



The Influence of Adaptive Work Culture on the Performance of Smart Energy Solar Cell Utilization in the Tofu Industry

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ABSTRACT

This research explores the influence of adaptive work culture on the performance of smart energy solar cell utilization in the tofu industry. As the tofu industry increasingly adopts renewable energy technologies like solar power, understanding the role of employees' adaptability to these changes becomes crucial. The study utilizes a quantitative approach with a sample size of 30 employees involved in the implementation and operation of solar energy systems in tofu production. Data were analyzed using SmartPLS 24 software, applying several analytical methods, including validity, reliability, multicollinearity, R-square, and hypothesis testing. The research finds a significant positive relationship between adaptive work culture and the effective performance of solar energy systems, with key factors such as work flexibility, openness to change, and learning ability contributing to higher operational efficiency and system optimization. The results indicate that fostering an adaptive work culture within the workforce leads to better management, maintenance, and utilization of solar energy technology, enhancing overall production outcomes. Based on these findings, the study concludes that businesses in the tofu industry, and similar small-scale industries, should prioritize cultivating an adaptive work culture to successfully integrate and optimize renewable energy technologies.

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1. INTRODUCTION

Tofu has long been a favored food product among the Indonesian population, appreciated not only for its taste but also for its rich nutritional value. As a plant-based protein source, tofu provides an affordable and accessible alternative to animal protein for many households across the country. Its main ingredient, soybean, is considered an essential commodity that supports both domestic food consumption and the broader food processing industry [1]. The tofu industry in Indonesia has gained substantial popularity over time due to the simplicity of its production process and the growing demand for tofu as a staple food. This has led to the development of many small and medium enterprises involved in tofu manufacturing. Over the

past decade, the industry has continued to evolve in line with changes in consumer behavior, product diversification, and increasing attention to product quality [2].

Indonesia's tofu industry is currently home to tens of thousands of production facilities operating at various scales, from small home-based businesses to large manufacturing plants. The country hosts approximately 84,000 tofu processing units. These facilities collectively consume around 2.56 million tons of soybeans per year, reflecting their significant role in national food supply. Between 2019 and 2023, national per capita tofu consumption averaged 2.782 kilograms per year, although yearly figures fluctuated in response to market conditions [3].

In this growing and competitive environment, tofu producers are constantly seeking new strategies to maintain and improve production efficiency [4]. A tofu factory located in the city of Bekasi has attempted to address such challenges by applying a more sustainable approach through the use of solar energy. The factory produces an average of 209 trays of tofu each day, with one tray consisting of 100 pieces. Most sales are carried out by the tray, each priced at IDR 48,000, although retail sales are also offered at IDR 750 per piece. The factory occasionally experiences increased production volumes during certain months, leading to overtime work that exceeds its intended daily output. To manage energy demands during these high-output periods, the factory has implemented a Smart Energy Solar Cell system. This system is designed to convert solar energy into electricity, thereby helping reduce dependency on conventional energy sources [5].

Solar energy is considered a suitable solution for tofu factories due to several operational and environmental advantages. In areas such as Bekasi, where sunlight is available in abundance throughout the year, solar panels can offer a consistent and renewable power supply. In addition to reducing electricity costs, the use of solar energy helps maintain more stable production activities and contributes to broader efforts to adopt environmentally friendly practices in small-scale industries [6]. This transition also supports Indonesia's goals in encouraging cleaner technologies within the manufacturing sector.

As the tofu industry begins to incorporate modern energy technologies such as solar power, it becomes increasingly important to understand how human resources within these traditionally low-tech environments adapt to such changes. The adoption of solar energy in small-scale industries is not only a technical issue but also a social and organizational one. Qamar et al. [6] emphasized that while solar energy offers long-term sustainability and climate change mitigation benefits, its adoption by micro, small, and medium enterprises (MSMEs) is often constrained by several factors, including limited scale, access to financial resources, and inadequate operational capacity. These factors create significant barriers to effective implementation, particularly in developing countries where industrial infrastructure is still evolving. In this context, solar energy remains underutilized, despite its clear environmental and economic benefits. Mekhilef et al. [7] further explored the potential of solar applications in small-scale industries, noting that renewable energy solutions like solar power could be ideal for industries seeking to reduce energy costs and environmental impacts, but their adoption is often slow due to technical challenges and a lack of familiarity with such systems in smaller enterprises.

Additionally, Lefore et al. [8] found that even when solar energy technology is available, its impact is often limited by the lack of proper planning, inadequate workforce training, and insufficient long-term maintenance strategies. In their study on solar irrigation for smallholder agriculture, they observed that while solar technologies could lead to significant improvements in energy access and productivity, these benefits were frequently undermined by insufficient local capacity to manage and maintain the technology over time. Similarly, Alam et al. [9] highlighted the importance of understanding user behavior in the adoption of renewable energy. Their research demonstrated that the willingness of small-scale users to adopt renewable energy solutions is strongly influenced by behavioral intentions, contextual readiness, and perceived economic benefits. When employees and small business owners are not fully aware of the long-term advantages of solar energy or lack the skills to operate it, the technology's potential remains untapped.

In parallel with technological considerations, the role of adaptive work culture has been identified as a critical factor in the successful implementation of new systems. Hidayat and Galib [10] found that adaptive behavior and organizational culture significantly influence employee satisfaction and operational alignment during leadership transitions. Their study on family-owned businesses highlighted how a strong organizational culture, one that supports flexibility and openness to change, can facilitate smooth transitions during the adoption of new technologies. Mahmud and Tesniwati [11] further supported this by demonstrating that adaptive work practices were strongly associated with enhanced performance in the context of digital transformation in public services. They argued that organizational cultures that embrace change, foster innovation, and encourage continuous learning were better positioned to successfully integrate new technologies, including energy systems. The research also observed that the effectiveness of adopting digital and sustainable energy solutions increases significantly when backed by a workforce that is ready and willing to adapt to new processes and technologies. Their study on customs services in Indonesia found that the application of digital tools and new technologies led to greater efficiency, but only when the workforce

had been adequately prepared for the change, demonstrating the critical role of adaptive culture in technological adoption.

In the specific context of tofu production, the integration of Smart Energy Solar Cell technology presents both opportunities and challenges. The potential benefits of this technology, such as reduced energy costs and enhanced environmental sustainability, can only be fully realized if the workforce is equipped with the necessary knowledge and skills to manage and optimize its use. The technical capabilities of the solar energy system alone are not sufficient; the successful adoption of such innovations depends heavily on how well the employees can adapt to these new systems, engage with them, and ultimately ensure their efficient operation. Therefore, understanding the relationship between adaptive work culture and technological performance becomes crucial in evaluating the overall success of this renewable energy initiative in the tofu industry.

2. RESEARCH METHOD

Research Variable

This study focuses on two main variables: Adaptive Work Culture (X) as the independent variable and Work Performance of Smart Energy Solar Cell Utilization (Y) as the dependent variable. The Adaptive Work Culture variable refers to the degree to which employees are capable of adjusting to dynamic changes in the work environment, especially those related to the integration of technological innovations such as the use of solar energy in production systems. In the context of small-scale industries like tofu manufacturing, which traditionally rely on manual and low-tech processes, the shift toward renewable energy requires not only technical adaptation but also significant cultural and behavioral transformation within the workforce. As highlighted by Hidayat and Galib [10], adaptive work culture encompasses an organization's ability to foster flexibility, openness to change, and collective readiness during periods of transition. Similarly, Mahmud and Tesniwati [11] emphasized that work environments characterized by innovation, continuous learning, and acceptance of new ideas are more likely to achieve successful implementation of modern systems. In this study, indicators of adaptive work culture are derived from Mahmud and Tesniwati [11], including work flexibility (the ability to shift roles or methods as needed), openness to change (receptiveness to new ideas and processes), learning ability (engagement in training and skill development), and participation in innovation (active involvement in adopting and improving new technologies).

The Work Performance of Smart Energy Solar Cell Utilization variable, on the other hand, represents the effectiveness of employees in managing, applying, and optimizing the solar energy system that has been installed at the tofu factory. This includes their ability to ensure the consistent performance of the technology and maximize its intended benefits, such as reducing energy costs, improving production stability, and supporting environmentally friendly practices. The successful utilization of solar power systems, as discussed by Mekhilef et al. [7], requires not only access to the technology but also the operational knowledge and maintenance skills necessary to keep the systems functional over time. Lefore et al. [8] and Alam et al. [9] further asserted that without proper workforce training and engagement, the full potential of solar technologies remains underutilized. Accordingly, this study measures the performance of solar energy utilization through several key indicators: production outcomes (output quality and quantity achieved while using the solar system), energy efficiency (extent to which solar power replaces conventional energy use), system maintenance (routine care and troubleshooting of the solar panels and related components), and technical understanding (employee knowledge and familiarity with the system's functions and troubleshooting mechanisms). These performance metrics aim to capture both the tangible results and the underlying operational competencies required for sustainable use of solar energy in tofu production.

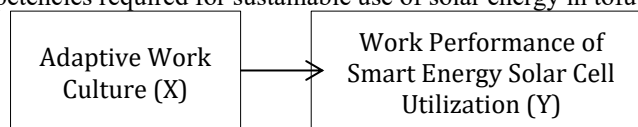


Figure 1. Research Framework

H1: Adaptive Work Culture has a positive and significant effect on Work Performance of Smart Energy Solar Cell Utilization

Research Design and Method

This study adopts a quantitative approach using a survey method [12], aiming to examine the influence of adaptive work culture on the performance of smart energy solar cell utilization in the tofu industry. The quantitative approach is chosen as it allows the measurement of relationships between variables using numerical data and statistical analysis. The research design is explanatory, aiming to explain the causal relationship between adaptive work culture and technological performance based on empirical data collected

in the field. The research subjects include 30 employees from a tofu factory located in Bekasi that has implemented a Smart Energy Solar Cell system. Respondents are selected purposively, individuals directly involved in the operation or maintenance of the solar energy system.

The research instrument consists of a closed-ended questionnaire constructed based on theoretical indicators of each variable. The questionnaire uses a five-point Likert scale ranging from “Strongly Disagree” to “Strongly Agree” to assess respondents’ perceptions and experiences regarding adaptive work culture and its impact on technology performance. In addition to surveys, the researcher also conducts direct observation of the production process and management of the solar energy system on site. In-depth interviews with production managers and technicians are also carried out to strengthen the survey results and provide additional context to the quantitative data (data triangulation).

Data Analysis Techniques

The collected data are analyzed using descriptive and inferential statistical analysis. Descriptive analysis is used to describe the characteristics of respondents and the distribution of scores for each variable indicator. Inferential analysis is performed using simple linear regression through the SmartPLS 4 application to test the influence of adaptive work culture on the work performance of solar energy utilization. Validity is tested through outer loading, while reliability is tested using composite reliability and Cronbach’s alpha values. Multicollinearity is tested to ensure that there is no high correlation among indicators that might disrupt the regression results, with attention to Variance Inflation Factor (VIF) values. The R Square value is used to determine how much influence adaptive work culture has on the performance of smart energy solar cell utilization in the tofu industry. Then the p value is used to analyze the significant effect of X to Y [13].

3. RESULTS AND DISCUSSION

Data Analysis

Table 1. Validity Test

No.	Item	Loading	Remark
Adaptive Work Culture (X)			
X.1	Work flexibility	0.783	Valid
X.2	Openness to change	0.802	Valid
X.3	Learning ability	0.776	Valid
X.4	Participation in innovation	0.810	Valid
X.5	Responsiveness to new systems	0.768	Valid
X.6	Readiness for transformation	0.799	Valid
Work Performance of Smart Energy Solar Cell Utilization (Y)			
Y.1	Production outcomes	0.825	Valid
Y.2	Energy efficiency	0.791	Valid
Y.3	System maintenance	0.804	Valid
Y.4	Technical understanding	0.788	Valid
Y.5	Responsiveness to technical issues	0.775	Valid
Y.6	Operational accuracy	0.809	Valid

Source: SmartPLS Output, 2025

Table 2. Reliability Test

Variable	Cronbach’s Alpha	Remark
Adaptive Work Culture (X)	0.865	Reliable
Work Performance of Smart Energy Solar Cell Utilization (Y)	0.851	Reliable

Source: Researcher’s Data Processing, 2025

Table 3. Multicollinearity Test

Variable	Tolerance	VIF	Remark
Adaptive Work Culture	0.764	1.309	No multicollinearity

Source: Researcher's Data Processing, 2025

Table 5. Coefficient of Determination

Model	R	R Square	Adjusted R Square	Std. Error
1	0.702	0.493	0.479	0.42157

Source: Researcher's Data Processing, 2025

The results of the analysis demonstrate that all items under the variables Adaptive Work Culture and Work Performance of Smart Energy Solar Cell Utilization are valid, as each item shows a loading factor above 0.70, indicating strong indicator reliability (Table 1). Furthermore, both variables meet the reliability criteria with Cronbach's Alpha values of 0.865 and 0.851 respectively, confirming internal consistency (Table 2). The multicollinearity test also shows acceptable results with a tolerance of 0.764 and a VIF of 1.309, indicating no multicollinearity issues among predictors (Table 3). Lastly, the coefficient of determination (R Square) is 0.493, meaning that 49.3% of the variance in work performance related to solar cell utilization can be explained by adaptive work culture, which reflects a substantial influence (Table 5). These findings suggest that adaptive work culture plays a significant and positive role in enhancing employee performance in the utilization of smart solar energy technology.

Regression

Table 6. Hypothesis Testing

Model	Beta	t	Sig. (p-value)
Adaptive Work Culture (X) -> Work Performance of Smart Energy Solar Cell Utilization (Y)	0.701	6.174	0.000

Source: Researcher's Data Processing, 2025

The results of the hypothesis testing show that the Beta coefficient for the relationship between Adaptive Work Culture (X) and Work Performance of Smart Energy Solar Cell Utilization (Y) is 0.701, with a t-value of 6.174 and a p-value of 0.000, which is less than the significance level of 0.05. This indicates that there is a significant positive relationship between adaptive work culture and the performance of solar energy utilization in the tofu industry. As the adaptive work culture improves, so does the performance in utilizing smart energy solar cells. Therefore, H1 is accepted, affirming that a strong adaptive work culture enhances the performance of smart energy solar cell systems in this context.

Discussion

The results of this study confirm a positive and significant relationship between Adaptive Work Culture (X) and Work Performance of Smart Energy Solar Cell Utilization (Y) in the context of tofu production. This finding highlights the critical role that organizational and behavioral readiness play in the successful integration of modern energy technologies such as solar cells, particularly in traditionally low-tech, small-scale industries. The strength of the model is indicated by a coefficient of determination ($R^2 = 0.493$), suggesting that nearly half of the variance in performance outcomes can be explained by variations in adaptive work culture. This supports the assertion that beyond technological factors, human adaptability remains a fundamental enabler of effective renewable energy adoption.

In this study, all indicators for Adaptive Work Culture yielded high validity loadings, such as participation in innovation ($X.4 = 0.810$), openness to change ($X.2 = 0.802$), and readiness for transformation ($X.6 = 0.799$). These results reflect that employees who are responsive to innovation and willing to embrace change are more capable of ensuring the smooth operation of solar energy systems in tofu production. This is consistent with Hidayat and Galib [10], who demonstrated that adaptive behavior significantly influences operational alignment during organizational transitions, and that a flexible culture fosters more effective responses to new technological systems.

Likewise, the work performance indicators related to Smart Energy Solar Cell Utilization also demonstrated high factor loadings, including production outcomes ($Y.1 = 0.825$), system maintenance ($Y.3 = 0.804$), and operational accuracy ($Y.6 = 0.809$). These data suggest that an adaptive workforce contributes directly to the improved performance of solar cell systems, enhancing not only energy efficiency but also production reliability. Mekhilef et al. [7] echoed these findings by emphasizing that although solar power offers potential cost savings and environmental benefits, adoption in small industries is often hindered by a lack of familiarity and technical capacity, both of which can be overcome with a workforce that is trained, adaptable, and innovation-oriented.

Moreover, Lefore et al. [8] emphasized that the success of solar technologies is frequently limited not by the hardware itself, but by gaps in workforce planning, training, and maintenance strategies. Even in cases where the technology is readily available, performance outcomes depend on whether users are adequately prepared to manage and sustain its use. This underscores the importance of high-scoring indicators in this study such as learning ability ($X.3 = 0.776$) and responsiveness to new systems ($X.5 = 0.768$). These adaptive traits enhance employee engagement and technical proficiency, leading to more reliable system maintenance and higher productivity.

Behavioral readiness also plays a significant role in influencing the intention to adopt solar energy. As Alam et al. [9] observed, the decision of small-scale users to adopt renewable energy is heavily shaped by perceived benefits and behavioral factors. In this study, the tofu industry workforce demonstrated that when workers are encouraged to adopt a mindset open to change and learning, their work performance improves substantially. This reinforces the notion that adaptive culture is not a passive attribute, but a strategic asset for achieving technological and environmental goals.

Additionally, Qamar et al. [6] highlighted that small-scale enterprises often face barriers to adopting renewable technologies due to limited resources and operational capacity. This makes it even more crucial for such industries to leverage internal strengths, particularly adaptive work culture as a compensating factor. By cultivating an environment that encourages flexibility, innovation, and continuous learning, enterprises can better overcome financial and technical limitations in the pursuit of sustainability.

In line with these findings, Mahmud and Tesniwati [11] argued that adaptive work practices are directly linked to enhanced organizational performance in the face of digital and technological transformation. Their research showed that success in adopting new systems is closely tied to an organization's ability to foster cultures that embrace change and encourage innovation. This aligns directly with the observed effects in the tofu industry, where the integration of solar cell systems succeeded most when supported by a workforce exhibiting adaptive behaviors.

4. CONCLUSION

The results of this study indicate that adaptive work culture has a significant and positive influence on the performance of Smart Energy Solar Cell utilization in the tofu industry. Employees who demonstrate flexibility, openness to change, learning ability, and active participation in innovation contribute more effectively to the operation, maintenance, and optimization of solar energy systems. This finding underscores the importance of aligning technological implementation with human adaptability, particularly in small-scale, traditional industries where new technologies are not easily adopted without adequate workforce engagement and preparedness.

Based on these findings, it is recommended that tofu industry stakeholders prioritize developing an adaptive organizational culture by investing in regular training, promoting open communication about change, and encouraging innovative behavior among employees. Government and energy policy makers are also encouraged to support MSMEs with capacity-building programs that integrate technical skill development with cultural adaptation strategies. Doing so will not only enhance the performance of renewable energy systems but also contribute to the broader goals of sustainability and energy efficiency in local industries.

REFERENCES

- [1] Ginting, Elisabeth, Khamidah, Rinaldi, Ambarsari, and Antarlina, "The nutritional and economic potential of tofu dreg (okara) and its utilization for high protein food products in Indonesia," *J. Agric. Food Res.*, vol. 16, p. 101175, 2024.
- [2] Lubis, Sintawardani, Hamidah, Astuti, and Dwiartama, "Sustainability Assessment of Small-Scale Tofu Industry Based on Water Resource Case Study of Giriharja Hamlet, Indonesia," *Sanit. Value Chain*, vol. 5, no. 2, pp. 55–70, 2021.
- [3] Sintawardani, Hamidah, Wulan, and Nilawati, "Recovery of energy and materials from small-scale tofu processing industries in Indonesia," in *Handbook of Research on Green, Circular, and Digital Economies as Tools for Recovery and Sustainability*, IGI Global Scientific Publishing, 2022, pp.

- 231–256.
- [4] Zheng, Regenstein, Teng, and Li, “Tofu products: A review of their raw materials, processing conditions, and packaging,” *Compr. Rev. Food Sci. Food Saf.*, vol. 19, no. 6, pp. 3683–3714, 2020.
 - [5] Rani, Suresh, Kapula, Akram, Hemalantha, and Soni, “IoT based smart solar energy monitoring systems,” *Mater. Today Proc.*, vol. 80, no. 1, pp. 3540–3545, 2023.
 - [6] Qamar, Shoaib, M. Ahmad, B. Oryani, and Q. Zhang, “Solar energy technology adoption and diffusion by micro, small, and medium enterprises: sustainable energy for climate change mitigation,” *Environ. Sci. Pollut. Res.*, vol. 29, no. 3, pp. 49385–49403, 2022.
 - [7] Mekhilef, Saidur, and Safari, “A review on solar energy use in industries,” *Renew. Sustain. energy Rev.*, vol. 15, no. 4, pp. 1777–1790, 2011.
 - [8] Lefore, Closas, and Schmitter, “Solar for all: A framework to deliver inclusive and environmentally sustainable solar irrigation for smallholder agriculture,” *Energy Policy*, vol. 154, no. 1, p. 112313.
 - [9] Alam, Hashim, Rashid, Ahsan, and Ismail, “Small-scale households renewable energy usage intention: Theoretical development and empirical settings,” *Renew. energy*, vol. 68, no. 1, pp. 255–263, 2014.
 - [10] Hidayat and Galib, “Pengaruh Perilaku Adaptif Dan Budaya Organisasi Pada Perusahaan Keluarga Terhadap Kepuasan Kerja Karyawan Melalui Suksesi Kepemimpinan Sebagai Variabel Intervening,” *Akmen J. Ilm.*, vol. 19, no. 2, pp. 120–131, 2022.
 - [11] Mahmud and Tesniwati, “Peningkatan kinerja melalui transformasi digital layanan publik kepabeanaan yang diperkuat dengan budaya dan pola kerja adaptif,” *J. Ilm. Ekon. Bisnis*, vol. 28, no. 2, pp. 161–182, 2023.
 - [12] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Bandung: Alfabeta, 2019.
 - [13] I. Ghozali and H. Latan, *Partial Least Squares: Konsep, Teknik, dan Aplikasi Menggunakan Program SmartPLS 3.0*. Semarang: BP Undip, 2020.