

Investigation Of Value Creation In The Projects Of Construction Equipment Manufacturing Industry

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How to cite this article: Sujit Phunde, Sudarshan Sanap, Subas Mahapatra, Shivam Nalkar , Tanmay Lagad (2024). Investigation Of Value Creation In The Projects Of Construction Equipment Manufacturing Industry. *Library Progress International*, 44(3), 8106-8119.

ABSTRACT

Abstract: construction equipment manufacturing is a vital sector in the global economy, providing tools and machines for infrastructure construction. It faces challenges like rapid technological advancements, environmental preservation, and profit maximization. The industry offers various services, including intangible products and functional sales. Service strategies include product-oriented, use-oriented, and result-oriented services. Heavy machinery, which is capital-intensive and requires extensive maintenance, is used in various industries. Asset management is crucial for businesses using heavy machinery, combining engineering principles with business practices to maximize return on assets and capital velocity. Maintenance services are essential for high return on investment, and service providers must ensure constant access to them. The construction equipment industry is expected to grow gradually through 2028 due to urbanization and infrastructure initiatives.

Keywords: Construction Materials, Construction Site, Value Creation, Construction, Equipment, Manufacturing Industry.

1. Introduction

Manufacturing construction equipment is an important sector of the international economy since it supplies the tools and machines needed to build infrastructure and other structures all over the globe. It includes a broad variety of vital construction equipment, such as excavators, bulldozers, cranes, and loaders. The construction equipment manufacturing industry is at the forefront of technical innovation and economic progress in an age characterized by increasing urbanization and infrastructure expansion. This sector is important for satisfying the needs of expanding people, but it also helps with economic growth, trade, and job creation. But it also confronts a wide range of difficulties and possibilities, especially in light of the rapid development of technology, the need to preserve the environment, and the desire to maximize profits.

Delivering better goods, services, and solutions that fulfill the requirements and expectations of consumers while being profitable and sustainable is what value creation means in the context of the construction equipment manufacturing business. It's a wide-ranging idea that includes things like progress in areas like creativity, practicality, and safety.

Importance of Value creation in construction equipment industry

A construction equipment's capacity to deliver value through performance, dependability, and new features increases client satisfaction. Customer satisfaction increases the likelihood that they will buy from you again and refer others to you, which fosters brand loyalty.

The productivity of construction sites is enhanced by the use of efficient and user-friendly construction equipment. Modern technology, intuitive user interfaces, and time-saving features increase operational efficiency and decrease downtime.

Creating value entails inventing machinery that provides affordable answers to construction-related problems. Customers can save money on running costs thanks to factors including long-term durability, fuel efficiency, and less maintenance requirement.

In the construction equipment sector, companies differentiate themselves by ongoing innovation and the incorporation of state-of-the-art technologies. Technological innovations that enhance equipment performance and supply real-time data for improved decision-making include automation, telematics, and Internet of things connectivity

Value creation guarantees that clients receive goods and services that either fulfill or surpass their requirements. Customers that are happy with a brand are more inclined to recommend it and make repeat purchases. Businesses that prioritize creating value have a competitive advantage in the marketplace. This entails providing distinctive features, enhanced functionality, or more affordable solutions in contrast to rivals.

Establishing and maintaining enduring connections with clients is essential. Value creation promotes loyalty and trust, which opens the door to further commercial partnerships and even joint ventures on future initiatives. Innovation in product design, usefulness, and efficiency is stimulated by value creation. Companies benefit from this innovation by becoming leaders in their sector and differentiating themselves from the competition.

Being the cheapest does not always equate to being the best value. It frequently entails providing high-quality solutions while maximizing the cost-effectiveness of goods and services to guarantee better overall value for the money.

A positive brand image is a result of putting an emphasis on value creation. A solid reputation for providing value raises a business's profile and can draw in new clients and business partners. Value creation encompasses comprehensive assistance across the whole lifecycle of the product and goes beyond the first sale. In order to guarantee the equipment's longevity and peak performance, this may entail maintenance, the availability of spare parts, and client education.

2. Construction equipment Manufacturing Industry

2.1 Part of Heavy Industries

Capital-intensive, bulky, inconvenient to move, lasting longer, technologically more sophisticated, and requiring more extensive maintenance, these are all characteristics of the heavy equipment that makes up the backbone of most industries. The complexity of heavy machinery stems from the fact that it is often built to order. Due to the significant cost involved, optimizing your return on assets (ROA) and capital velocity is of paramount significance when dealing with heavy machinery. Heavy machinery comes in a wide variety of forms. Industries as diverse as mining, construction, forestry, agriculture, and transportation all rely on this machinery. For instance, Heavy Machinery for Buildings (Peurifoy & Ledbetter, 1985).

- Tractors and associated machinery

- Excavating tools
- Trenching tools
- Transporting and Hauling Equipment: Trucks, Wagons, and Piles Devices for Use in Mines.
- Shovel, working face, dumper, stacker, and rig, drill, and underground loader are all examples of equipment used in open pit mines.

It would be challenging to generalize about heavy equipment due to the wide variety of it and its uses. Size, weight, cost, lifespan, serviceability, specialized equipment, service facility, maintenance needs, operating conditions, service expertise, core competence, subsystem, and income generation are all examples of differentiators that may be used to heavy machinery. The study's primary subject is the heavy machinery used in the mining industry. In addition, the supply chain in the heavy equipment business involves other parties that play crucial roles in delivering value to customers. Design firms, factories, suppliers, governments, service providers, and other businesses are all included.

Investment in businesses that use heavy machinery will be substantial, therefore maximizing return on assets (ROA) and capital velocity is crucial. Asset management takes on new significance in this setting. To achieve public expectations, a more organized and flexible approach to decision-making is required, and this is what asset management is all about. This process combines engineering principles with sound business practice and economic rationale, and it equips decision-makers with the tools they need to do so. Maintenance is an ongoing activity that continues for as long as the asset is in use. Further, according to the definition provided asset management includes all the procedures and activities necessary to reduce investment and ownership costs, maximize commercial return, optimize strategic value, and manage risk. Maintenance, operations, engineering, procurement, and even upper management are all involved strategically in asset management. Maintaining assets is an essential part of physical asset management.

High Return on Investment is impossible without readily available equipment. It might cost hundreds of thousands of dollars per hour for firms to deal with the downtime of essential machinery that underpins core operations. As a result, the heavy-equipment sector must address the challenge of ensuring constant access to maintenance services. This fact presents a chance for profit on the part of the service provider by motivating them to provide services more suited to the wants of their clientele. Defining the best possible service level is a major challenge in the field of service development. In this context, the service level is crucial. To begin, the performance of the service provider is reflected in the service level. It demonstrates how the service provider's quality stacks up against that of its competitors. It also establishes the number of resources that will be needed or allotted to provide the promised service. It is simpler to convert corporate goals into operational needs after service standards have been established. Additionally, the service level is information that guarantees the quality of service the consumer may anticipate from the service provider. In addition, it might help you choose more reliable service providers.

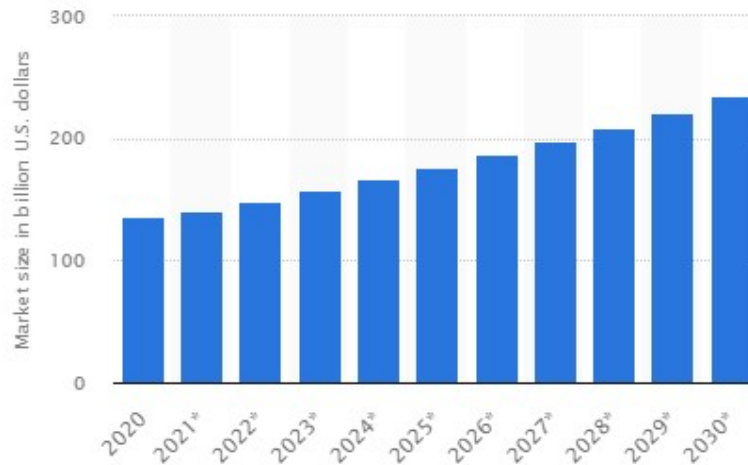
Regarding client assets, the quality and availability of any services necessitated by the customer depend on the customer's own asset service level. Numerous studies have examined the best practices for designing SLAs and creating methodologies and tools for managing service levels to ensure that they are met. However, the heavy equipment sector has not done much research on this topic. In certain instances, the service level is established entirely by prior experience notwithstanding the significance of the service level. It is widely held that, in order to maximize advantages for both the service provider and the client, service level must be defined using more formal and nuanced approaches.

When it comes to manufacturing heavy machinery used in construction and mining, Caterpillar Inc. is among the best in the world. As a result of a combination between two major American tractor manufacturers in 1925, the firm was established in California. Caterpillar is a global corporation with headquarters in North America, but it employs people from all around the globe.

The leading heavy equipment manufacturers worldwide as of May 2023, based on sales (in billion U.S. dollars)

The market for construction and mining machinery was valued at almost \$160 billion in 2021, and is expected to continue growing gradually through 2028. North America, Western Europe, and East Asia are the most important markets for this sector. The construction equipment market is expected to expand on the back of rising urbanization and governmental and private sector investments in infrastructure initiatives like the Belt and Road Initiative.

Global construction equipment market size between 2020 and 2025 (in billion U.S. dollars)



3. The implications of servitization in construction

Changing from project execution centered on building entities to service supply centered on customer requests is at the heart of what servitization in construction entails. This shift fundamentally modifies the common practices for bringing forth value in building. Business models in the construction sector will shift, as will the synergistic links between companies. Adding value, the business model, and the operational model are the three main areas of construction that have been affected by servitization.

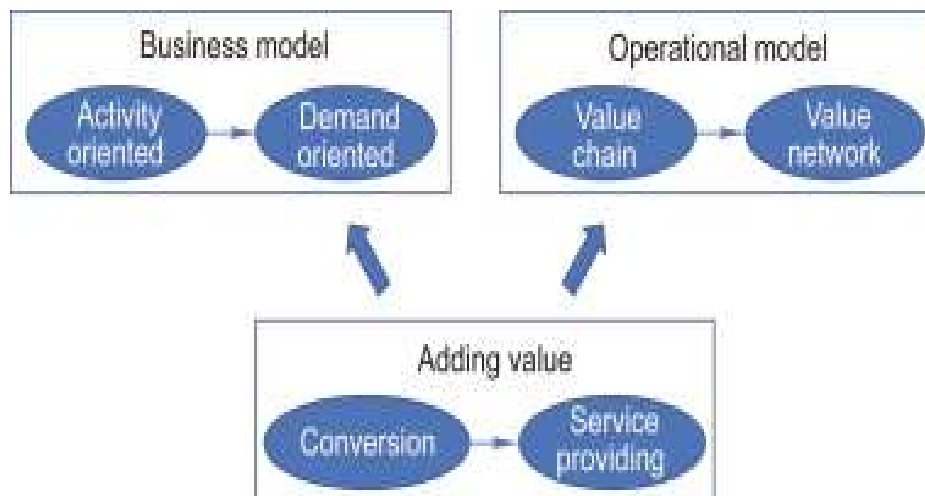


Fig. 5. Changes implied by servitization in construction.

Interplay between mechanical engineering and value creation

The dynamic and mutually beneficial interaction between mechanical engineering and value creation is a key factor in the proliferation of cutting-edge practices and technologies across many sectors. Mechanical engineers are essential in many fields because of the value they produce:

- Mechanical engineers are essential to the creation of novel responses to urgent societal problems and the fulfillment of ever evolving client needs. Their expertise in materials science, thermodynamics, and mechanics enables the creation of novel technologies. Innovation generates value because it leads to fresh perspectives, improved results, and more fulfilling interactions for end users.
- In the manufacturing process, mechanical engineers aim to increase output while lowering costs and raising quality. Methods like lean manufacturing, automation, and process optimization simplify production, cut waste, and create value through more cost-effective product delivery.
- More than ever, the advancement of sustainability programs depends heavily on mechanical engineers. They develop novel carbon-cutting technologies, produce goods with little energy consumption, and produce environmentally friendly goods. Value is achieved through lower long-term costs and improved CSR through the implementation of sustainable practices that align with societal norms.
- Mechanical engineers prioritize consumer safety and product dependability above everything else when creating new products. When products are dependable and fulfill their intended functions, risks and liabilities are minimized and value is generated for all stakeholders. Reliability directly benefits customers by boosting their confidence and reducing their long-term maintenance and repair costs.
- Serviceability is the first priority for mechanical engineers when creating new products and systems. This element lowers running costs, lengthens the lifespan of equipment, and reduces breakdowns. Effective maintenance increases the lifespan value of machinery and products.
- Mechanical engineers utilize life cycle assessments, or LCAs, to examine a product's environmental impact from start to finish. This approach looks for ways to reduce resource consumption, waste creation, and environmental effect in order to produce value by matching goods with sustainability targets and regulatory requirements.
- Mechanical engineers embrace cutting-edge technologies like robots, artificial intelligence, and the Internet of Things eagerly in order to create better products and systems. These technologies improve consumer experiences, reduce energy use, and increase efficiency for products and services.

In essence, there is a never-ending cycle of innovation, efficacy, and durability between mechanical engineering and value creation. Because they apply their expertise to produce goods and services that not only meet consumer wants but also improve society and the environment, mechanical engineers are essential to this cycle. In the fast-paced market of today, this engagement is still essential to the development of products and solutions that provide value.

4. Research Methodology

We developed a questionnaire by revising the measurement items employed in previous studies. A multiple-item method is used for this study, in which each item is measured on a five-point Likert scale ranging from "fully disagree" to "fully agree." A draft version of the questionnaire is pretested via in-depth interviews conducted with , developers, and operators, through which the intelligibility of the survey questions are repeatedly assessed, and

appropriate adjustments are made to the questionnaire items. The measurement items employed in this study are provided in.

The questionnaire includes general information, as well as UGC use status and research variables. The final survey questionnaire was distributed by the visit to companies, and private sector employees . It also was sent out via messengers or e-mail for approximately eight weeks, from December 2023 to January 2024. The survey was formulated to reach people who had been using Value Engineering .

A questionnaire was distributed, corresponding to an 46 % response rate.. We exclude questionnaires containing missing data or invalid responses, as well as those answered by people with no experience in Value Engineering use. A total sample of 2 questionnaires is used for our analysis.

5. LITERATURE REVIEW

SN	Author Name	Year	Conclusion	Research Gap
1	Tillman P, Ballard G, Tzortzopoulos P, & Formosa C.	2012	It may be claimed that in today's complicated and ever-changing surroundings, a management style as static as this no longer works. However, there are currently no standardized procedures for determining who the relevant stakeholders should be and why they should be engaged. Since complexity grows in tandem with stakeholder count, it's also important that there aren't too many of them.	Stakeholder identification, categorization, and management may be improved with the use of a systematic procedure used in project management. This dissertation aims to close this knowledge gap by exploring how early stakeholder participation and integration might improve project value generation and the stakeholder identification and management process in the built environment.
2	Humbeck, Philipp & Mangold, Siegfried & Bauernhansl, Thomas	2020	This research uses the scenario approach to predict how value will be created in the mechanical engineering industry in the future, with a particular emphasis on innovation leadership, partnership difference, and hardware supplier status. Experts in mechanical engineering then assess the level of consistency and provide potential courses of action. The findings not only help professionals plan for the future, but they also motivate academics to look at ways to include futurology into strategy studies.	However, the future of value generation in mechanical engineering has not been thoroughly studied in the literature. Creating value is essential to the health of any economy and the continued survival of any business. Long-term strategic planning in business is greatly aided by a better understanding of potential futures in mechanical engineering.
3	Humbeck, Philipp & Goss, Franziska	2019	The purpose of this article is to examine the opportunities and threats associated with PSS in business ecosystems and to	While research has evaluated the value created via PSS development and operation and the value created in business

	& Bauernhansl, Thomas.		derive management needs in this area. A literature study was conducted to find common ground between the two ideas. Second, in order to determine the most important areas of focus, a qualitative content analysis of 28 semi-structured interviews with subject matter experts has been performed. Third, a cause-and-effect analysis was used to expound on what it takes to be an effective senior manager. The findings help us better grasp the difficulties and forthcoming needs of management in maintaining innovation.	ecosystems separately, a conjoint approach has been inadequately explored in the literature.
4	Bertoni, Marco & Panarotto, Massimo & Jonsson, Pontus	2017	In this study, we investigate how a model-based strategy might facilitate discussion about value in interdisciplinary design teams. Case studies in the road compaction equipment sector provide the basis for this paper's examination of user preferences for value modelling help in the iterative process of converting customer wants into requirements for engineers' design choices. It also recommends a structure for value-driven engineering design that takes into account the need of revising the value model definition from qualitative to quantitative when new information becomes available. This research shows that the suggested chain of value models is useful because they provide a common frame of reference for igniting value dialogues across departments and job functions, which does not currently occur organically in most organizations.	To fill this void, researchers have suggested many equations, including one given by Lindstedt and Burenius (2006). To help people build arguments for selling their innovative ideas, both internally and externally, the authors propose a chain of value models to fill a void in stimulating value discussions across functions and organizational roles and maintaining focus on the underlying business case.
5	Jian Qina, Ying Liua, Roger Grosvenor	2016	The main contribution is a description of the implementation structure of Industry 4.0, which consists of a multi-layered framework, and an illustration of	The article presents an overview of the existing industrial infrastructure and the core ideas behind Industry 4.0. It also highlights the knowledge

			how this structure might help individuals comprehend and meet the demands of Industry 4.0.	gaps between the existing state of production systems and the needs of Industry 4.0. Researchers have varied views on the criteria for achieving Industry 4.0 and what that would look like in practice.
6	Ilias Naskoudakis, Kleopatra Petroutsatou	2016	The current investigation identifies and discusses key research themes like optimization, maintenance/downtime, productivity, robotics and automation, operator's competence, innovation, and the environment through a systematic review of the academic literature published over the past decade, primarily identified through online databases. The work presented in this study will help scholars in the future build a foundation of information about the evolution of construction machinery and its possible applications.	An up-to-date study of the most recent scholarly articles devoted to construction equipment would not only outline prospective gaps for future research but also disclose the areas the research was ultimately directed to. The article starts with a presentation of the methodology used to identify the key findings from the study conducted, then moves on to a literature review. Key research topics are highlighted, while current practices, potential knowledge gaps, and potential future research approaches are examined. At last, a verdict is reached.
7	Toshiya Kaihara, Nariaki Nishino, Kanji Ueda, Mitchell Tseng, József Váncza, Paul Schönsleben, Roberto Teti, Takeshi Takenaka	2018	This study highlighted the shifting role of production, arguing that the traditional producer-consumer paradigm is giving way to the idea of value creation in contemporary society. This study provided many examples to illustrate the significance of value creation throughout the manufacturing process. To improve product value and provide new services for consumers, IoT uses real-time log data from internet-connected gadgets.	The Kano model is a well-known theory that divides consumers' expectations of quality into many categories, including "must have," "unidimensional," and "attractive." In this view, 'attractive quality' contributes to happiness when it is fully realized but has no negative effect when it is lacking. Having a 'must be' quality is important to consumers, yet failing to deliver on that quality may result in major customer unhappiness. The gap between human happiness and technology endeavors to enhance quality of life is shown in this model.
8	Aki Pekuri	2015	Business model knowledge may help managers initiate change in	This study's findings, combined with the dearth of academic

			the construction sector as a whole. Consistent management practice and process development may be built on top of well-defined business models. As the current paradigm shifts and company models are seen through the lenses of the customer and value creation, new opportunities for customer value creation may be seized.	interest in construction-specific business model research, suggest that the gap between generic literature and literature relating to strategic management practice in construction is at least as large as the business model construct itself. It's possible that in the future, with a deeper comprehension of business models in general, these two spheres will grow closer together.
9	Chang, Y.; Ming, X.; Zhang, X.; Zhou, T.; Liao, X.; Cao, S.	2021	Two new service models for project delivery were also uncovered by this research: comprehensive solutions and localization integration. Manufacturers wishing to use such service models would need extensive knowledge of BRI markets and an established track record of working with host countries. After the construction phase of a project is complete and throughout the project's lifecycle, the holistic solution model extends the traditional PPP and EPC project delivery models by including additional services such as real-time monitoring, fault diagnosis, and the categorization of maintenance and replacement services.	By (1) using a multiple case study approach to identify effective service models, along with their characteristics and advantages, and (2) combining the characteristics of sustainability with these service models to formulate proposals for how service model innovation could facilitate sustainable value creation, this study fills the gaps in the current body of research.
10	Gunther Kucza and Heiko Gebauer	2011	Supporting manufacturing companies' attempts to build new service-based and relationship-based value propositions is the exploration of global forms and supply chain configurations for services. This research provides new information for anyone considering whether or not to combine their service organization. By distinguishing between centralized and decentralized (market) service providers, it provides a further explanation of how to integrate	Despite these valuable contributions, there is still a significant research void concerning descriptions of prospective global organizational methods for the service company. By looking at how manufacturing firms throughout the world are approaching their service businesses, this essay hopes to help fill a vacuum in the literature. It is hoped that the findings would aid in designing more efficient organizational

			and separate the service company.	structures and worldwide service supply chains. Supporting the efforts of manufacturing enterprises to build new service-based and relationship-based value propositions, research on global forms and supply chain topologies for services is essential.
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Summary of Literature Review

SN	Outcome of literature review	Reference
1.	It is required for Construction Equipment Manufacturing Organisations (CEMO) to have built strong value centric management work culture for Value Creation.	2
2.	It is recommended that in CEMO have created common forums / platforms for discussions with internal and external stakeholders. These Discussions are focused, structured, specifically to Value Creation.	1
3.	It is required that CEMO organisations have special focus for value creation at project front end where Value Creation Discussions happen before start of Project.	6
4.	It is important that CEMO has focus on strengthening learning and training mechanism for upskilling workforce to understand value based practices.	1,2
5.	It is need for Project manager is responsible and additionally empowered for of coordination of value management interactions.	10

Format of Questionnaire

SN	Questions	Fully Agree	Partially Agree	Can't Say	Partially Disagree	Fully Disagree
1.	Construction Equipment Manufacturing Organisations (CEMO) have built strong value centric management work culture for Value Creation.					
2.	CEMO have created common forums /					

	platforms for discussions with internal and external stakeholders. These Discussions are focused, structured, specifically to Value Creation.					
3.	CEMO organisations have special focus for value creation at project front end where Value Creation Discussions happen before start of Project.					
4.	CEMO has focus on strengthening learning and training mechanism for upskilling workforce to understand value based practices.					
5.	Project manager is responsible and additionally empowered for of coordination of value management interactions.					

Sample Size selection and Industry Survey

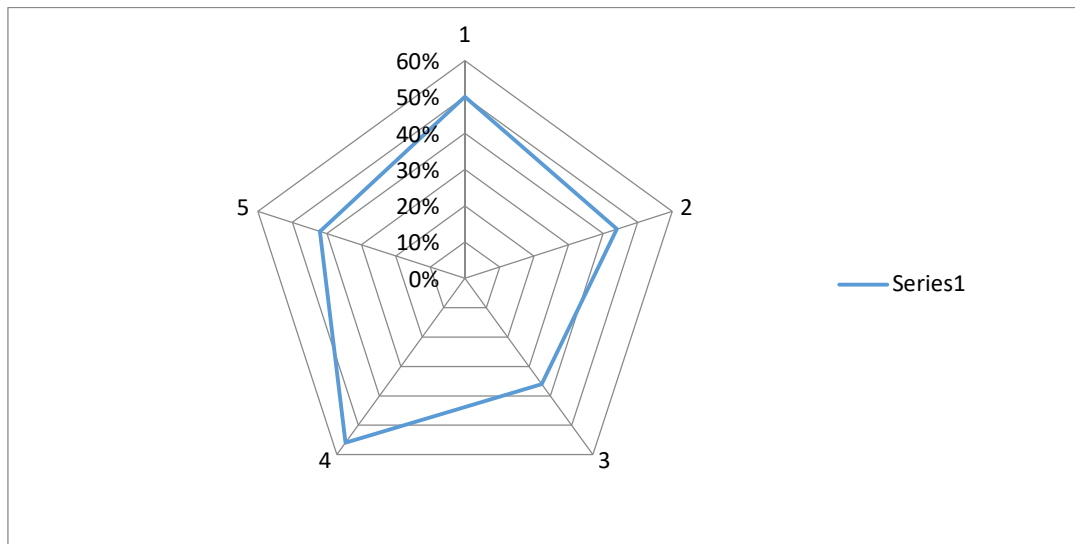
We have chosen to sample the Heavy Duty Automobiles, Ancillaries to these Industries, and Construction Equipment Manufacturing Industries near Pune . In order to determine the sample size, the construction equipment business and its ancillary support industries are the primary focus of attention. The businesses were located by using online sources. To obtain a comprehensive understanding of process requirements, questionnaires were distributed to project managers, designers, production, and quality personnel.

A total of 75 companies were enlisted in the section, and 50 company representatives (66%) responded. The companies were identified via online sources. To obtain a comprehensive understanding of process requirements, questionnaires were distributed to project managers, designers, production, and quality personnel. Additionally, we distributed the questionnaire to 60 businesses involved in the construction equipment industry's supply chain, which includes automotive, ancillary, and related heavy industry projects. Thus, we got input from fifty individuals representing forty-seven companies.

6. Results & Values of Feedback

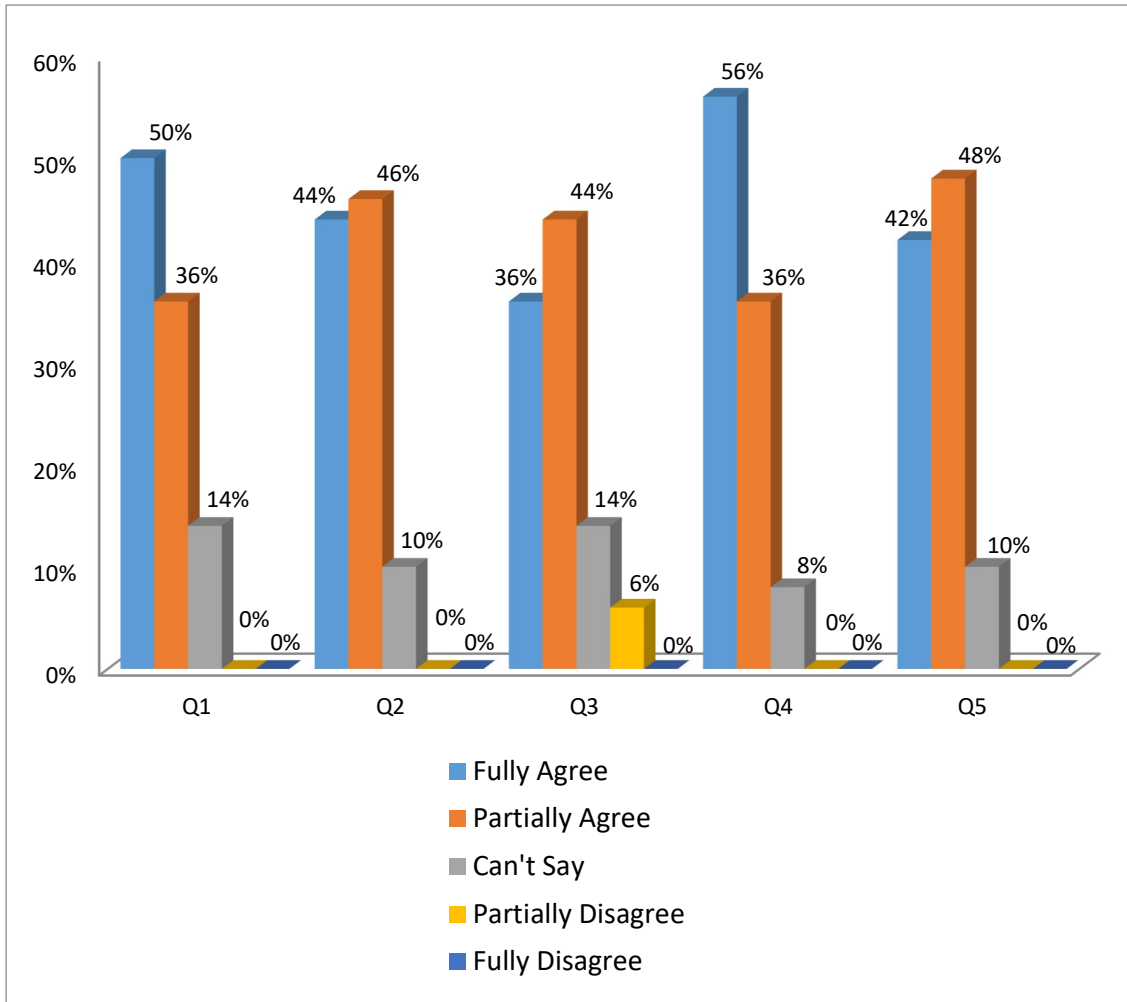
SN	Fully Agree	Partially Agree	Can't Say	Partially Disagree	Fully Disagree	Grand Total
1.	50%	36%	14%	0%	0%	100%
2.	44%	46%	10%	0%	0%	100%
3.	36%	44%	14%	6%	0%	100%
4.	56%	36%	8%	0%	0%	100%
5.	42%	48%	10%	0%	0%	100%

SN	Fully Agree	Partially Agree	Can't Say	Partially Disagree	Fully Disagree	Grand Total
1	25	18	7	0	0	50
2	22	23	5	0	0	50
3	18	22	7	3	0	50
4	28	18	4	0	0	50
5	21	24	5	0	0	50



The average actual adoption rate of these notions in practice is 46%. Academicians and practitioners still have a great deal of room to collaborate in order to take this notion distribution and penetration to the next level.

7. Result (%)



8. Discussion –

Analysis Q1- The notion that Construction Equipment Manufacturing Organisations (CEMO) have built strong value centric management work culture for Value Creation that 50% of respondents fully agree with. Conversely, only 36% say they agree only partly. However, 14% cannot say for sure whether or not active participation is required, compared to 0% who disagree somewhat and 0% who disagree completely.

Analysis Q2- According to 44% of respondents, CEMO has established common channels and platforms for conversations with internal and external stakeholders. On the other hand, 46% claim to only somewhat agree. Ten percent, however, are unsure whether active participation is necessary, compared to zero percent who disagree somewhat and zero percent who disagree totally.

Analysis Q3- Among the participants, 36% fully think that CEMO organizations have a unique focus at the project front end, where Value Creation talks take place prior to the start of the project. This is followed by 44% who agree in part, 14% who disagree in part, and 6% who disagree neither entirely nor partially

Analysis Q4- Developing a CEMO requires a stronger learning and training system to upskill workers in value-based behaviors. 56% of those surveyed strongly agree, 36% agree somewhat, and eight percent are not sure if it is necessary. None of the respondents disagree.

Analysis Q5- Opinions expressed by survey participants about the responsibility and empowerment of project managers in coordinating value management interactions were found to be mixed. 10% couldn't determine, 42% agreed completely, 48% agreed slightly, and zero percent disagreed both partially and completely.

9. Future research directions.

The purpose of this study is to comprehend how value management techniques are spreading in relation to the expanded function of project managers in project-based industries. The sample size of the study has limits. The majority of the sample came from the Pune, Maharashtra. It will be interesting to learn how this understanding is perceived across the nation. Additionally, a case-by-case analysis may be conducted to further sample a particular category of company, such as various segments of the heavy engineering industry, such as the steel, fertiliser, mining, construction, textile, and sugar industries, as well as agricultural machinery, tractors, pumps, and diesel engines.

In this manner, we will comprehend the more profound viewpoints of value management dissemination and concentrate on improving project managers and project management offices

10. CONCLUSION

In this paper, we provide the first findings from our research into the development of heavy-equipment services. The results showed that product-centric services were the most often offered to customers. The purpose of this study was to provide a comprehensive theory of servitization in the construction sector in order to help practitioners bring about servitization transformation. This article is a good introduction to the study of servitization in building, but much more work is needed to address the numerous theoretical and practical issues that have been raised. As a result, further service growth is possible, given that companies can deal with risks and high capital costs. More study is required before drawing this conclusion. This article is a component of a wider body of work that will investigate other aspects of the company's operations, such as service quality, service pricing, and maintenance service preparation and execution. Value in the construction equipment manufacturing business is based on the mechanical standpoint of innovation, efficiency, safety, sustainability, and performance improvement. Mechanical engineers are the driving force behind these endeavors, with the final goal of providing construction businesses and end-users with sustainable, efficient, and cost-effective machinery. Mechanical engineers play a crucial role in the building sector, both now and in the future, and they provide value to many different parties.

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