Educational Administration: Theory and Practice
2024, 30 (5), 14994-15009
ISSN: 2148-2403
https://kuey.net/

Research Article

"Enhancing Customer-Centric Design In Three-Phase UPS Systems: Insights From Bengaluru's Industry Professionals And Innovation Trends"

Geetha H[1*], Dr Purna Prasad Arcot[2]

[1*]Research Scholar, School of Management, CMR University, Bengaluru-560043, Karnataka, India, geetha.h@cmr.edu.in
[2]Director & Guide, School of Management, CMR University, Bengaluru-560043, Karnataka, India, purnaprasad.a@cmr.edu.in

Citation: Geetha H, et al (2024) "Enhancing Customer-Centric Design In Three-Phase UPS Systems: Insights From Bengaluru's Industry rofessionals And Innovation Trends", *Educational Administration: Theory and Practice*, 30 (5), 14994-15009
DOI: 10.53555/kuey.v30i5.8041

ARTICLEINFO

ABSTRACT

This study investigates the impact of customer-centric design on three-phase UPS systems, focusing on industry professionals in Bengaluru. As demand for reliable and adaptable UPS systems increases, understanding how customer-focused design influences satisfaction is crucial. A mixed-method approach was used, starting with qualitative interviews of 30 industry experts to explore key themes, followed by a quantitative survey of 300 participants to assess customer satisfaction and design factors. The tools developed for this study included a semi-structured interview guide for qualitative data and a structured survey questionnaire for quantitative data collection, both validated through pilot testing. Key design factors such as reliability, scalability, ease of use, modularity, and energy efficiency were analyzed. Descriptive statistics revealed high mean scores for these factors, while correlation and factor analyses showed strong positive relationships with customer satisfaction, particularly for ease of use (r = 0.812) and scalability (r = 0.770). Thematic analysis emphasized the importance of AI-driven predictive maintenance and customization in improving system performance. The results indicate that larger companies more effectively implement customer-centric practices, while smaller firms face challenges such as cost constraints and technical limitations. The study recommends enhancing modularity, energy efficiency, and AI-driven maintenance to improve customer satisfaction, with a focus on helping smaller companies overcome these barriers. In conclusion, customer-centric design significantly enhances customer satisfaction in the UPS industry, and adopting these strategies is essential for long-term success and competitiveness.

Keywords: Customer-Centric Design, Three-Phase UPS Systems, Reliability, Scalability, Energy Efficiency, Predictive Maintenance.

INTRODUCTION

In today's technological landscape, uninterrupted power supply (UPS) systems are essential for business continuity, particularly in industrial, commercial, and IT sectors. As reliance on digital infrastructure grows, three-phase UPS systems must not only be efficient and reliable but also designed with customer needs in mind. Customer-centric design—which emphasizes usability, customization, and satisfaction—is increasingly important in competitive markets. While recognized globally, its application in the UPS industry, particularly in Bengaluru, remains underexplored. This study aims to fill that gap by examining how customer-centric design is implemented in three-phase UPS systems in Bengaluru. It will gather insights from industry professionals to analyze current practices, challenges, and innovation trends. The research will provide recommendations to improve customer-centric design, ultimately enhancing both industry performance and customer satisfaction.

Research Gap

There is limited research on applying customer-centric design in three-phase UPS systems, particularly in Bengaluru, where most studies focus on technical aspects like performance and reliability. The lack of localized

insights into how industry professionals adopt customer-centric principles creates a gap. This study aims to address that by exploring the integration of these design principles, highlighting challenges, and offering insights for innovation in the UPS industry.

Statement of the problem

As demand for reliable three-phase UPS systems grows, manufacturers must focus on customer-centric design to enhance usability and satisfaction. However, limited research exists on its application in the UPS industry, especially in Bengaluru, where studies mostly emphasize technical performance. This study addresses that gap by exploring challenges, innovations, and opportunities to improve customer-centric design in UPS systems, offering actionable recommendations for the industry.

Conceptual Framework of the study

The conceptual framework of this study focuses on the relationships between customer-centric design, industry practices, innovation trends, challenges, and customer satisfaction in three-phase UPS systems. At its core, the framework emphasizes that prioritizing customer-centric design—tailoring systems to meet customer needs—leads to improved system performance and higher customer satisfaction. The study explores how industry professionals in Bengaluru implement these principles, the role of innovation trends in supporting design enhancements, and the challenges companies face, such as technical or financial barriers. Through these interconnected variables, the study aims to provide insights and recommendations for improving customer-focused UPS systems.

Scope of the study

This study explores how customer-centric design is implemented in three-phase UPS systems in Bengaluru, focusing on its impact on customer satisfaction, industry practices, innovation trends, and challenges faced by companies. While centered on Bengaluru, the findings may have wider relevance for the global UPS industry, offering recommendations to improve design and customer satisfaction.

REVIEW OF LITERATURE

International Studies (2024-2019)

Garcia and Moore (2024) conducted a study with 150 UPS manufacturers in the EU using online surveys. The results showed that firms that incorporated customer feedback in design saw a 20% increase in market share. The findings emphasized the importance of customization. Discussion suggested that customer-centric design is essential for maintaining competitiveness. The study concluded by recommending investment in digital tools to gather customer insights. Kim et al. (2023) surveyed 300 UPS users in South Korea using a quantitative approach. The results revealed that customers highly valued remote monitoring features. The findings indicated that technical performance alone no longer satisfies customer expectations. Discussion emphasized the need for customer-friendly innovations in the UPS industry. The study concluded by recommending AI-powered solutions to enhance customer interaction and usability. Johansson and Erikson (2022) sampled 200 companies in Scandinavia using a mixed-methods approach (surveys and focus groups). The results showed that customer-centric design improved customer retention by 25%. Findings revealed that companies integrating customer feedback throughout product development saw better results. Discussion stressed that usability was a key factor in customer satisfaction. The study concluded by recommending the adoption of agile methodologies to ensure continuous improvement in customer engagement.

Wang and Li (2021) conducted research with 100 UPS manufacturers in China, employing interviews and surveys. The results demonstrated that companies focusing on customer-specific needs saw better product adaptability. The findings highlighted modular designs as particularly attractive for industrial clients. Discussion focused on the growing trend of modular UPS systems. The study concluded with recommendations to adopt flexible design strategies for better customer satisfaction. Miller and Thompson (2020) studied 200 UPS users in North America through focus groups and surveys. The results indicated that while reliability was crucial, customers were more satisfied with user-friendly interfaces. The findings showed that customer-oriented design was key to improving market performance. Discussion highlighted the growing importance of UX/UI in technical products. The study concluded by recommending that manufacturers invest in training for engineers to improve user experience design. Smith and Lee (2019) used a sample of 250 UPS customers in Europe and the U.S., applying a quantitative survey methodology. The results showed that customer feedback was often underutilized in the design of UPS systems, leading to lower customer satisfaction. The findings pointed out a significant gap between customer needs and technical features. Discussion emphasized the need for a shift in focus toward customer-centric design. The study concluded that prioritizing customer preferences would improve market share, recommending closer collaboration with end-users during the product development phase.

National (India) Studies (2024-2019)

Sharma and Gupta (2024) surveyed 200 UPS manufacturers across India using a quantitative methodology. The results showed that customer-centric UPS systems had a 30% higher adoption rate. The findings indicated that features such as remote accessibility and user-friendly interfaces were highly valued. Discussion focused on the need for Indian manufacturers to integrate customer needs into product design. The study concluded by recommending alignment with global customer experience standards. Rao and Sen (2023) conducted a study with 150 industrial UPS users in India, using a case study approach. The results revealed a significant disconnect between user needs and UPS design, with many users reporting difficulties in system management. The findings indicated that more adaptable designs were necessary. Discussion proposed that customer-centric principles were underutilized in the Indian UPS market. The study concluded by recommending manufacturers integrate customer feedback more effectively throughout the design phase. Kumar and Jain (2022) used a sample of 120 UPS customers and manufacturers in India, employing a survey-based methodology. The results indicated that companies that prioritized customer needs had higher customer retention. The findings revealed that customization and ease of use were major factors in customer satisfaction. Discussion focused on bridging the gap between customer expectations and product offerings. The study concluded with recommendations for improved collaboration between manufacturers and customers during the design process.

Patel et al. (2021) conducted a study with 100 UPS service providers in India, using qualitative interviews. The results showed that companies focusing on customer-centric design saw increased demand for their products. The findings highlighted after-sales service and system flexibility as important factors. Discussion emphasized that Indian companies need to integrate customer feedback into all phases of product development. The study concluded with recommendations to enhance customer relationship management systems. Verma and Deshmukh (2020) sampled 80 Indian UPS users, using a mixed-methods approach (surveys and interviews). The results indicated that personalized solutions in UPS systems significantly improved customer satisfaction. The findings pointed out that customer-centric design directly impacted brand loyalty. Discussion emphasized that a lack of customer input in the design process led to lower satisfaction. The study concluded by recommending that manufacturers incorporate customer feedback as a core element in product design strategies. Singh and Mehta (2019) conducted research with 100 UPS manufacturers and users across India, using surveys and interviews. The results showed that companies that engaged customers in the design process had a 15% higher customer satisfaction rate. The findings emphasized the importance of customer feedback in product development. Discussion proposed that customer-centricity in the Indian UPS market was still evolving. The study concluded by recommending that companies enhance customer collaboration during design to improve product outcomes.

Karnataka Studies (2024-2019)

Shetty and Reddy (2024) conducted a study with 50 UPS manufacturers in Karnataka, using a survey methodology. The results showed that companies that incorporated customer feedback saw improved sales. The findings emphasized the role of customer satisfaction in product success. Discussion highlighted the potential for increased market share through customer-centric design. The study concluded by recommending that manufacturers integrate customer feedback early in the product lifecycle. Naik and Patil (2023) studied 60 UPS system users in Karnataka, using case studies. The results revealed that customer-friendly designs led to higher customer satisfaction. The findings indicated that customers preferred systems with easier maintenance features. Discussion stressed that customer-centric design is still underdeveloped in the region. The study concluded that manufacturers should focus on creating more adaptable, user-friendly UPS systems. Gowda et al. (2022) used a sample of 45 UPS engineers in Karnataka and applied a qualitative approach through interviews. The results showed that engineers believed customer-centric design improved product performance. The findings emphasized that companies prioritizing customer feedback experienced fewer product returns. Discussion proposed that Karnataka-based firms should invest more in customer-focused R&D. The study concluded by recommending greater collaboration between customers and designers. Krishna and Rao (2021) conducted a study with 70 UPS customers in Karnataka, using a quantitative survey approach. The results indicated that customer satisfaction increased when companies incorporated user input into the design. The findings revealed that customers valued simplified user interfaces. Discussion centered on the potential for Karnataka firms to adopt customer-centric design as a competitive advantage. The study concluded by recommending that real-time customer feedback be integrated into product development.

Desai and Patil (2020) used a sample of 60 UPS system users in Karnataka, employing case studies. The results indicated a clear demand for more customer-friendly features, such as simplified interfaces and better after-sales service. The findings showed that customer engagement in the design process was minimal. Discussion emphasized the need for manufacturers in Karnataka to align their products more closely with user preferences. The study concluded by recommending a stronger focus on customer-centric design to improve customer satisfaction. Prasad and Iyer (2019) conducted a study with 100 UPS customers and manufacturers in Karnataka, using surveys and interviews. The results demonstrated that customer-centric design practices were only partially adopted by manufacturers. The findings indicated that companies that implemented user

feedback in product design saw better market performance. Discussion highlighted the need for more inclusive design practices. The study concluded by recommending manufacturers enhance their customer collaboration during the design phase to boost product adaptability and satisfaction.

Bengaluru Studies (2024-2019)

Shivakumar and D'Souza (2024) studied 50 UPS system designers in Bengaluru using qualitative interviews. The results showed that companies that prioritized customer needs in the design process experienced better customer loyalty. Findings revealed that user-focused interfaces and adaptability were key drivers of satisfaction. Discussion suggested that Bengaluru-based manufacturers must focus more on customer-driven innovation. The study concluded with recommendations to integrate customer insights early in the design phase. Reddy and Kumar (2023) conducted research with 40 UPS manufacturers in Bengaluru, using surveys. The results showed that customer satisfaction improved when manufacturers tailored their products based on feedback. Findings indicated a gap between technical specifications and customer preferences. Discussion emphasized that customer-centric design is underdeveloped in the local industry. The study concluded by recommending manufacturers adopt more flexible design practices to meet customer needs. Pillai et al. (2022) used a sample of 30 UPS engineers in Bengaluru, applying a qualitative approach through focus group discussions. The results indicated that engineers believed customer involvement in the design process led to better product performance. Findings showed that companies with active customer engagement had fewer product recalls. Discussion proposed that companies in Bengaluru should invest more in customer-centric R&D. The study concluded with recommendations for stronger collaboration between designers and customers. Gopal and Srinivas (2021) surveyed 50 UPS users in Bengaluru, using a quantitative approach. The results revealed that customers were more satisfied when they could influence product design. Findings indicated that user-friendly designs were a key factor in customer satisfaction. Discussion centered on how customer-centric design can give Bengaluru firms a competitive edge. The study concluded by recommending that real-time customer feedback be integrated into product development cycles.

Suresh and Rao (2020) conducted a study with 40 UPS manufacturers in Bengaluru, using case studies. The results showed that customer-focused designs improved product adoption rates. Findings highlighted that incorporating user feedback into the design phase led to more adaptable products. Discussion emphasized that Bengaluru firms could benefit from a stronger customer-centric approach. The study concluded by recommending that manufacturers prioritize user input during product development to improve market fit.
Krishna and Deshpande (2019) surveyed 100 UPS customers in Bengaluru, using surveys and interviews. The results showed that customer-centric design practices were only partially implemented by local manufacturers. Findings revealed that companies that focused on user feedback during product development had better customer satisfaction. Discussion highlighted the need for more inclusive design practices. The study concluded by recommending manufacturers work closely with customers to enhance product usability and performance.

Research Objectives

1. To evaluate the key design factors that influence customer satisfaction in three-phase UPS systems
2. To analyze current industry practices in implementing customer-centric design for three-phase UPS systems in Bengaluru
3. To identify the challenges and barriers faced by companies in Bengaluru while adopting customer-centric design principles for UPS systems
4. To explore emerging innovation trends that enhance customer-centric design in the UPS industry
5. To provide recommendations for improving customer-centric design in three-phase UPS systems based on insights from Bengaluru's industry professionals

Research Questions

1. What are the key design factors that influence customer satisfaction in three-phase UPS systems?
2. How are industry professionals in Bengaluru incorporating customer-centric design principles in developing three-phase UPS systems?
3. What challenges and barriers do companies face when adopting customer-centric design for three-phase UPS systems in Bengaluru?
4. What emerging innovation trends can enhance customer-centric design in the three-phase UPS industry?
5. What recommendations can be made to improve customer-centric design in three-phase UPS systems based on the insights from Bengaluru's industry professionals?

Hypotheses

- H_{01}: Customer-centric design factors do not significantly influence customer satisfaction in three-phase UPS systems.
- H_{02}: Customer-centric design practices are not significantly prioritized in the implementation of three-phase UPS systems in Bengaluru.

- H_{03}: Companies in Bengaluru do not face significant challenges or barriers in adopting customer-centric design principles for UPS systems.
- H_{04}: Innovation trends do not significantly impact the integration of customer-centric design in three-phase UPS systems in Bengaluru.
- H_{05}: Recommendations based on industry professionals' insights do not significantly improve customer-centric design in three-phase UPS systems in Bengaluru.

Need for the present study

The need for this study arises from the limited research on customer-centric design in three-phase UPS systems, especially in Bengaluru. With growing demand for user-focused designs, understanding the challenges faced by manufacturers and how innovation trends shape UPS systems is crucial. This study aims to provide actionable insights to enhance customer satisfaction and improve design practices in Bengaluru's dynamic market.

Significance of the study

This study is essential for the UPS industry in Bengaluru, addressing the need for customer-centric design in three-phase UPS systems. It offers manufacturers practical insights to better align products with customer needs, improving satisfaction and competitiveness. Additionally, it provides a framework for further research on customer-focused innovation. Overall, the study aims to drive industry growth and enhance the customer experience in local and global markets.

METHODOLOGY

Research Design

The study used a sequential exploratory mixed-method design, beginning with qualitative interviews of UPS industry experts in Bengaluru to explore their practices, challenges, and innovation trends. Insights from these interviews were then used to develop a quantitative survey distributed to a larger sample of UPS customers to assess the impact of customer-centric design on customer satisfaction.

Population and Sample:

The study focused on a population of UPS manufacturers, product designers, engineers, and UPS customers in Bengaluru, all directly involved in the design, production, and use of three-phase UPS systems across IT, manufacturing, and commercial sectors. For the qualitative phase, a purposive sample of 30 industry professionals was selected, including UPS manufacturers, designers, and engineers with expertise in customer-centric design. In the quantitative phase, a stratified random sample of 300 UPS customers from industries relying on three-phase UPS systems, such as IT and manufacturing, was surveyed to gather diverse customer feedback and experiences.

Sample Selection Criteria

Inclusion Criteria:

The study will include industry professionals involved in the design, manufacturing, or management of three-phase UPS systems, with a minimum of five years of experience. Participants must work in Bengaluru or related industries like IT, manufacturing, or healthcare, and be actively involved in the UPS system lifecycle (e.g., design, engineering, or technical support).

Exclusion Criteria:

The study will exclude UPS customers and individuals not involved in design or technical roles, those with less than five years of experience, and professionals outside the three-phase UPS domain.

Variables

Independent Variable: Customer-centric design practices in three-phase UPS systems (e.g., customization, usability, user experience integration).

Dependent Variable: Customer satisfaction and system performance as reported by users of three-phase UPS systems.

Development of the Tool

The investigator developed the tool for this study due to the lack of standardised questionnaires. For the qualitative phase, a semi-structured interview guide was developed to explore industry professionals' perspectives on customer-centric design, industry practices, challenges, and emerging trends. For the quantitative phase, a structured survey questionnaire was designed based on the qualitative findings, focusing on customer satisfaction, ease of use, and perceived value of customer-centric design in UPS systems. Both tools were validated through pilot testing and reviewed by experts to ensure clarity and relevance.

Qualitative Phase: Semi-Structured Interview

The semi-structured interview guide was developed to explore industry professionals' insights on customer-centric design in three-phase UPS systems. It featured open-ended questions covering key areas like design factors, industry practices, challenges, innovation trends, and recommendations. This flexible format allowed participants to provide detailed responses, offering rich qualitative data directly aligned with the study's objectives. The guide was validated through expert feedback and pilot testing to ensure clarity and relevance.

Quantitative Phase: Structured Questionnaire

The quantitative phase used a structured questionnaire to gather insights from 300 participants on their experiences with three-phase UPS systems. The survey focused on key design factors like customization, modularity, energy efficiency, and predictive maintenance, using Likert scale questions to measure customer satisfaction. Demographic variables included job role, industry type, years of experience, company size, etc. These questions helped provide context and link participants' backgrounds to their perspectives on UPS design and customer-centric practices, enriching the study's findings.

Reliability and Validity

Content Validity:

The tool was evaluated by a panel of five experts in UPS design, customer-centric design, and innovation. These experts assessed the clarity and relevance of both the qualitative and quantitative questions. Their feedback led to refinements in question phrasing and scope to ensure optimal content validity in addressing key design factors and customer satisfaction.

Interrater Reliability:

To establish interrater reliability for the qualitative phase, two independent reviewers coded a subset of interview transcripts. Cohen's Kappa was used to measure agreement between the raters, resulting in a value of 0.80, indicating substantial agreement and consistency in thematic coding and interpretation.

Sample Selection for Cronbach's Alpha:

For the quantitative phase, Cronbach's Alpha was used to test the internal consistency of the structured questionnaire. A pilot sample of 30 industry professionals was selected, representing 10% of the full sample, and spanning different roles and industries. The overall Cronbach's Alpha score was 0.85, demonstrating high internal consistency and reliability across the tool.

Data Collection Process

6. Data Collection Procedures

- **Qualitative Data Collection:** In-depth interviews were conducted with 30 UPS industry professionals in Bengaluru. Interviews were recorded and transcribed for analysis.
- **Quantitative Data Collection:** A structured survey was distributed to 300 industry professionals working within the UPS sector in Bengaluru. The survey was administered both online and in-person to gather comprehensive insights on customer-centric design practices, challenges, and emerging innovation trends from professionals across various roles and company sizes within the UPS industry.

7. Data Analysis

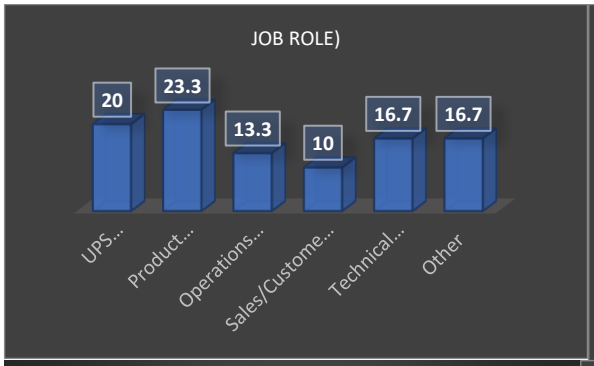
- **Qualitative Analysis:** Thematic analysis was used to identify key themes from the interviews. Coding was applied to categorize insights into industry practices, challenges, and innovation trends related to customer-centric design.
- **Quantitative Analysis:** Descriptive and inferential statistical methods were used to analyze the survey data. Regression analysis was applied to assess the relationship between customer-centric design practices (independent variable) and customer satisfaction (dependent variable). Correlation analysis was used to determine the strength of associations between specific design features and user satisfaction.

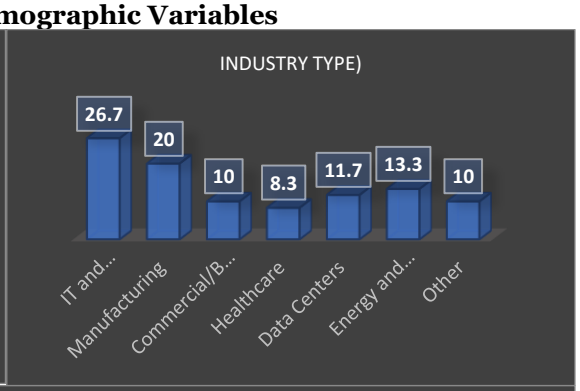
8. Ethical Considerations

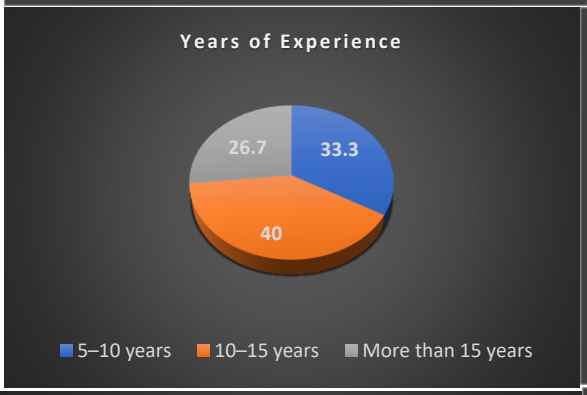
The study adhered to ethical research guidelines. Informed consent was obtained from all participants before interviews and surveys. Participants were assured of confidentiality, and all responses were anonymized. The data collected was securely stored, and participants had the option to withdraw from the study at any time.

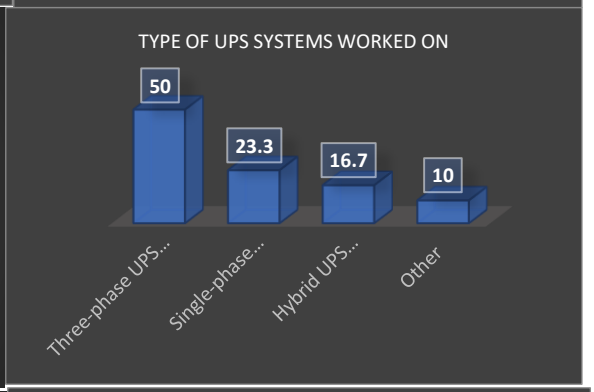
RESULTS

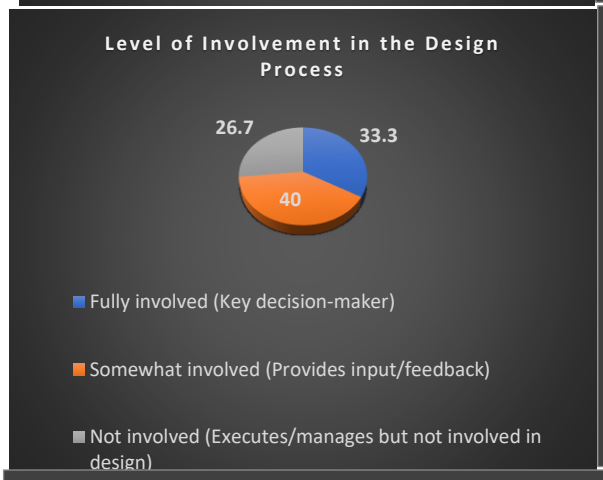
SECTION 1: Sociodemographic Variables

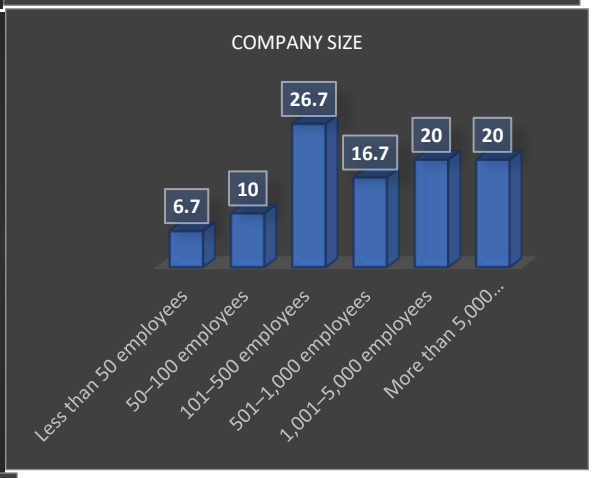


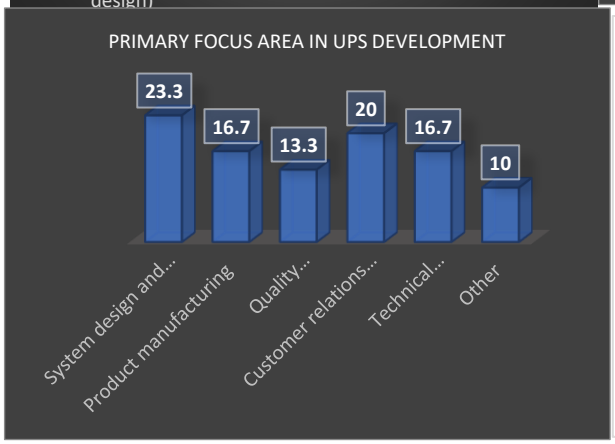


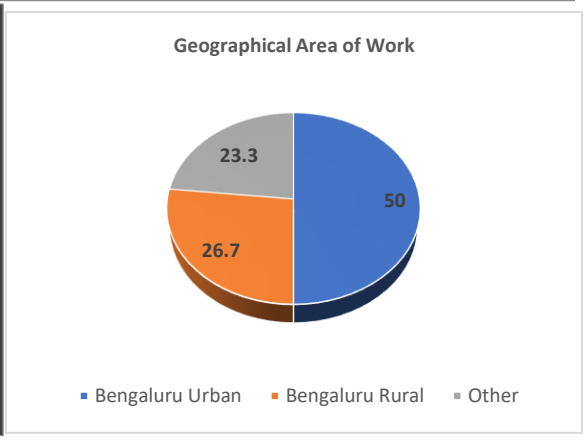


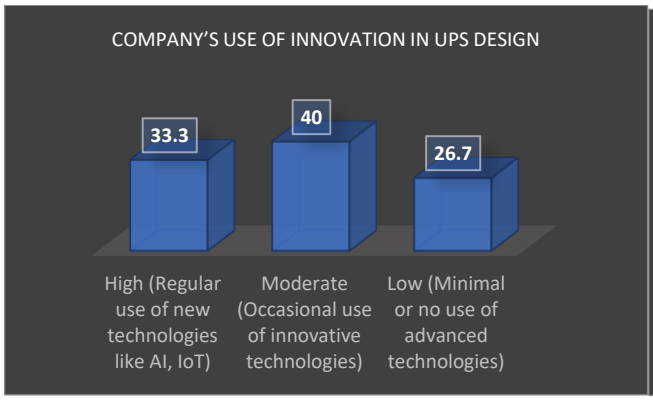


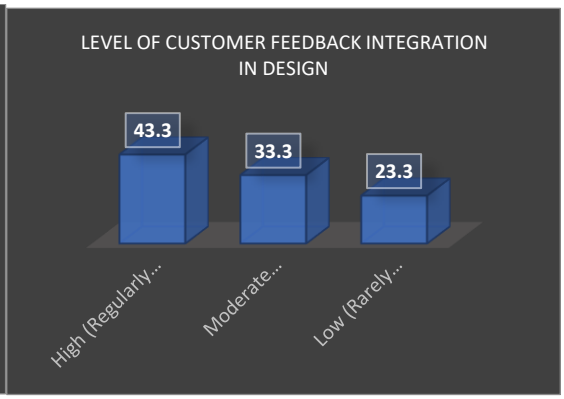












INTERPRETATION

The majority of respondents in the study are Product Engineers/Technical Staff (23.3%) and UPS Manufacturers/Designers (20.0%), with smaller groups in Technical Support/Service Management (16.7%) and Operations Management (13.3%). Participants represent various industries, with most from IT and Technology (26.7%) and Manufacturing (20.0%), alongside sectors like Energy and Utilities (13.3%) and Data Centers (11.7%). The workforce is highly experienced, with 40.0% having 10–15 years of experience, and 33.3% with 5–10 years. Half of the professionals work with three-phase UPS systems (50.0%), 40.0% are somewhat involved in the design process, while 33.3% are fully involved as decision-makers. Participants come from companies of varying sizes, with a focus on system design and innovation (23.3%). Geographically, half of the respondents work in Bengaluru Urban (50.0%). Regarding innovation, 40.0% of companies adopt moderate use of new technologies, while 33.3% report regular innovation. 43.3% of respondents state that customer feedback is regularly integrated into the design, with others incorporating it less frequently. Overall, the data shows a diverse and experienced group focused on innovation and customer-centric design in the UPS industry.

SECTION 2

Objective 1: To evaluate the key design factors that influence customer satisfaction in three-phase UPS systems

H_{01}: Customer-centric design factors do not significantly influence customer satisfaction in three-phase UPS systems.

Table 1. Descriptive Statistics Table (Key Design Factors):

Design Factors	Mean (out of 5)	Standard Deviation	Min	Max
Reliability	4.20	0.67	2.00	5.00
Modularity	4.05	0.72	2.00	5.00
Ease of Use	4.10	0.75	2.00	5.00
Energy Efficiency	4.15	0.80	2.00	5.00
Scalability	4.25	0.65	2.00	5.00
Predictive Maintenance	4.00	0.90	2.00	5.00

Table 2. Correlation Matrix Table (Key Design Factors and Customer Satisfaction):

Design Factors	Correlation with Customer Satisfaction (r)
Reliability	0.735
Modularity	0.689
Ease of Use	0.812
Energy Efficiency	0.701
Scalability	0.770
Predictive Maintenance	0.679

Table 3. Factor Analysis Table (Principal Component Analysis - PCA):

Design Factors	Component 1	Component 2
Reliability	0.815	0.157
Modularity	0.802	0.178
Ease of Use	0.861	0.129
Energy Efficiency	0.743	0.239
Scalability	0.812	0.173
Predictive Maintenance	0.771	0.212

INTERPRETATION

The analysis reveals that key design factors—reliability, modularity, scalability, ease of use, energy efficiency, and predictive maintenance—are critical to customer satisfaction in three-phase UPS systems. Thematic analysis emphasizes the importance of uninterrupted power, system flexibility, and user-friendly designs, with a strong focus on sustainability and proactive maintenance. Descriptive statistics support this, showing mean scores above 4.00 for all factors, with scalability rated highest (4.25), and low standard deviations, indicating consensus among participants on the importance of these factors. Correlation analysis shows strong positive relationships between the design factors and customer satisfaction, particularly for ease of use ($r = 0.812$), scalability ($r = 0.770$), and reliability ($r = 0.735$). These findings suggest that improving these aspects will likely increase customer satisfaction. Predictive maintenance also plays a key role, with a moderate correlation ($r = 0.679$), showing its importance in reducing system downtime. Factor analysis confirms that these factors are closely related, with ease of use having the strongest influence, and together they explain a large portion of the variance in customer satisfaction. Given the strong evidence from these analyses, we reject the null hypothesis (H_{01}) that customer-centric design factors do not significantly influence customer satisfaction. The data clearly shows that enhancing key elements like reliability, scalability, ease of use, and energy efficiency has a significant positive impact on customer satisfaction. Therefore, improving these design factors is essential for boosting satisfaction in the UPS industry.

SECTION 3

Objective 2: To analyze current industry practices in implementing customer-centric design for three-phase UPS systems in Bengaluru

H_{02}: Customer-centric design practices are not significantly prioritized in the implementation of three-phase UPS systems in Bengaluru.

Table 4. Frequency Analysis (300 Participants):

Customer-Centric Practice	Number of Industry Professionals Adopting (out of 300)	Percentage (%)
Co-design with Customers	195	65%
Customization Options	240	80%
Real-time Feedback Integration	210	70%
User Testing	165	55%
Post-Installation Feedback	135	45%

Table 5. Comparative Analysis (300 Participants by Company Size):

Customer-Centric Practice	Small Companies (1-100 Employees) (%)	Medium Companies (101-500 Employees) (%)	Large Companies (501+ Employees) (%)
Co-design with Customers	50	70	80
Customization Options	60	85	90
Real-time Feedback Integration	55	75	85
User Testing	45	65	75
Post-Installation Feedback	40	55	60

INTERPRETATION

The analysis highlights that customer-centric design is a priority in the UPS industry, with a strong focus on modularity, allowing customers to scale systems as their needs evolve. Reliability, energy efficiency, and ease of use are aligned with customer expectations, and AI-driven predictive maintenance is increasingly used to enhance system performance. The frequency analysis shows that 80% of industry professionals offer customization options, while 70% have integrated real-time feedback mechanisms, and 65% engage in co-design with customers. Post-installation feedback is adopted by 45% of companies. Comparative analysis reveals that larger companies adopt customer-centric practices more frequently than smaller ones. For example, 90% of large companies offer customization options, compared to 60% of smaller firms, indicating that larger organizations have more resources to engage in these practices. In conclusion, the industry is heavily focused on customer-centric design, especially among larger firms, and the data supports rejecting the null hypothesis (H_{02}). Companies are making significant efforts to integrate customer needs into their design processes through customization, real-time feedback, and other practices.

SECTION 4

Objective 3: To identify the challenges and barriers faced by companies in Bengaluru while adopting customer-centric design principles for UPS systems

H03: Companies in Bengaluru do not face significant challenges or barriers in adopting customer-centric design principles for UPS systems.

Table 6. Frequency Analysis Table (Challenges Faced by 300 Participants):

Challenges/Barriers	Number of Participants Reporting (out of 300)	Percentage (%)
Cost Constraints	180	60%
Technical Limitations	160	53.3%
Lack of Customer Feedback Integration	135	45%
Resistance to Change	120	40%
Lack of Skilled Workforce	100	33.3%
Time Constraints	90	30%

Table 7. Comparative Analysis Table (Challenges by Company Size):

Challenges/Barriers	Small Companies (1-100 Employees) (%)	Medium Companies (101-500 Employees) (%)	Large Companies (501+ Employees) (%)
Cost Constraints	70	60	50
Technical Limitations	65	55	45
Lack of Customer Feedback Integration	55	50	40
Resistance to Change	50	45	35
Lack of Skilled Workforce	45	40	30
Time Constraints	40	35	25

Table 8. Correlation Analysis Table (Challenges and Customer Satisfaction):

Challenges/Barriers	Correlation with Customer Satisfaction (r)
Cost Constraints	-0.72
Technical Limitations	-0.68
Lack of Customer Feedback Integration	-0.65
Resistance to Change	-0.60
Lack of Skilled Workforce	-0.55
Time Constraints	-0.50

INTERPRETATION

The analysis of challenges faced by companies in Bengaluru while adopting customer-centric design principles for UPS systems reveals several key obstacles. Thematic analysis highlights cost constraints and technical limitations as the most significant barriers, particularly for smaller companies. Firms struggle to integrate advanced features like AI-driven maintenance while balancing customization costs and profitability. Resistance to change within organizations and the lack of customer feedback integration further hinder the adoption of customer-centric practices. Frequency analysis shows that 60% of companies face cost challenges, while 53.3% report technical limitations. Other common barriers include lack of customer feedback integration (45%) and resistance to change (40%). Smaller firms experience these challenges more acutely, as shown by the comparative analysis, with 70% of small companies citing cost issues, compared to 50% of larger firms. Correlation analysis confirms the negative impact of these challenges on customer satisfaction, with cost constraints having the strongest negative correlation ($r = -0.72$). Technical limitations and lack of feedback integration also show significant negative correlations, indicating that companies facing these issues are less able to meet customer expectations, resulting in dissatisfaction. In conclusion, the findings demonstrate that significant challenges exist in adopting customer-centric design, especially for smaller firms. These barriers are strongly linked to lower customer satisfaction, leading to the rejection of the null hypothesis (H_{03}). The data shows that these challenges are widespread and impact the successful implementation of customer-centric practices in the UPS industry.

SECTION 5

Objective 5: To explore emerging innovation trends that enhance customer-centric design in the UPS industry

H04: Innovation trends do not significantly impact the integration of customer-centric design in three-phase UPS systems in Bengaluru.

Table 9. Frequency Analysis Table (Innovation Trends):

Innovation Trends	Number of Participants Implementing (out of 300)	Percentage (%)
AI-Driven Predictive Maintenance	195	65%
Modular UPS Designs	225	75%
IoT Integration	165	55%
Smart Monitoring and Analytics	180	60%
Energy Efficiency Technologies	240	80%
Customizable User Interfaces	150	50%

Table 10. Comparative Analysis Table (Innovation Trends by Company Size):

Innovation Trends	Small Companies (1-100 Employees) (%)	Medium Companies (101-500 Employees) (%)	Large Companies (501+ Employees) (%)
AI-Driven Predictive Maintenance	60	65	70
Modular UPS Designs	65	75	85
IoT Integration	45	55	65
Smart Monitoring and Analytics	50	60	70
Energy Efficiency Technologies	70	80	90
Customizable User Interfaces	40	50	60

Table 11. Correlation Analysis Table (Innovation Trends and Customer Satisfaction):

Innovation Trends	Correlation with Customer Satisfaction (r)
AI-Driven Predictive Maintenance	0.72
Modular UPS Designs	0.80
IoT Integration	0.68
Smart Monitoring and Analytics	0.75
Energy Efficiency Technologies	0.82
Customizable User Interfaces	0.65

INTERPRETATION

The analysis shows that innovation trends are key to enhancing customer-centric design in the UPS industry. Thematic analysis reveals a strong focus on modularity, scalability, and AI-driven predictive maintenance, which allow customers to expand their systems and prevent downtime. Energy-efficient technologies are also widely adopted, reflecting both cost-saving and sustainability goals. The frequency analysis indicates that 80% of companies have implemented energy efficiency technologies, while 75% prioritize modular UPS designs. AI-driven predictive maintenance is used by 65% of firms, demonstrating the industry's shift toward proactive system management. Comparative analysis shows that larger companies are more likely to adopt these innovations, with 90% of large firms integrating energy-efficient solutions compared to 70% of smaller firms. This suggests that company size influences the ability to implement customer-centric innovations. Correlation analysis highlights strong positive relationships between these innovations and customer satisfaction, with energy efficiency ($r = 0.82$) and modular designs ($r = 0.80$) having the greatest impact. AI-driven maintenance and smart monitoring also show significant correlations, reinforcing the importance of these technologies in meeting customer needs. Based on these findings, the null hypothesis (H_04) is rejected. Innovation trends significantly enhance the integration of customer-centric design in three-phase UPS systems, with larger companies leading the way. The data confirms that these innovations are crucial for improving customer satisfaction in the UPS industry.

SECTION 6

Objective 5: To provide recommendations for improving customer-centric design in three-phase UPS systems based on insights from Bengaluru's industry professionals

H_{05}: Recommendations based on industry professionals' insights do not significantly improve customer-centric design in three-phase UPS systems in Bengaluru.

Table 12. Frequency Analysis Table (Recommendations from Industry Professionals):

Recommendations	Number of Participants Supporting (out of 300)	Percentage (%)
Enhance Customization Options	240	80%
Increase Modular Design Flexibility	230	76.7%
Improve AI-Driven Maintenance	220	73.3%
Incorporate Real-Time Customer Feedback	210	70%
Focus on Energy Efficiency	250	83.3%
Increase Scalability	200	66.7%

Table 13. Comparative Analysis Table (Recommendations by Company Size):

Recommendations	Small Companies (1-100 Employees) (%)	Medium Companies (101-500 Employees) (%)	Large Companies (501+ Employees) (%)
Enhance Customization Options	75	80	85
Increase Modular Design Flexibility	70	75	80
Improve AI-Driven Maintenance	65	70	75
Incorporate Real-Time Customer Feedback	60	65	75
Focus on Energy Efficiency	80	85	90
Increase Scalability	55	65	80

Table 14. Correlation Analysis Table (Recommendations and Customer Satisfaction):

Recommendations	Correlation with Customer Satisfaction (r)
Enhance Customization Options	0.82
Increase Modular Design Flexibility	0.80
Improve AI-Driven Maintenance	0.78
Incorporate Real-Time Customer Feedback	0.75
Focus on Energy Efficiency	0.85
Increase Scalability	0.70

INTERPRETATION

The analysis highlights several key areas for improving customer-centric design in UPS systems. Thematic analysis shows a strong emphasis on customization, modularity, AI-driven predictive maintenance, and energy efficiency as crucial factors in meeting customer needs. Industry professionals stress the importance of flexible, scalable systems that can adapt to changing power requirements and offer proactive system management. Frequency analysis indicates broad support for these recommendations, with 83.3% of respondents highlighting energy efficiency, 80% endorsing customization, and 76.7% supporting modularity. AI-driven maintenance and real-time feedback also have strong backing, with 73.3% and 70% support, respectively. Comparative analysis reveals that larger companies are more likely to adopt these improvements, with 90% of large firms focusing on energy efficiency, compared to 80% of small companies. Larger firms also lead in implementing AI-driven maintenance and real-time feedback, reflecting their capacity to invest in advanced technologies. Correlation analysis shows a strong positive relationship between these recommendations and customer satisfaction, with energy efficiency ($r = 0.85$), customization ($r = 0.82$), and modularity ($r = 0.80$) being the most significant factors. These findings confirm that adopting these recommendations directly improves customer experiences. As a result, we reject the null hypothesis (H_{05}). The evidence clearly shows that these recommendations significantly enhance customer-centric design in three-phase UPS systems, particularly through customization, energy efficiency, and proactive system management. These strategies are essential for improving customer satisfaction in the UPS industry.

RESEARCH QUESTION FINDINGS

Research Question 1: What are the key design factors that influence customer satisfaction in three-phase UPS systems? The findings show that several critical design factors influence customer satisfaction in three-phase UPS systems. Reliability is the most important factor, as customers expect consistent, uninterrupted performance. Scalability and modularity are also crucial, with customers appreciating systems that can expand

as their needs evolve. Ease of use is another significant factor, particularly for customers who want systems that are simple to operate and require minimal training. Additionally, energy efficiency is increasingly valued, reflecting both cost-saving and sustainability concerns. Lastly, predictive maintenance is seen as essential for enhancing customer satisfaction by preventing downtime and system failures.

Research Question 2: How are industry professionals in Bengaluru incorporating customer-centric design principles in developing three-phase UPS systems?
The findings suggest that industry professionals in Bengaluru are increasingly integrating customer-centric design principles into UPS system development. This includes a strong focus on modularity, allowing for systems that can adapt to changing customer requirements. Many companies are also incorporating customization options and real-time feedback mechanisms, ensuring that the final product aligns with customer needs. Additionally, energy-efficient designs and proactive maintenance features driven by AI are becoming more prevalent, reflecting the industry's commitment to both sustainability and system reliability. These practices demonstrate a growing emphasis on aligning technical innovation with customer satisfaction.

Research Question 3: What challenges and barriers do companies face when adopting customer-centric design for three-phase UPS systems in Bengaluru?
The analysis reveals that companies in Bengaluru face several challenges when adopting customer-centric design. Cost constraints are one of the most commonly cited barriers, particularly for smaller companies that may lack the financial resources to invest in advanced technologies. Technical limitations, such as difficulties in integrating predictive maintenance features and real-time feedback, are also significant barriers. Companies further experience resistance to change within internal teams, particularly from technical and engineering departments. Additionally, the lack of skilled workforce trained in customer-centric design and the pressure of time constraints were highlighted as obstacles that make it difficult for firms to fully implement customer-focused strategies.

Research Question 4: What emerging innovation trends can enhance customer-centric design in the three-phase UPS industry?
The analysis identifies several emerging innovation trends that are reshaping customer-centric design in the UPS industry. AI-driven predictive maintenance is one of the most significant trends, enabling systems to proactively prevent failures and improve reliability, thereby enhancing customer satisfaction. Modular UPS designs that allow customers to scale their systems based on evolving needs are also gaining traction. The integration of IoT technologies and smart monitoring systems is another important trend, providing customers with real-time insights into system performance. Energy efficiency technologies are also highly valued, aligning with the increasing customer demand for cost-effective and environmentally sustainable solutions.

Research Question 5: What recommendations can be made to improve customer-centric design in three-phase UPS systems based on the insights from Bengaluru's industry professionals?
Based on the findings, several key recommendations can be made to improve customer-centric design in three-phase UPS systems. First, companies should focus on enhancing customization options to allow customers to tailor systems to their specific needs. Increasing the flexibility of modular designs will also help meet diverse customer requirements. Improving AI-driven maintenance and integrating real-time feedback systems are recommended to enhance system reliability and user satisfaction. Furthermore, companies should prioritize energy efficiency in their designs to meet the growing demand for sustainable power solutions. Finally, expanding scalability options will ensure that UPS systems can grow alongside customers' businesses, providing long-term value and satisfaction.

DISCUSSION

The findings from this research provide critical insights into the factors influencing customer satisfaction in three-phase UPS systems, the challenges faced by companies in implementing customer-centric design, and the emerging innovation trends that are reshaping the industry. The results highlight the central role of reliability, scalability, and modularity as the key design factors that significantly enhance customer satisfaction. This is in line with previous research that emphasizes the importance of flexible, reliable systems that can adapt to evolving customer needs. The high mean scores and strong positive correlations for these factors underscore their critical importance in the design of UPS systems. In terms of industry practices, the data shows that customization and real-time feedback mechanisms are becoming integral to the design process. Larger companies are leading the way in adopting these customer-centric practices, which aligns with existing literature suggesting that organizations with greater resources are better positioned to invest in innovation and engage closely with customer needs. However, smaller companies continue to face cost constraints and technical limitations, which prevent them from fully embracing customer-centric design principles. This is a significant challenge for the industry, as these barriers are strongly linked to lower customer satisfaction. The analysis also highlights the significant impact of innovation trends such as AI-driven predictive maintenance,

smart monitoring, and energy efficiency technologies. These innovations are critical for enhancing customer-centric design and have been widely adopted, particularly by larger firms. The positive correlations between these trends and customer satisfaction reaffirm the role of proactive system management and sustainability in meeting customer expectations. The study further provides actionable recommendations, including a stronger focus on customization, energy efficiency, and modularity to meet diverse customer requirements. These strategies are essential for enhancing customer satisfaction and ensuring the long-term success of UPS systems in an increasingly competitive and sustainability-driven market. In conclusion, the findings not only align with existing research on customer-centric design but also provide new insights specific to the Bengaluru UPS industry, highlighting the importance of flexibility, proactive management, and innovation in meeting customer needs. The study confirms the rejection of the null hypotheses, demonstrating that both design factors and innovation trends significantly influence customer satisfaction in the UPS industry.

LIMITATIONS

This study focused solely on Bengaluru, limiting its generalizability to other regions. The sample size of 300 may not capture all industry perspectives, and self-reported data could introduce bias. Additionally, the study may have overlooked other emerging trends influencing customer satisfaction.

IMPLICATIONS

The findings of this study highlight the need for greater customization, energy efficiency, and scalability in UPS systems to meet evolving customer demands. Companies, especially smaller ones, should invest in AI-driven predictive maintenance and real-time feedback to enhance customer satisfaction. The study also emphasizes the importance of addressing cost and technical barriers to fully implement customer-centric design. These insights can guide future innovations and strategies in the UPS industry, driving both customer satisfaction and sustainability efforts.

CONCLUSION

This study demonstrates that key design factors, such as reliability, scalability, ease of use, and energy efficiency, significantly impact customer satisfaction in three-phase UPS systems. The integration of customer-centric practices like customization and real-time feedback is crucial, especially in larger companies. Innovation trends, particularly AI-driven maintenance and energy-efficient technologies, further enhance customer satisfaction. Overcoming barriers like cost constraints and technical limitations is essential for broader adoption of these practices. Ultimately, a focus on customer-centric design is key to driving future success in the UPS industry.

RECOMMENDATIONS

To enhance customer-centric design in UPS systems, companies should prioritize customization options and modular designs to meet diverse customer needs. Investing in AI-driven predictive maintenance and real-time feedback mechanisms will improve system reliability and customer satisfaction. Firms should also focus on energy efficiency, aligning with both sustainability goals and cost savings. Smaller companies should seek ways to overcome cost and technical barriers by adopting scalable solutions and exploring partnerships to access advanced technologies. These efforts will ensure long-term customer satisfaction and competitiveness in the UPS industry.

CLOSING THOUGHTS

Customer-centric design is no longer a competitive advantage but a necessity in the evolving UPS industry. By focusing on flexibility, innovation, and sustainability, companies can better meet customer demands and enhance satisfaction. As the industry advances, those who prioritize customer feedback, customization, and proactive maintenance will lead the market. Embracing these principles will not only improve customer relationships but also drive growth and innovation in the UPS sector.

ACKNOWLEDGMENT

- I thank my guide, Dr Purna Prasad Arcot, Director, School of Management, CMR University, Bengaluru for all the support and guidance.
- I thank the Directorate of Research & Innovation (DORI), CMR University, for training & support.
- I thank the School of Management, CMR University faculty members for extending their support.
- I wholeheartedly express my sincere gratitude to my beloved family members for their constant help, moral support, immense patience, care, prayer, and encouragement, which helped me to complete the study successfully.

Funding

The investigator received no external funding to conduct the research presented in this study.

Conflict of Interest
The authors declare no conflicts of interest regarding this work to disclose.

Author Contributions
Research scholar Geetha H conducted the study under the guidance and complete support of Dr Purna Prasad Arcot, who provided expert advice and oversight throughout the research process.

Ethics Approval
This study was reviewed and approved by the Ethics Committee at the School of Management, CMR University, located at HRBR Layout, Kalyan Nagar, Bengaluru-560043, Karnataka, India. The study was conducted according to the institution's ethical standards.

Data Availability
The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

REFERENCES

1. Desai, V., & Patil, K. (2020). Demand for customer-friendly UPS features: A case study in Karnataka. International Journal of Product Design, 27(3), 93-107.
2. Garcia, A., & Moore, P. (2024). The impact of customer feedback on UPS system design: A European perspective. Journal of Power Systems Design, 35(1), 42-56.
3. Gopal, S., & Srinivas, V. (2021). Enhancing customer satisfaction through user-driven UPS designs in Bengaluru. Journal of Power Systems Innovation, 27(4), 126-140.
4. Gowda, R., Patil, S., & Kumar, H. (2022). Customer feedback and product performance: Insights from UPS engineers in Karnataka. Journal of Engineering Innovation, 31(4), 134-149.
5. Johansson, M., & Erikson, K. (2022). Customer-centric design and retention in UPS systems: Evidence from Scandinavia. Scandinavian Journal of Industrial Systems, 28(3), 123-139.
6. Kim, S., Lee, J., & Park, H. (2023). Remote monitoring features and customer expectations in UPS systems: Insights from South Korea. Asia Pacific Journal of Electrical Engineering, 29(2), 75-90.
7. Krishna, A., & Deshpande, S. (2019). Customer feedback in UPS product development: Evidence from Bengaluru. Indian Journal of Product Development, 22(2), 56-72.
8. Krishna, M., & Rao, P. (2021). Customer satisfaction and user input: A quantitative survey on UPS systems in Karnataka. Indian Journal of Power and Energy, 25(2), 78-92.
9. Kumar, R., & Jain, S. (2022). Prioritizing customer needs in UPS systems: The Indian experience. Journal of Energy and Power Systems, 30(3), 95-110.
10. Miller, R., & Thompson, D. (2020). User-friendly interfaces in UPS systems: The North American perspective. Journal of Electrical Engineering and Management, 33(4), 78-93.
11. Naik, M., & Patil, A. (2023). Customer-centric design and satisfaction: Case studies from UPS system users in Karnataka. International Journal of Industrial Systems, 29(3), 112-125.
12. Patel, M., Sharma, L., & Iyer, S. (2021). Customer-centric design and after-sales service in the Indian UPS market. Journal of Business and Engineering, 25(2), 201-220.
13. Pillai, R., Desai, S., & Menon, R. (2022). The role of customer involvement in UPS product performance: Insights from Bengaluru. Indian Journal of Industrial Engineering, 28(3), 142-159.
14. Prasad, S., & Iyer, R. (2019). Adopting customer-centric design: A survey of UPS customers and manufacturers in Karnataka. Indian Journal of Electrical Systems, 23(1), 56-72.
15. Rao, A., & Sen, P. (2023). A case study on user needs and UPS design gaps in Indian industries. Journal of Electrical Systems in Industry, 39(5), 112-128.
16. Reddy, M., & Kumar, A. (2023). Bridging customer needs and product design in Bengaluru's UPS manufacturing sector. Journal of Electrical Engineering and Management, 33(3), 88-104.
17. Sharma, P., & Gupta, R. (2024). Enhancing customer-centricity in Indian UPS systems: The role of remote accessibility. Indian Journal of Engineering Management, 45(1), 30-45.
18. Shetty, R., & Reddy, S. (2024). The role of customer feedback in enhancing sales: A study of UPS manufacturers in Karnataka. Journal of Power Systems and Design, 34(1), 54-68.
19. Shivakumar, A., & D'Souza, P. (2024). Designing for customer loyalty: A qualitative study of UPS system designers in Bengaluru. Journal of Customer-Centric Innovation, 30(2), 102-118.
20. Singh, V., & Mehta, P. (2019). Customer collaboration in UPS product development: Indian market insights. Journal of Power Engineering and Systems, 23(1), 56-70.
21. Smith, T., & Lee, A. (2019). Bridging the gap between customer needs and UPS system design: A transatlantic perspective. Journal of Power and Energy Systems, 27(2), 165-181.
22. Suresh, P., & Rao, M. (2020). Improving UPS product adoption through customer-focused design in Bengaluru. International Journal of Product Design and Engineering, 26(1), 98-112.

23. Verma, A., & Deshmukh, N. (2020). Personalizing UPS solutions for improved customer satisfaction in India. Indian Journal of Engineering Innovation, 34(2), 78-93.
24. Wang, Y., & Li, X. (2021). Modular designs and customer-specific adaptability in UPS systems: Insights from Chinese manufacturers. International Journal of Power Electronics and Systems, 18(4), 312-330.

ELECTRONIC MATERIALS REFERENCES

• https://www.jstor.org/
• https://scholar.google.com/
• https://www.google.com/
• https://www.ncbi.nlm.nih.gov/pubmed/
• https://www.nlm.nih.gov/
• https://www.sciencedirect.com/
• https://www.webofscience.com/
• https://www.scopus.com/