firm 10 |                                                                   |                                                                              |                                               | ✓                                                |                                             |                          |
| Firm 11 |                                                                   |                                                                              | ✓                                             | ✓                                                |                                             |                          |

#### 4.2. Service Model Innovation in Sustainable Value Creation

We found that many of the selected manufacturing firms were promoting project delivery services while expanding their businesses in the BRR and that the advantages of applying service models were not limited to profit growth. Firms should deliver sustainability value through their core businesses [90]. Till 2021 there are nearly 140 countries participating in the BRI and most of them are developing nations [91]. The United Nations has stated that sustained economic growth is critical for the world's economic and social development, particularly in developing nations (<https://undocs.org/en/A/RES/51/240>, accessed on 12 October 2021), the BRI countries' desire to build better infrastructure needs to be fully respected. Consider the BRI countries' desire to build better infrastructure and manufacturing firms' willingness to join, the main goal of this study is to find sustainable cooperation paths for manufacturers who have invested in or are about to enter the BRI, which has recently become popular. To fulfill their needs, we do need to take economic sustainability as the main point. However, we would like to point out that the study also looked into environmental friendliness as the component of cooperation strategies.

Part II of our study explored how and from what perspective service model innovation could improve sustainability development (corresponding to RQ5: How can effective industrial service models contribute to sustainable value creation in the BRR?) With service innovation proving to be an important method of sustainable value delivery, we analyzed

the effects of servitization on sustainability from a systematic perspective and considered the critical requirements of both the manufacturers and BRI countries. The framework for sustainability issues under BRI background is summarized in Table 4. This table summarized how the BRI considered both regional economic growth and environment-friendly issues for bilateral cooperation. In the second column, the dimensions related were explained. We had the necessary literature and official government websites linked as references to further describe the BRI's sustainable development plan in the third column of the table. This study did not just focus on how the cooperation can bring economic success, achieving pollution control in project construction is also emphasized.

**Table 4.** Sustainability issues under BRI background.

|                                                                                                                     | Detailed Dimensions Related                                                                                                                                   | Reference<br>(The Relevant Study and Official Plan) |
|---------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| Economic                                                                                                            | Identify new markets in the broader region through discovering and better fulfill customer requirements in BRI countries.                                     | [92,93]                                             |
| Sustainability                                                                                                      | Provide extra services during the product or project construction to improve customer satisfaction in the BRI region.                                         | [94,95]                                             |
| (Give opportunity to manufacturers and promote the economic growth of relevant BRI countries).                      | Realize technology innovation and high-quality standard exportation to help manufacturers gain more profit.                                                   | [96,97]                                             |
| Environmental                                                                                                       | Sustainable development for manufacturers overseas requires the efficient allocation of resources.                                                            | [98]                                                |
| Sustainability                                                                                                      | The belt and road ecological and environmental cooperation plan mentioned the importance of energy saving for the project constructed (green infrastructure). | [99–101]                                            |
| (Pay attention to possible environmental issues in project cooperation, promoting a low-carbon development in BRI). | Promote higher resource usage efficiency and avoid waste in project delivery, try to reduce carbon emission if possible.                                      | [102,103]                                           |

This section focuses on the environmental and economic aspects as few case firms in this study mentioned activities from the social sustainability aspect. Multiple manufacturing firms have applied various service models of product and project delivery. We have found that effective service models could provide service offerings combined with sustainable value creation. The relevant service model innovation could promote resource usage efficiency and reduce carbon emission, as well as core technology and standards exportation (as high value-added contents). These four aspects can create sustainable value in terms of both economic and environmental development, which are important dimensions for sustainability [104]. Figure 3 illustrates the perspectives that can enhance sustainable value creation through relevant activities in the discovered service models.

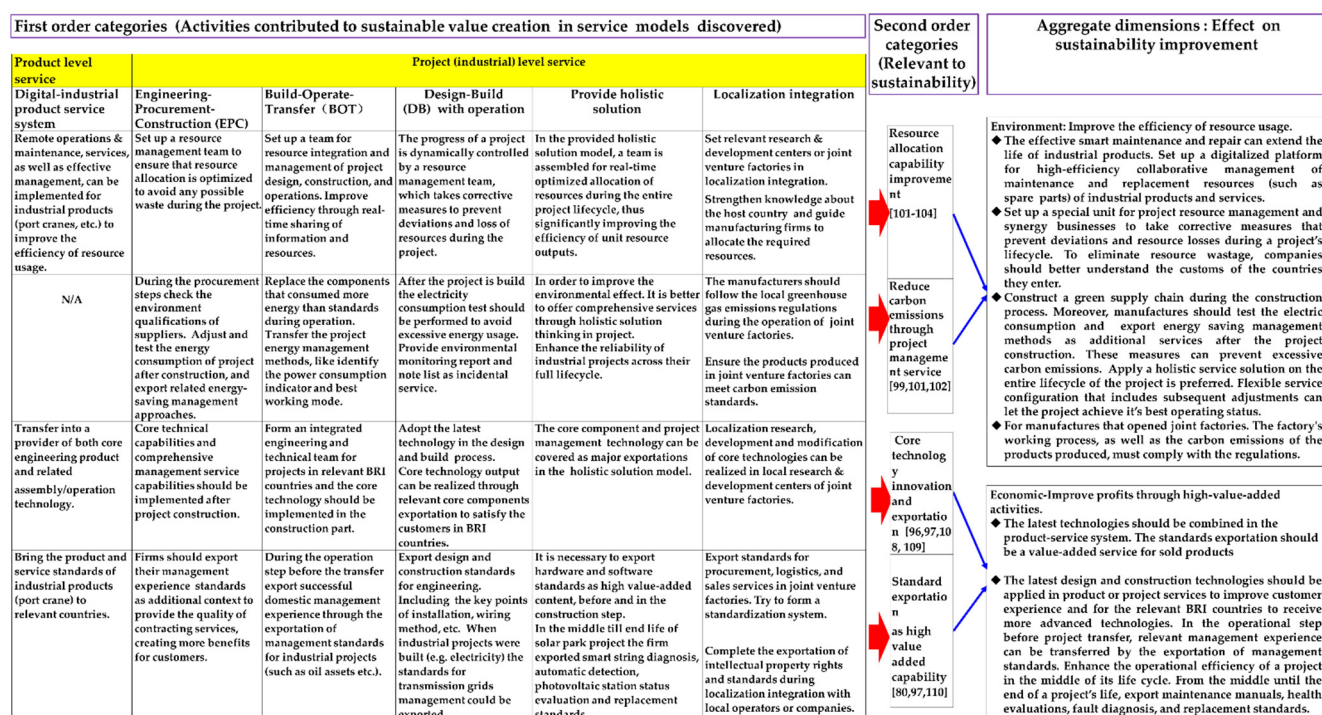


Figure 3. Perspectives that can enhance sustainable value creation through relevant service models.

#### 4.2.1. Environmental Perspective: Increase Resource Usage Efficiency and Reduce Carbon Emissions in Industrial Cooperation Projects

The BRI is designed to support the achievement of sustainable development objectives. Manufacturers should pay attention to the allocation of resources within and between firms for environmental concerns [104,105] in the BRR. Compliance with environmental regulations is the foundation of engineering project construction. The selected manufacturing firms described how they avoided possible waste and improved resource allocation capabilities through effective service models.

The digitalized industrial product-service model can contribute to effective resource allocation through remote operations and management consulting service platforms. The service manager from Firm 1 stated: “The operating conditions and product life were significantly improved through the digitalized industrial product-service model we applied for our port customers. With effective monitoring and maintenance, the life of the port crane products could be extended. The waste caused by frequent replacements was avoided.” The respondent from Firm 7 stated: “When we started our business in Central Asia, the local automotive parts industry was relatively backward and customers were willing to receive on time and accurate automotive parts services. By establishing logistic supply chain collaboration service platforms, incorrect deliveries and waste of resources were avoided.” It is essential for manufacturers to build a digitalized platform for high-efficiency collaborative management of industrial product maintenance and repair resources (such as spare parts).

Firms that applied project delivery services reported their methods for improving resource allocation. They usually established teams for resource management during project delivery service. The respondent from Firm 3 stated: “When our firm adopted EPC general contracting services for grid network projects in Malaysia and India, we usually set up teams for resource management. These teams enriched the management of traditional construction progress control in resource planning and management. Resources such as personnel, equipment, and service could be effectively managed and optimized to avoid possible waste during the project.” Many of the firms also established teams for project resource management applying the DB and BOT models in automotive parts services. The responder from Firm 5 stated: “We applied the DB model to electricity industry project services. A team was set up to dynamically control the project's implementation and progress. During the design stage, the types and quantities of resources

required for each part of the power station were specified. Improvements in resource allocation were made during the building stage.” The responder from Firm 11 stated: “In the design and construction step of the DB natural gas project, a team was established for resource management. This team communicated with the design and construction units in real-time. Corrective measures were taken to prevent deviations and losses of resources during project design and construction.” Provide real-time sharing of information and resources are essential for the DB model.

We found that the firms using the BOT project delivery model had also established teams for resource control and management. The respondent from Firm 11 stated: “As we had been granted concessions from the local government to operate the oil well for a certain length of time, we set up a team in charge of the resource integration and management for the project design, construction, and operational stages. This team improved project efficiency by sharing information and resources. The transitions and misallocation of resources in our BOT projects were greatly reduced.” We found that the firms could have chosen different PPP or EPC models for project deliveries in various markets, but almost all of them had chosen to establish teams for project resource management and synergy businesses. Resource planning management is as important as schedule management, so firms should pay enough attention to it. The resource management team in each project can reduce the waste of resources due to poor management coordination and cross construction.

According to the feedback of the respondents, improving resource allocation capability is also considered to be important in the novel holistic solution and localization integration service models. A manager from Firm 9 stated: “We provided holistic solution services in industry park construction. As the holistic solution model focuses on providing services during the project construction lifecycle, our firm strengthened the optimization allocation for the real-time status of resources, thus significantly improving the efficiency of unit resource outputs.” The localization integration model can improve resource allocation by a thorough understanding of the host country. The respondent from Firm 6 stated: “With the localization integration model, our firm gained trust in the BRI countries we entered. The joint venture factories in the representative countries captured the requirements and conditions of the local customers. We developed the proper types of automobiles on time with less material waste.” The respondent from Firm 11 stated: “After we built several joint venture factories in three major Middle Eastern countries, we built the relevant research and design (R&D) centers for product design and localization to strengthen our understanding of the host countries’ requirements. The equipment for the petroleum industry can be designed and manufactured according to local requirements and environmental standards.” Localization integration can help a firm understand markets and conditions more precisely, as well as improve the coordination and integration of both domestic and foreign resources, thus reducing resource wastage while increasing focus on adding value.

In addition, to promote energy-efficient in project construction, BRI also has a goal of minimizing carbon emissions in project cooperation [102]. Manufacturing firms are also encouraged to consider low-carbon and energy-saving initiatives in collaborative projects. In this study, several firms mentioned the carbon emissions can be reduced through their project service, while two firms added relevant measures using the EPC model. The responder from Firm 3 stated: “Our firm took the EPC model in several transmission grid network upgrade projects in BRI countries. During the engineering and procurement steps, we collaborate with equipment providers to detect potential environmental hazards and avoid using high-energy-consuming components. After the project is constructed, we will test the power saving effect of the grid because the project will be used for a long period. Since we have better transmission line technology than the country entered, our equipment for power transmission can realize less power loss.” Firm 11 also mentioned that their group noticed the importance of achieving low-carbon emissions during procurement and construction functions. The respondent from Firm 11 stated: Under the EPC model our firm is responsible for the entire construction project as the general contractor. In the procurement step, we chose the suppliers that meet both the quality and environmental protection standards. Thus prevent the suppliers with substandard carbon emissions from entering the supply chain. After the construction, our firm is trying to apply an additional service for less energy-consuming. Our technical group test

*the electric energy consumption of each oil & gas project makes adjustments and maintenance until the project can comply with relevant energy consumption standards. Customers in the host country can benefit from relevant oilfield energy-saving management experience, which covers the five core processes of oil production.*" These two case firms highlighted the importance of export-related energy-saving management approaches for the project constructed.

The manufacturing firms that applied DB or BOT models for project management service also realized carbon emissions reduction through achieving higher energy usage efficiency. The respondent from Firm 5 stated: *"When our firm constructs the electric transformation stations through DB model we upgraded related device and apply better standards in the project building step. The systematic shakedown test was performed to ensure the electric power loss can be reduced."* The respondent from Firm 10 stated: *"When we granted concessions from oil-producing countries along the BRI, trying to avoid environmental pollution is also a part of the BOT contract. The electric power consumption of oil wells is usually large. Therefore in the operation step before project transfer, our firm will test the amount of power consumption. Equipment and production lines that consume more energy than the project's requirements will be replaced."* The effective method for achieving engineering projects with relatively low energy usage should be transferred to host BRR countries. Carbon dioxide emissions can be lowered as a result of increased efficiency in energy usage with these strategies.

Our results also imply that relevant measures are found for energy-saving and reduce carbon emission through the two new service models discovered. What we find interesting is that two case firms that delivered renewable energy projects used a novel holistic solution strategy to ensure the project's success. As the responder from Firm 4 stated: *"Our firm applied the relevant services during the entire lifecycle of the wind power project. Advantages for the optimization of wind power plants are not limited to the economic aspect. The wind farm selection services with base station positioning technology can help the customers choose the best wind energy resources in the region. The real-time monitoring and smart fault diagnostic after construction can make wind farms generate electricity reliably. These measures can maximize the local's wind power potential, and reduce the usage of fossil fuels as much as possible."* The responder from Firm 8 also stated: *"Our service configuration covered the whole project lifecycle in holistic smart photovoltaic solar park solution provided. Including the evaluation of solar energy potential and the selection of park addresses before construction, which is used to locate the location that receives the most solar energy. After the project is constructed, our firm offers real-time monitoring and fault diagnostic services during the operation of the solar park. With these measures, the firm can utilize the full potential of solar energy resources for the customer."* Renewable energy-related manufacturers applied holistic service solutions on the entire lifecycle of their projects. With this model, the flexible service configuration that includes subsequent adjustments can let renewable energy projects achieve their best-operating status. The use of electric and thermal energy is lowered as a result of enhancing the reliability of industrial projects, resulting in lower carbon emissions.

Moreover, the manufacturing firms that applied the localization integration service model also noticed the importance of achieving a cleaner factory. The respondent from Firm 6 stated: *"Our firm established several joint venture factories in Indonesia. We adopt clean production technology and energy-saving solutions during the design and manufacturing process. Including optimize manufacturing equipment warm-up and start-up time, promote smart management for factory lighting and air conditioning systems, etc. We also have detailed requirements on the carbon emission limit of the automobiles produced, usually stricter than the country's carbon emission standards where the factory is located."* Firm 2's respondent also stated: *"When we operate localized joint venture factories in BRR we did not only consider the customer requirements on product quality. Our firm developed a systematic evaluation system with relevant criteria on carbon emission, port cranes that do not fulfill carbon emission standards are not allowed to be sold."* For the manufacturers that opened joint factories. The factory's own working process, as well as the carbon emissions of the products produced, must comply with the regulations.

In this study, we discovered that with the deepening of cooperation, many manufacturers started their cooperation at the project level. In contrast to the product service

system which primarily saves energy through production process optimization and product sharing [106], project management services focused more on promoting a green supply chain during the project construction process. What needs to be emphasized is that manufacturers should export energy-saving management methods as additional services of the project, as the infrastructure projects are usually used for a long time.

#### 4.2.2. Economic Perspective: Increasing Quality and Profits through Core Technology and Standards Exportation

Economic perspective is considered one of the main factors in the three pillars of sustainability indicator framework construction [105,107]. Crucial technology and industrial standards innovation are important for realizing sufficient economic incentives [108,109] and standardization activities are an important aspect of service extension [88,110]. Effective technology and standards exportation can enhance the efficiency and quality of industrial project-service systems [111]. These achievements can improve customer satisfaction, gain more profits, and promote economic sustainability [112,113]. This section explains how effective service strategies can improve sustained economic growth.

The results of this study have indicated that many of the selected firms had realized technology and standards exportation through the applied service models. The respondent from Firm 1 stated: *“A digitalized industrial product-service system was applied for port crane equipment. Our firm exported relevant technologies and product standards overseas, such as the transportation and assembly technics of the cranes. We also exported the general standards of the remote maintenance system, condition monitoring, and fault diagnosis.”* Customers can receive advanced technologies and customer experience can be improved through the latest technologies.

Economic sustainability is even more important for project level services and improving the rates of return is essential [114,115]. Therefore, the firms had to apply high value-added services to increase profits. Several respondents mentioned that the core technologies and relevant standards were exported during their project delivery services. Among the firms that used EPC, the respondent from Firm 1 stated: *“In the EPC service model, we displayed subjective initiative and promoted our management experience. Our firm exported relevant port management standards to improve the quality of contracting services, thus creating more benefits for the customers.”* The respondent from Firm 3 stated: *“Core technical services, including the implementation of core technical capabilities and comprehensive management service capabilities, should be applied in the EPC model.”* Three firms mentioned that they had promoted core technologies or standards exportation with the DB and BOT project delivery models. The respondent from Firm 5 stated: *“During the DB model applied for project construction services on electric transformation stations, we enhanced core technology outputs, such as large-capacity high-voltage transformers, to satisfy the customers in Belt and Road countries. While signing some foreign cooperation agreements for undertaking power transmission and transformation projects, we indicated the use of our standards. When electricity-related projects were built, the relevant standards for transmission grids and high-voltage substations could be exported.”* Both design and building are considered important opportunities for core product technology and standards exportation. The respondent of Firm 9 stated: *“With the DB model, we successfully built several mobile phone communication and broadband base stations in many BRI countries. As our firm took full responsibility from design to construction, there were many processes for achieving technology and standards outputs. The crucial technology outputs, such as our power adapters and SingleRAN radio access networks, were realized through relevant core components exportation. Standards exportation contained design and construction standards for wireless engineering base stations and covered the key points of equipment installation, wiring methods, etc.”*

Our results imply that the firms had found paths for offering technology and standards exportation with the BOT model. The respondent from Firm 11 stated: *“Our firm used the BOT model for petrol asset project construction and operating services. In the “build” phase of cooperation, we formed several integrated engineering and technical service teams. Core technologies, such as core technical support for petroleum equipment, were exported with payments. During*

*the project operational step before the transfer, we exported our successful domestic management experience through the exportation of management standards for oil assets.*" The feedback from the firms showed that PPP models could cover more than the completion of projects. The exportation of core technologies and standards can be provided as service offerings in various project delivery models.

The respondents also mentioned the methods and importance of technology and standards exportation. Our results imply that more opportunities are found for technology and standards exportation through the holistic service model. The respondent of Firm 4 stated: *"We provided holistic service solutions for wind power plants. The technology exportation services, such as low voltage ride-through ability, SCADA remote monitoring, and wind farm power prediction, brought us profits. At the beginning of the project's life, our standards for the definition, measurement, and prediction of wind strength were brought to the country where the construction was located. Then, the operation and maintenance manuals for wind turbines and towers were also exported during the middle and end of life phases of the project. After a wind power station in Kazakhstan implemented our standards, the power loss was reduced by 14%."* The respondent from Firm 9 also stated: *"Our firm spent much on R&D investments and completed the accumulation of related technologies. Our technology and standards exportation, including the communication optical fibers hardware and related ICT software, before the project's construction, covered almost the entire lifetimes of the solar park projects. From the middle until the end of the life of the solar park, we exported smart string diagnostic, automatic detection, photovoltaic station status evaluation, and replacement standards."* The core technology, operation, and maintenance standards can be covered as high value-added content in the holistic service model, thus strengthening the value chain's competitiveness.

The localization integration model provides access for a firm's integration into the host country and access for technology/standards exportation as an extra service. The responder from Firm 2 stated: *"We set up several localized joint venture factories in major regional countries along the BRI. The relevant core technologies and key components were imported among the factories and combined with local requirements. The standards for procurement, logistics, and sales services were also exported to form a standardization system."* The responder from Firm 6 stated: *"Our firm established several subsidiaries and production factories in Indonesia. During the localized production in the Belt and Road countries, we participated in the innovation of international standards for automobile lights and obtained certification from Europe."* Localization integration can also improve technology transfer through developing local R&D centers. The responder from Firm 11 stated: *"What needs to be emphasized is that our joint venture factories do not simply manufacture oil equipment but also contain R&D centers for product design and technology localization. We brought technology transfer services during product manufacturing and exported the factory management and operating standards."* In the localization integration model, localized research, development, and modification of core technologies were realized in the R&D centers and joint venture factories. Relevant technology and standards exportation during localization integration with local operators or firms promoted the localization of the value chain.

This section discussed how effective service models could contribute to the sustainable development of the economies in the BRR through the exportation of relevant core technologies and standards.

#### 4.3. Effective Servitization in Contributing to Sustainable Value

We formed a consensus and compiled a list of coherent first-order categories corresponding to the related service models. Then, we extracted the first-order categories and refined them into three second-order categories [88] by referring to the relevant literature. We discovered that the firms had mentioned resource allocation improvement, as well as core technology, and standards exportation, as the major themes in providing sustainable value. From a detailed analysis of the selected firms, we determined that the improved aspects of sustainable value through service model innovation included both environmental and economic pillars. The environmental pillar can be improved by the op-

timization of resource allocation capability and minimize carbon emissions through project management service. Effective service models can also enhance economic sustainability through the exportation of core technologies and relevant standards during the project lifecycle. These activities not only earn more profits for the firms but also contribute to more sustainable and balanced development in the Belt and Road countries, thus achieving win-win outcomes.

## 5. Conclusions

### 5.1. Discussion and Main Contributions

The Belt and Road Initiative (BRI) offers huge potential for social and economic development, which is an important approach to economic globalization. Previous studies [92,116] have discovered the potential of the BRI in economic integration. This initiative has the objective of fulfilling sustainable development goals, which include reducing poverty, improving infrastructure, and levels of economic development through connectivity between related countries [116,117]. However, as different regions have diverse cultures, economies, and political conditions, manufacturing firms need to fully consider the various conditions and requirements. To the best of our knowledge, few studies have focused on both the service model innovation and sustainable value creation strategies in the BRI. This is the first study that systematically explored effective service models and how they could contribute to sustainable value creation in the BRI. We have summarized these findings in both servitization and sustainability typology.

From the servitization strategy perspective, we have been able to identify three types of service models applied during cooperation. Our conclusions are described below from Part I of the multiple case study.

- (1) For manufacturing firms that have recently entered the BRI: If they are relatively unfamiliar with the host countries and are in the primary stages of their service businesses, then they can start with product-service delivery as the initiation of servitization. They need to improve their product plus service into systematic digital product-service systems.
- (2) For the manufacturing firms who have accumulated a certain basis for cooperation in the Belt and Road region (BRR): this study provides recommendations on models for project delivery services, contributes to the research on servitization by its discovery of a project-service system with a more systematic way of bringing services to the customers, and describes the advantages of applying the EPC and PPP models, as well as related measures, in the BRI. The project delivery services can be seen as an expansion of conventional product-service systems.
- (3) This study also discovered two novel service models for project delivery services: holistic solutions and localization integration. These service models require the manufacturers to have a deep understanding of the BRI markets and to accumulate a certain foundation for cooperation in the host countries. The holistic solution model is an extension of the conventional PPP and EPC project delivery models because it covers more services, including real-time monitoring, fault diagnosis, and classification of the maintenance and replacement services, after the project construction stage until the end of the project's life. The localization model requires in-depth cooperation with the host countries, thus gaining more access to technology and standards exportation. In these two models, service value is efficiently co-created with the customers and other stakeholders in the host countries. Thus, the experiences, technical knowledge, skills, and resources of the manufacturing firms could be more integrated into the entire project-service system.

The BRI aims at global and sustainable economic and environmental development [118], so it is important to discover how overseas firms can contribute to sustainable development in the BRR [116]. This study also briefly described how sustainable value could be created through effective service models and discussed several related aspects, including improve resource allocation capability, reduce carbon emissions through project management ser-

vice, as well as core technology and standards exportation, found in Part II of the multiple case study.

- (1) **Environmental sustainability:** Promoting sustainable value in cooperation through the improvement of resource allocation. Product-service systems should have digitalized platforms for the collaborative management of maintenance and replacement resources (such as spare parts and logistics). For those firms that have started industrial projects, it is essential to have special units for project resource management and synergy businesses, regardless of the kind of project delivery service. These units are to apply corrective measures to prevent deviations and losses of resources during the project-service lifecycle. Moreover, in order to develop low carbon projects during cooperation, manufacturers should conduct energy consumption assessment tests on completed projects. Export energy-saving management methods as additional services are also strongly recommended.
- (2) **Economic sustainability:** This study has found effective paths for improving economic performance and competitiveness through relevant technology and standards exportation, which apply to various service models at different stages. The latest technologies should be combined in industrial product-service systems and the standards exportation should be a value-added service for sold products. Manufacturing firms that choose to apply project-service systems have various opportunities in technology and standards exportation at different phases of the project lifecycle. At the beginning of a project's life, the latest design and construction technologies (such as the core components) could be applied. With these measures, BRI countries can receive higher project quality and improved customer experience. During the middle of a project's life, the relevant experience can be transferred through the exportation of management standards to enhance the operational efficiency of project construction. At the end of a project's life, manufacturers can promote the exportation of maintenance manuals, health evaluation, fault diagnosis, and replacement standards.

In summary, this study contributes to the research on servitization and the BRI. Several effective service models were discovered, their contexts were described, and how sustainable value creation could benefit from the service strategies was discussed in detail. Such effective service models can contribute to the competitiveness of the manufacturing firms and bring opportunities for sustainable development in the Belt and Road countries.

## 5.2. Limitations of the Study and Directions for Future Studies

BRI provides regional cooperative platforms in various countries, which include many advanced European countries and less developed countries. There may be some concern that China has political views that are different from those of Western countries [117]; however, there are a few who argue for the huge potential of fast regional economic development. This study has presented several strategies for servitization, as well as the discovery and classification of effective service models at both the product and project levels, and offered a few insights into sustainable value creation from the perspective of service innovation.

This study can provide recommendations for service strategies to manufacturers entering the BRR, but during cooperation, firms may face policy and currency risks. For future research, scholars could explore alternative strategies for risk prevention and systems for the evaluation of the sustainability of service models by measuring their effects on the environmental, economic, and social dimensions.

**Author Contributions:** Conceptualization, Y.C.; methodology, Y.C., X.Z.; software, Y.C.; validation, Y.C., X.Z., and X.M.; formal analysis, X.Z.; investigation, X.M.; resources, X.M., T.Z.; data curation, Y.C.; writing—original draft preparation, Y.C., X.L.; writing—review and editing, Y.C., S.C.; supervision, X.M.; project administration, X.M.; funding acquisition, X.M. All authors have read and agreed to the published version of the manuscript.

**Funding:** The authors would like to thank the 2019 Industrial Internet Innovation Development Project-Industrial Internet Identification Resolution System's Secondary Node (Application Service Platform for Home Appliance Industry) Project supported by the Ministry of Industry and Information Technology of the People's Republic of China (Grant No. TC190A3X8-10) and the 2019 Shanghai Industrial Internet Innovation and Development Special Project supported by the Shanghai Municipal Commission of Economy and Informatization (Grant No. 2019-GYhIW-01007) for the funding of this study. The authors would also like to thank the National Natural Science Foundation of China (Grant 71632008) for the funding of this study.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The data presented in this study are available within the article. It was compiled from notes that the authors took during the interviews carried out and are compiled in the article itself.

**Acknowledgments:** We sincerely thank the firms and interviewees who took part in this study. We would also like to thank the reviewers and editors for their patience and kind suggestions.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

Information of selected firms:

**Table A1.** Information of selected firms and their respondents.

|                                  | Firm 1                                  | Firm 2                              | Firm 3                                      | Firm 4                                                          | Firm 5                                             | Firm 6                                                      | Firm 7                                                  | Firm 8                                                | Firm 9                                   | Firm 10                                    | Firm 11                                                                            |
|----------------------------------|-----------------------------------------|-------------------------------------|---------------------------------------------|-----------------------------------------------------------------|----------------------------------------------------|-------------------------------------------------------------|---------------------------------------------------------|-------------------------------------------------------|------------------------------------------|--------------------------------------------|------------------------------------------------------------------------------------|
| Number of employees (as of 2020) | 8701                                    | 15,559                              | 29,552                                      | 8373                                                            | 15,777                                             | 20,000 (approximate)                                        | 180                                                     | 197,000                                               | 70,066                                   | 4606                                       | 8000 (approximate)                                                                 |
| Industry type                    | Marine equipment                        | Construction machinery              | Electrical equipment                        | Wind electricity generation                                     | Electrical equipment                               | Automobile manufacturing                                    | Automotive parts                                        | Telecommunications and networking                     | Telecommunications and networking        | Oil and gas equipment                      | Oil and gas equipment                                                              |
| Major products and business      | Port cranes                             | Construction machinery and vehicles | Power generation and transmission equipment | Wind turbines and wind plant construction                       | Electric transmission and transformation equipment | Passenger automobile manufacturing                          | Automotive parts, including engines, and transmissions  | Telecommunications equipment and consumer electronics | Communications equipment and accessories | Oil drilling and rig equipment             | Oil drilling equipment, and oilfield integrated engineering and technical services |
| Respondent                       | Manager of Marketing and Service Center | Customer service Manager            | Senior Service Development Manager          | Vice President of Operations and Service Manager of Wind Plants | Overseas Project Manager                           | General Manager of Overseas Business and Engineering Center | Deputy Director of Project Operation Service Department | Overseas Project Manager                              | Customer Service Manager                 | Senior Project-Service Development Manager | Engineering Project Manager                                                        |
| Years at the firm                | >10                                     | >10                                 | >15                                         | >20                                                             | >10                                                | >15                                                         | >15                                                     | >10                                                   | >10                                      | >15                                        | >10                                                                                |

## Appendix B

**Questionnaire:**

Dear managers of the manufacturing firms, this is a questionnaire for collecting your service methods for the servitization of manufacturing, and how effective service models could contribute to sustainable value creation. The list of questions is provided below.

Service-model-related questions

1. In which manufacturing industry and in what major business is your firm?
2. Please describe your position in your firm and how your firm entered the BRI host countries.
3. What is the major method applied to promote servitization? Please describe according to the levels, such as product-service level or a more macroscopic project level. (For example: how does your firm develop its product-service system and what are its features?)

4. If your firm applies servitization at the project level, please describe how the services are delivered in detail, including the background and main activities. Also, please label the characteristics if possible.
5. Please describe how your firm increased service offerings through the deepening of cooperation.
6. We are also interested in the possible future development of your service transformation. Please describe the major changes in the servitization process and your firm's plans for the next phase.

Sustainability-related questions:

1. Is the sustainability aspect considered in your firm's strategic plan for your servitization transformation in BRI countries?
2. What method does your firm use for improving the environmental sustainability of your service model? Please describe the activities in detail and in terms of the dimensions related to environmental sustainability. (For example: increased resource or energy usage, and avoidance of waste.)
3. What are the measures used by your service model for economic and social improvement? Please describe in terms of the dimensions related to economic sustainability. (For example: enhancing business quality and customer satisfaction, delivering higher quality, and earning more profits.)
4. Please provide any relevant news, websites, and official firm announcements as supplementary data if possible.

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