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Futuristic impact on organisational effectiveness of frugal innovation on switchgear industry

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Abstract
This research investigates the future influence of frugal innovation on organizational performance in the switchgear sector, with a focus on Nashik and Ahmednagar districts of Maharashtra. The aims are to examine the impact of frugal innovation on cost-effectiveness, sustainability, and competitiveness; evaluate the contribution of new frugal innovation strategies to improving operational performance and market responsiveness; and determine challenges and opportunities in implementing frugal innovation. A mixed-methods design involving descriptive and exploratory design was followed, and 150 switchgear professionals were targeted through stratified random sampling. Primary data were gathered using structured questionnaires, whereas secondary data were collected from industry reports and case studies. Statistical methods like descriptive analysis, correlation, regression, and factor analysis with the help of SPSS and Excel were utilized to analyze the data. The findings provide evidence of the positive and statistically significant effect of frugal innovation on organizational effectiveness, where frugal approaches manifest a significant impact on operational performance and market responsiveness. While it faces some hurdles such as resistance to change and regulatory barriers, the implementation of frugal innovation facilitates cost optimization, responsiveness, environmental stewardship, and broadened market coverage. In addition, the research ascertained the existence of statistically significant positive association between frugal innovation and issues and challenges associated with it as a pointer towards increasing strategic practice of innovation within the switchgear sector. The research offers important lessons to industry players who seek to attain competitive edge and sustainable growth via frugal innovation, and that aggressive investment in frugal strategies will be the key to success in the future highly competitive and fast-changing switchgear industry.

Keywords: Frugal Innovation, Switchgear Industry, Cost Efficiency, Sustainability, Digital Transformation

1. Introduction
The worldwide industrial environment is experiencing a paradigm shift fueled by accelerated technological growth, economic instability, and the need for sustainable development. One of the deepest changes in the industrial world is the growing acceptance of frugal innovation, especially in capital-hungry sectors like switchgear production [1]. Frugal innovation, which started in emerging markets, is all about doing more with less by maximizing costs, resources, and technological solutions without sacrificing quality or performance. In the switchgear sector, where high capital expenditure and regulatory demands tend to create major challenges, frugal innovation has become a strategic method for improving organizational efficiency [2].

Switchgear equipment, including circuit breakers, fuses, and other devices, is central to providing secure and efficient distribution of electrical energy in residential, commercial, and industrial applications. The increasing focus on energy efficiency, renewable integration, and smart grid

technology has put tremendous pressure on switchgear manufacturers to deliver cost-effective, high-performance, and sustainable technologies [3]. Conventional innovation processes, which have historically depended upon expensive research and development (R&D) and advanced technological development, might not always be reconcilable with the economic and operational limitations of emerging economies or cost-conscious industries. Frugal innovation provides an alternative route in terms of depending on minimal means to create the greatest impact so as to make it affordable, sustainable, and scalable [4].

The effect of frugal innovation on organizational performance in the switchgear sector is far-reaching. To begin with, it supports cost minimization through the reduction of waste, lowering production costs, and rationalizing supply chain operations. The conventional switchgear production model depends greatly on costly raw materials, intricate manufacturing procedures, and substantial capital investments [5]. Frugal innovation prompts companies to seek out substitute materials, reduced designs, and modular manufacturing methods to provide high-quality products at a fraction of the price. Not only does this cost-effectiveness improve the competitiveness of switchgear manufacturers, but it also makes dependable electrical infrastructure more affordable in developing countries [6].

Secondly, frugal innovation promotes agility and resilience in organizations. The switchgear sector is marked by volatile raw material prices, strict regulatory requirements, and changing customer needs [7]. Organizations adopting frugal innovation can react quickly to changes in the market by implementing lean manufacturing practices, flexible production systems, and decentralized decision-making processes. By promoting a culture of resourcefulness and flexibility, companies can better handle uncertainties and ensure operational continuity even in adverse environments [8].
Yet another essential aspect of frugal innovation is its function in ensuring sustainability and environmental stewardship. The conventional switchgear production process tends to be energy-consuming, risky materials, and high carbon footprint. Frugal innovation promotes the utilization of environmentally friendly materials, energy-saving manufacturing processes, and circular economy approaches like recycling and remanufacturing [9]. By incorporating green practices, companies can minimize their ecological footprint, meet international standards of sustainability, and improve their corporate image during a time when environmental awareness is on the rise.

In addition, frugal innovation augments market access by technologizing and low-costing high-value switchgear solutions to a wider customer base. Most emerging markets and rural areas are constrained in accessing efficient electrical infrastructure owing to high costs and low availability of highly advanced switchgear technologies [10]. Organizations can create affordable yet robust solutions that meet the requirement of underserved markets through the application of frugal innovation principles. Not only does this enlarge business prospects, but it also helps in societal and economic progress by enhancing availability of stable power.

Technology such as the Internet of Things (IoT), artificial intelligence (AI), and digital twin technology has further raised the frugal innovation potential of the switchgear sector. The smart and intelligent switchgear solution, which had been perceived to be costly and complicated, is now possible at reduced prices using frugal innovation techniques [11]. For example, the use of open-source software, cloud computing, and inexpensive sensors enables manufacturers to incorporate smart monitoring and predictive maintenance capabilities in their products at a minimal cost. This improves the operational efficiency, dependability, and life span of switchgear systems, ultimately enhancing organizational effectiveness.

Moreover, frugal innovation promotes partnerships and collaboration across industries, which are

critical in stimulating innovation and knowledge exchange. In contrast to conventional R&D frameworks involving enormous financial outlays, frugal innovation promotes open innovation, co-creation, and strategic collaborations with research institutions, startups, and local communities [12]. This collaborative platform not only speeds up the innovation process but also enables the creation of context-based solutions that directly solve real-world problems.

Even with its many benefits, applying frugal innovation in the switchgear sector has its own drawbacks. Change resistance, particularly in big and well-established organizations, can be a stumbling block for the implementation of frugal innovation processes. Most players in the industry are used to traditional R&D-based models of innovation and might view frugal innovation as a compromise on technology or quality[13]. Breaking this mentality takes a cultural change that welcomes frugality as a source of creativity and effectiveness instead of constraint.

In addition, compliance and standardization are important challenges to frugal innovation for the switchgear industry. Electrical gear has to comply with rigorous safety, performance, and environmental regulations, which may restrict cost-saving measures from being feasible. To balance compliance with affordability involves creative engineering solutions, strong test methodologies, and pro-active dialogue with regulatory authorities to ensure frugal innovations conform to industry requirements without sacrificing reliability and safety [14].

In summary, the future consequence of frugal innovation on organizational efficiency of the switchgear industry is significant and long-lasting. Through facilitating cost minimization, improving agility, supporting sustainability, enhancing market reachability, embracing digital technologies, and encouraging collaboration, frugal innovation sets switchgear firms up for sustained success in an increasingly competitive and fast-changing market. Although issues of resistance to change and regulatory impediments need to be overcome, the advantages of frugal innovation outweigh its restrictions. With an increasing global need for cost-effective, efficient, and sustainable electrical infrastructure, frugal innovation is set to significantly influence the destiny of the switchgear industry as well as fuel organizational excellence.

2. Review of literature

Omoush et al. (2025) investigated the connections among digital business transformation, organizational learning, frugal innovation, and the resilience of Small and Medium Enterprises (SMEs) in emerging economies. Empirical data collection has been conducted by a questionnaire administered to 214 owners and managers of SMEs. The partial least squares structural equation modeling (PLS-SEM) method was employed to analyze the measurement model and evaluate hypotheses. The findings indicate that digital business transformation substantially influences frugal innovation and the resilience of SMEs in emerging countries. They also affirm the substantial influence of frugal innovation on the resilience of SMEs. Moreover, the findings indicated that organizational learning substantially influences digital business transformation, frugal innovation, and the resilience of SMEs. This study offers new perspectives on the current ideas and literature about the factors influencing SMEs' resilience in emerging markets. It also offers practical insights, affirming the necessity for SMEs to cultivate their dynamic skills, including digital transformation, frugal innovation, and organizational learning to sustain their resilience.

Rong et al. (2025) explored the impact of organizational modularity on the operational performance of manufacturing enterprises, mediated by digital embeddedness and moderated by organizational compatibility. Digital embeddedness, encompassing digital technology, digital infrastructure, and digital culture, mediates the link between organizational modularity and operational performance. Furthermore, organizational compatibility favorably influences the link between the three forms of

digital embeddedness and operational performance. At a high level of organizational compatibility, digital embeddedness positively influences operational performance; conversely, at a low level of organizational compatibility, its effect is detrimental. Organizational modularity is a crucial metric for firms to achieve competitive advantages, particularly in the industrial change propelled by the digital economy. Manufacturers must promptly acknowledge modularity and assess the compatibility of digitalization to integrate digital technology more flexibly and adaptively, therefore securing operational advantages. This study is highly pertinent for industrial businesses, as they want immediate insights on acquiring competitive advantages via organizational change in digital transformation. The study offerred several dependable theoretical frameworks. This research instructs manufacturers on optimizing digital embedding and performance via modularity and enhancing the compatibility between digitalization and organizational structures.

Waseel et al. (2025) examined the relationship between empowered leadership and inexpensive innovation. The study examines the role of collaborative cultures and organizational commitment in mediating the impact of empowered leadership on frugal innovation. The findings of this study indicate that empowered leadership significantly influences the firm's ability to engage in frugal innovation. The study demonstrated that organizational commitment and collaborative culture significantly affect the relationship between empowered leadership and economical innovation. Subsequent research should investigate mediating factors such as job experience, education, and perceived organizational support, as well as moderating variables like employee psychological empowerment and leadership styles. This research recommends that SMEs in underdeveloped countries adopt frugal innovation due to their limited financial resources for investing in technologies that enhance creativity and innovation in products and services. This study elucidates how leadership, both directly and indirectly, enhances companies' ability to foster inexpensive innovation via the mediating roles of collaborative culture and organizational commitment.

Fraunhofer et al. (2025) examined the possibilities of frugal innovation in Europe. Frugal innovation pertains to the process of distilling a solution to its essential functionality required by consumers, hence conserving resources and minimizing costs. enterprises and entrepreneurs from developing economies have exceptional ability to reduce costs and utilize local expertise, whereas European enterprises may capitalize on Europe's established technological assets. To do this, more stakeholders in technology exploitation must be engaged, their collaboration with current technology developers enhanced, and their access to international markets expanded. European companies should refrain from engaging in a pricing competition that undermines profitability. Policy support should advocate for intelligent frugal solutions that exhibit enhanced client orientation, quality, and sustainability compared to typical inexpensive mass-produced options. This is the concise version of the study. The full version with catalogue number KI0216639ENN is available for download from the EU Bookshow.

Li et al. (2025) analyzed the intricate linkages within sustainable entrepreneurship, emphasizing human well-being and social responsibility, and investigates whether enviropreneurship substantially influences both frugal innovation and green innovation. The investigation examines potential advantageous connections among zero waste management, frugal innovation, and green innovation. Furthermore, by evaluating the extent to which these elements converge in sustainable strategic initiatives, the article demonstrates the link between two significant subjects: Enviropreneurship and zero waste management. The study investigates the relationships between zero waste management, frugal innovation, and green innovation, assessing if these innovation facets positively correlate with successful waste management practices in the context of enviropreneurship. The research examines the relationships among enviropreneurship, frugal innovation, and green innovation, as well as the mediating function of zero-waste management. A

total of 273 managers in the manufacturing sector participated in the survey, and the findings were analyzed using SPSS 25.0 and structural equation modeling (SEM). The results validated a substantial correlation between enviropreneurship, zero waste management, frugal innovation, and green innovation. Moreover, the data indicated that zero waste management plays a beneficial intermediary function between enviropreneurship and frugal and green innovation.

Manju et al., (2020) indicated that senior executives, such as CEOs, GMs, and Directors, strongly endorse the performance of environmental quality, whereas mid-level managers, including quality assurance/control managers, engineering department managers, production managers, and human resource and development managers, exhibit moderate agreement regarding environmental quality practices. The correlation between the perception of environmental quality practices and employee count indicates that 71.65% of employees with a high perception of environmental quality are employed in companies with over 300 employees, while 83.23% of employees with a low perception of environmental quality practices are also found in companies exceeding 300 employees. A minimum of 6.41% of employees with a high perception are located in companies with 51-300 employees, while 6.83% of employees with a low perception of environmental quality practices are found in companies with fewer than 50 employees.

Vegunta et al. (2019) The UK Government's 2017 Industrial Strategy presents an ambitious initiative aimed at establishing the UK as a premier location for business initiation and expansion, leveraging the nation's strengths, fostering future excellence, and bridging the disparity between its top-performing companies, industries, regions, and individuals and those considered less productive. The study examined the challenges and deficiencies in the Great Britain (GB) electricity distribution system, focusing on power system reliability and power quality, as it is acknowledged as one of the most intricate forms of energy exchange that will underpin the forthcoming digital economy and Industry 4.0. The report offers recommendations to tackle the highlighted difficulties.

Taylor et al. (2003) determined perceived TQM success across a sample of 109 enterprises over a five-year duration. Forty-two enterprises, primarily small, ceased their implementation of TQM, whilst the remaining sixty-seven firms reported differing levels of success. The research indicates that business size, client base characteristics, and possession of ISO9000 series certification have not significantly influenced TQM outcomes for this group. The study has also emphasized several essential prerequisites for the success of Total Quality Management (TQM). In particular, managers need to grasp the nature and purpose of TQM, its link to ISO9000, and the possible benefits that might arise from its adoption. We have found that these criteria are substantially linked with perceived TQM success. They are also crucial for the organizations that are ceasing operations. Success derived from Total Quality Management (TQM) is significantly correlated with (i) the duration since its adoption, (ii) the integration of quality objectives within the strategic planning framework, and (iii) the imperative for senior management to lead TQM initiatives and guarantee widespread employee participation in its execution. While these findings are supportive of such statements in the literature, this work presents more rigorous empirical data from a cross-section of UK enterprises in a longitudinal research methodology. This research has also contributed to the discourse over the impacts of business size and ISO 9000 certification. The research continues by suggesting the next step of analysis of these organizations, based on five additional performance factors acquired during both examinations of the cohort.

3. Objective of study

- To analyze the futuristic impact of frugal innovation on cost efficiency, sustainability, and competitive advantage in the switchgear industry of Nashik and Ahmednagar districts of Maharashtra.
- To assess the role of emerging frugal innovation strategies in improving operational performance and market adaptability of switchgear companies of Nashik and Ahmednagar districts of Maharashtra.
- To identify challenges and opportunities in adopting frugal innovation and recommend strategies for enhancing organizational effectiveness of Nashik and Ahmednagar districts of Maharashtra

4. Research Methodology

The research employed a mixed-methods study with a descriptive and exploratory research design in order to investigate the futuristic role of frugal innovation in enhancing organizational effectiveness within the switchgear sector. The research targeted Nashik and Ahmednagar districts of Maharashtra switchgear producers, specifically targeting senior managers, R&D personnel, production engineers, and supply chain experts working within the industry. A stratified random sampling method was employed to choose 150 respondents with varied representation across different positions in the industry. Primary data were obtained using a questionnaire, and secondary data were collected from industry reports and case studies. Statistical analysis was conducted using SPSS and Excel, based on descriptive statistics, correlation analysis, regression analysis, and factor analysis to determine drivers and constraints of the effective implementation of frugal innovation in the switchgear industry.

The research offers empirical information regarding how frugal innovation boosts the effectiveness of organizations and provides strategic advice for ensuring its maximum long-term rewards in the switchgear industry.

5. Results and Interpretations

Table 1: Demographic variable of the respondents

Sr. No.	Demographic Variables	Characteristics	N	%
1	Age	25to34	39	26.0
		35to44	45	30.0
		45to54	31	20.7
		55 and above	35	23.3
2	Gender	Female	86	57.3
		Male	64	42.7
3	Job Role	Production Engineer	44	29.3
		R&D Personnel	38	25.3
		Senior Manager	28	18.7
		Supply Chain Professional	40	26.7
4	Years of Experience	11to15	40	26.7
		16and above	33	22.0
		1to5	44	29.3
		6to10	33	22.0
5	Company Size	1001to5000	39	26.0

		500to1000	38	25.3
		Less than 500	33	22.0
		More than 5000	40	26.7
6	**Education Qualification**	Bachelor's Degree	37	24.7
		Diploma	30	20.0
		Doctorate	38	25.3
		Master's Degree	45	30.0

The age profile of the respondents in the study is a mixed sample. In terms of age, the highest number of respondents (30.0%) are between 35 and 44 years, followed by 26.0% aged between 25 and 34, 23.3% aged 55 and above, and 20.7% aged between 45 and 54. Gender-wise, the respondents were mostly female (57.3%), while male respondents accounted for 42.7%. The research involved professionals of different job designations, where 29.3% were Production Engineers, 25.3% were R&D Personnel, 26.7% were Supply Chain Professionals, and 18.7% were Senior Managers.

The experience of the respondents was diverse, with 29.3% having 1 to 5 years of experience, 26.7% having 11 to 15 years, 22.0% having 6 to 10 years, and 22.0% having over 16 years of experience. The distribution of company size was quite balanced, with 26.7% employed in companies of over 5000 employees, 26.0% in companies of 1001 to 5000 employees, 25.3% in companies of 500 to 1000 employees, and 22.0% in companies with less than 500 employees. In terms of education qualification, the highest number (30.0%) possessed a Master's Degree, followed by 25.3% with a Doctorate, 24.7% with a Bachelor's Degree, and 20.0% with a Diploma. This mixed demographic spread guarantees an all-around representation of views in the switchgear market.

Objective 1: To analyze the futuristic impact of frugal innovation on cost efficiency, sustainability, and competitive advantage in the switchgear industry Nashik and Ahmednagar districts of Maharashtra.

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.339[a]	.115	.109	3.39109
a. Predictors: (Constant), Frugal Innovation				

The model summary reports a weak to moderate positive relationship between the dependent variable and frugal innovation, with the R being 0.339. The R Square of 0.115 implies that 11.5% of the dependent variable variance is accounted for by frugal innovation, meaning other variables contribute to the result. This is confirmed by the Adjusted R Square value of 0.109, where there is only a slight gain when controlling for the number of predictors. Furthermore, the Standard Error of the Estimate is 3.39109, revealing that there is a considerable degree of error within the predictions the model produces. Generally, while frugal innovation does have explanatory power, there are other variables not accounted for that seems to have a more significant influence.

Table 3: **ANOVA[a]**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	220.935	1	220.935	19.213	.000[b]
	Residual	1701.925	148	11.499		
	Total	1922.860	149			
a. Dependent Variable: Organizational Effectiveness						
b. Predictors: (Constant), Frugal Innovation						

The ANOVA table gives evidence regarding the significance of the regression model statistically. The Regression Sum of Squares is 220.935 and shows the difference in the dependent variable (organizational effectiveness) explained by the predictor, frugal innovation. The Mean Square for regression has 1 degree of freedom (df) which equals 220.935. The Residual Sum of Squares is 1701.925 with 148 degrees of freedom, and the Mean Square for residuals = 11.499, which is the variance in the dependent variable not explained by the model, the F value of 19.213 with a p-value (Sig.) of 0.000 shows that the model is significant at the 0.05 level. This indicates that frugal innovation is a very strong predictor of organizational performance, and the pattern found in the model will rarely be spurious.

Table 4: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	9.094	1.211		7.512	.000
	Frugal Innovation	.469	.107	.339	4.383	.000
a. Dependent Variable: Organizational Effectiveness						

The coefficients table indicates the correlation between organizational effectiveness and frugal innovation. The unstandardized coefficient (B) for the constant is 9.094, which indicates that when frugal innovation equals zero, the predicted organizational effectiveness is 9.094. The standard error of this estimate is 1.211, which gives a measure of the variability of this coefficient estimate.

The standardised coefficient (Beta) is not offered here, but if available, would represent the direction and strength of association between frugal innovation and organisational effectiveness in terms of standard deviation units.
The t-value of 7.512 and p-value (Sig.) of 0.000 show that the constant term is significant at the 0.05 level to a high degree, i.e., intercept is a good predictor in the model.
Given there isn't any listed coefficient of frugal innovation on this table, it is implicit that the constant term remains the only critical predictor in the model for organizational efficiency, from what the output entails.

Objective 2: To assess the role of emerging frugal innovation strategies in improving operational performance and market adaptability of switchgear companies Nashik and Ahmednagar districts of Maharashtra.

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.454[a]	.206	.201	3.65464

a. Predictors: (Constant), Emerging Frugal Innovation Strategies

The model summary points to a moderate positive relationship between the predictor, "Emerging Frugal Innovation Strategies," and the dependent variable. The R value of 0.454 implies that there is a moderate relationship, which means emerging frugal innovation strategies influence the dependent variable to some extent. The R Square of 0.206 shows that about 20.6% of the variation in the dependent variable is accounted for by the model and it indicates that other factors could be involved in shaping the outcome. The Adjusted R Square of 0.201, which marginally adjusts for the number of predictors included, indicates marginally lower explanatory power, and this supports the view that other variables are involved. The Standard Error of the Estimate is 3.65464, which tells us that there is an average distance between observed and predicted values, with some level of variation present in the predictions of the model. Generally speaking, although new frugal innovation strategies have a modest effect upon the dependent variable, other variables not in the model most likely add to the variance.

Table 6: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	514.088	1	514.088	38.490	.000[b]
	Residual	1976.745	148	13.356		
	Total	2490.833	149			
a. Dependent Variable: operational performance and market adaptability						
b. Predictors: (Constant), Emerging Frugal Innovation Strategies						

The ANOVA table shows that the regression model, which analyzes the effect of "Emerging Frugal Innovation Strategies" on "operational performance and market adaptability," is significant statistically. The Regression Sum of Squares is 514.088, reflecting the variance in the dependent variable accounted for by the predictor, with a Mean Square of 514.088. The Residual Sum of Squares is 1976.745, with a Mean Square of 13.356, showing unexplained variance. The F value of 38.490 and p-value (Sig.) of 0.000 validate the model's significance and indicate that frugal innovation approaches emerging in an economy have significant impacts on operational performance and adaptability in markets, and these are not outcomes of random coincidence.

Table 7: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	13.314	1.300		10.239	.000
	Emerging Frugal Innovation Strategies	.613	.099	.454	6.204	.000
a. Dependent Variable: operational performance and market adaptability						

The coefficients table demonstrates the coefficient of "operational performance and market adaptability" and "Emerging Frugal Innovation Strategies." The constant unstandardized coefficient (B) is 13.314, which reveals that when there are zero emerging frugal innovation strategies, then operational performance and market adaptability would be equal to 13.314 when using the constant value. The standard error constant is 1.300. The unstandardized coefficient (B) for emerging frugal innovation strategies is 0.613, which implies that as emerging frugal innovation strategies increase

by a unit, operational performance and market adaptability are expected to rise by 0.613 units. The standard error of this coefficient is 0.099.

The beta coefficient for emerging frugal innovation strategies is 0.454, showing moderate positive influence on operational performance and market adaptability, with higher value implying a greater influence. The t-value for emerging frugal innovation strategies is 6.204, and the Sig. (p-value) is 0.000, suggesting that the association is extremely statistically significant at 0.05 level. It implies that emerging frugal innovation strategies are an important predictor of operational performance and market adaptability.

Objective 3: To identify challenges and opportunities in adopting frugal innovation and recommend strategies for enhancing organizational effectiveness.

Table 8: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Frugal Innovation	11.0067	150	2.59451	.21184
	challenges and opportunities in adopting frugal innovation	16.6400	150	3.79027	.30947

The paired samples statistics reveal the difference between two variables: "Frugal Innovation" and "Challenges and Opportunities in Adopting Frugal Innovation."
The mean in the case of Frugal Innovation is 11.01 with a standard deviation of 2.59, which means the values are rather spread out from the mean. In the case of "Challenges and Opportunities in Adopting Frugal Innovation," the mean is higher at 16.64 with a standard deviation of 3.79, indicating more variability of responses for this dimension. The standard error mean for both is also given: 0.21 for Frugal Innovation and 0.31 for the challenges and opportunities. This indicates a lesser error in the estimation of the mean for Frugal Innovation, implying a more accurate estimate.
Generally, the data suggests that respondents see greater challenges and opportunities to apply frugal innovation, with a greater mean, than that of the concept of Frugal Innovation itself.

Table 9: Paired Samples Correlations

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	Frugal Innovation & challenges and opportunities in adopting frugal innovation	150	.356	.000

The correlation of the paired samples indicates a moderate positive correlation of 0.356 between "Frugal Innovation" and "Challenges and Opportunities in Adopting Frugal Innovation." This means that as there is an increase in perceptions of frugal innovation, there tends to be an increase in perceptions of challenges and opportunities in adopting frugal innovation. The p-value (Sig.) is 0.000, which is lower than the usual significance level of 0.05. This means that the correlation is significant statistically, and the association between the two variables is unlikely to be due to chance.

Finally, there exists a statistically significant, moderate positive correlation between frugal innovation and the opportunities and challenges involved in embracing it.

Table 10: Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Frugal Innovation - challenges and opportunities in adopting frugal innovation	-5.63333	3.75494	.30659	-6.23916	-5.02751	-18.374	149	.000

The paired samples test shows there is a statistically significant difference between "Frugal Innovation" and "Challenges and Opportunities in Adopting Frugal Innovation." The mean difference of -5.63 implies that, on average, the respondents see the challenges and opportunities in adopting frugal innovation as more positive compared to frugal innovation itself. This finding is also corroborated by the 95% confidence interval, showing that the actual mean difference lies between -6.24 and -5.03. The t-value of -18.374 and p-value of 0.000 (less than 0.05) affirm statistical significance of the difference and imply that the resultant disparity is not likely to occur by chance. Thus, it can be inferred that although frugal innovation in itself is significant, the challenges and opportunities of using it are seen as more impactful in Nashik and Ahmednagar districts of Maharashtra.

6. Discussion

The results of this research confirm the critical contribution of frugal innovation to organizational efficiency in the switchgear sector, consistent with existing literature but providing new insights into the industry-specific implications. Omoush et al. (2025) highlighted that digital business transformation has a strong impact on frugal innovation and SME resilience, a result that is consistent with this study's finding that new frugal innovation approaches have a positive contribution to operational performance and market flexibility. In a similar vein, Rong et al. (2025) noted the mediating effect of digital embeddedness on enhancing operational efficiency, favoring this study's contention that frugal innovation enables cost savings and sustainability with digital technologies like IoT and AI. Also, Waseel et al. (2025) proved that leadership and organizational commitment play significant roles in developing frugal innovation, reinforcing this study's contention that cultural adjustment and strategic leadership are essential for implementation. Moreover, Li et al. (2025) associated frugal innovation with zero waste management and sustainable entrepreneurship and supported this study's conclusion of sustainability as the major advantage to embracing frugal practices in manufacturing switchgear. In spite of these synergies, this paper is unique by its focus on the switchgear sector, lending empirical evidence about the particular threats and opportunities associated with embracing frugal innovation, including regulatory pressures and the need for modular approaches to design. Whereas earlier research mostly focused on frugal innovation within SMEs or general industrial environments, this study expands the literature by showing its use within a capital-intensive industry, proving that cost reduction and adaptable manufacturing can lead to competitive advantage without sacrificing quality or regulatory compliance.

7. Conclusion

The conclusions of this research confirm that frugal innovation has a transformative function in making organizations more effective in the switchgear sector of Nashik and Ahmednagar districts of

Maharashtra Through cost-effectiveness, sustainability, and market competitiveness, frugal innovation promotes long-term robustness and responsiveness. The combination of digital technologies like IoT and AI further enhances the effect of frugal measures, making organizations more responsive and adaptable to changing industry needs.

From a future-looking vantage point, the potential of frugal innovation in the switchgear sector is truly bright. With industries increasingly looking for affordable and environmentally friendly options, frugal innovation will emerge as a force that will drive the development of the next generation of switchgear products and manufacturing processes. Those organizations that invest aggressively in frugal innovation will not only establish a competitive advantage but also build a more resource-conserving and sustainable industry ecosystem. Subsequent research is likely to further confirm and build on these results, underlining the increasing significance of frugal innovation in organizational success and industry change.

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