West Science Interdisciplinary Studies
Vol. 03, No. 10, October and 2025: pp. 1932-1940

The Impact of Environmental Uncertainty and Sense of Urgency on Individual Innovation in Bali's Renewable Energy Startups

Ratnawati Yuni Suryandari[1], Muhamad Ammar Muhtadi[2], Rival Pahrijal[3]
[1] Prodi Perencanaan Wilayah dan Kota, Fakultas Teknik, Universitas Esa Unggul, Jakarta and ratnawatiys@esaunggul.ac.id
[2] Universitas Nusa Putra and muhamadammarmuhtadi@gmail.com
[3] Universitas Nusa Putra and rivalpahrijal@gmail.com

ABSTRACT

This study investigates the impact of environmental uncertainty and sense of urgency on individual innovation in renewable energy startups in Bali. In dynamic and resource-constrained startup environments, the ability to innovate is critical for survival and competitiveness. A quantitative approach was employed, surveying 130 respondents from various renewable energy startups using a Likert-scale questionnaire. Data were analyzed using Structural Equation Modeling with Partial Least Squares (SEM-PLS 3) to test hypothesized relationships. The results indicate that both environmental uncertainty ($\beta = 0.342$, $p < 0.001$) and sense of urgency ($\beta = 0.540$, $p < 0.001$) significantly influence individual innovation. Furthermore, sense of urgency partially mediates the effect of environmental uncertainty on innovation, highlighting its role as a psychological catalyst that translates external pressures into actionable innovative behaviors. The findings provide theoretical contributions by integrating contingency theory and self-determination theory, and offer practical implications for startup managers and policymakers seeking to foster innovation in uncertain renewable energy markets.

Keywords: *Environmental Uncertainty, Sense of Urgency, Individual Innovation, Renewable Energy Startups, Bali.*

1. INTRODUCTION

The renewable energy sector has emerged as a critical component of sustainable development strategies worldwide, driven by the urgent need to reduce greenhouse gas emissions and address climate change. In Indonesia, and particularly in Bali, renewable energy startups are gaining traction as innovative actors aiming to provide alternative energy solutions that are environmentally friendly and economically viable. However, the dynamic and unpredictable nature of the energy market—characterized by fluctuating energy prices, evolving government policies, technological advancements, and competitive pressures—creates a high level of environmental uncertainty for these startups [1]. Such uncertainty presents both challenges and opportunities for entrepreneurs striving to maintain a competitive edge through innovation.

Innovation at the individual level is a key determinant of organizational success in the context of startups, where resources are limited, and decision-making is agile [2]. Individual innovation refers to the generation, promotion, and implementation of novel ideas, processes, or products by employees or founders that contribute to organizational performance. In the renewable energy domain, the ability to innovate is often influenced by external factors such as regulatory shifts, market volatility, and technological disruptions, as well as internal factors such as motivation, creativity, and the perceived urgency of responding to challenges [3].

The concept of sense of urgency is particularly relevant in highly uncertain environments. According to [4], sense of urgency represents the perception of the critical need to act promptly and decisively, which can stimulate proactive behavior and foster innovation. In startups, a heightened sense of urgency can encourage individuals to take calculated risks, implement novel solutions, and

adapt rapidly to changing circumstances. Conversely, a lack of urgency may result in delayed decision-making, missed opportunities, and stagnation in innovative activities.

While prior studies have explored the influence of environmental uncertainty on organizational innovation, limited research has examined how environmental uncertainty interacts with sense of urgency to shape individual innovation in the context of renewable energy startups, particularly in emerging markets like Bali. Considering the unique characteristics of Bali's renewable energy sector—marked by small- and medium-scale startups, reliance on local resources, and interaction with government and tourism stakeholders—understanding these relationships is essential for designing strategies that enhance innovation performance.

The current study aims to fill this research gap by investigating the following research question: How do environmental uncertainty and sense of urgency affect individual innovation in renewable energy startups in Bali? Specifically, this study examines the direct impact of environmental uncertainty on individual innovation and explores the mediating role of sense of urgency. A quantitative approach is adopted, using survey data from 130 respondents across various renewable energy startups in Bali, measured with a Likert-scale instrument and analyzed using Structural Equation Modeling with Partial Least Squares (SEM-PLS 3).

By addressing these questions, this study contributes to the literature in several ways. First, it provides empirical evidence on the role of environmental uncertainty in shaping individual innovation in a renewable energy context. Second, it highlights the importance of sense of urgency as a psychological mechanism that drives proactive innovation behaviors. Finally, the findings offer practical implications for startup founders, managers, and policymakers seeking to cultivate innovation in high-uncertainty environments, thereby promoting sustainable energy solutions in Bali and similar emerging markets.

2. LITERATURE REVIEW

2.1 Environmental Uncertainty

Environmental uncertainty refers to the unpredictability and complexity of external conditions that affect organizational decision-making and performance, encompassing factors such as market volatility, regulatory changes, technological disruption, and competitive intensity [5]. In the context of startups, particularly in the renewable energy sector, environmental uncertainty is often high due to rapidly evolving technologies, fluctuating energy demands, government policy shifts, and emerging competition. Studies have shown that high environmental uncertainty can both stimulate and constrain innovation: on one hand, it acts as a catalyst for creativity by forcing organizations and individuals to explore novel solutions to unforeseen challenges [6]; on the other hand, excessive uncertainty may induce risk aversion, delay decision-making, and reduce innovation performance [7]. Environmental uncertainty is typically categorized into three dimensions: state uncertainty, effect uncertainty, and response uncertainty [8]. State uncertainty refers to ambiguity regarding the current conditions of the environment, such as unclear market demand or shifting energy regulations; effect uncertainty concerns the unpredictability of the outcomes of organizational actions; and response uncertainty relates to the lack of clarity about how competitors, customers, or stakeholders will react to strategic initiatives. Understanding these dimensions is crucial

for renewable energy startups, as they operate in a sector characterized by both technological and institutional flux.

2.2 Sense of Urgency

Sense of urgency is defined as the perception that immediate action is necessary to address critical challenges or seize opportunities [4], and in both organizational and individual contexts, a heightened sense of urgency motivates proactive behavior, accelerates decision-making, and stimulates innovation. It can be intrinsic—arising from personal motivation, career aspirations, or commitment to organizational goals—or extrinsic, triggered by market pressures, regulatory deadlines, or stakeholder expectations. Research indicates that sense of urgency is particularly effective in uncertain environments, as it directs attention, allocates cognitive resources, and reduces procrastination, thereby enabling timely innovation [9]. For startups, cultivating a sense of urgency among founders and employees enhances responsiveness to changing conditions, accelerates product development, and facilitates adoption of emerging technologies. In renewable energy startups, where market conditions, funding availability, and technological advancements are highly dynamic, a sense of urgency ensures that individual innovation is not only generated but also implemented effectively.

2.3 Individual Innovation

Individual innovation refers to the process by which employees or entrepreneurs generate, promote, and implement novel ideas, processes, or products that contribute to organizational outcomes [2], and unlike organizational-level innovation, which emphasizes collective processes and structural capabilities, individual innovation focuses on personal creativity, initiative, and problem-solving capacity. Key drivers include cognitive abilities, intrinsic motivation, risk-taking propensity, and exposure to challenging situations [3]. In high-uncertainty environments, individual innovation is particularly critical because startups often rely on the ingenuity of their personnel rather than established processes or extensive resources, and employees who perceive environmental threats or opportunities are more likely to engage in innovative behaviors, especially when supported by a culture that encourages experimentation and tolerates failure.

2.4 Theoretical Foundation

This study draws on Contingency Theory and Self-Determination Theory (SDT) as theoretical foundations. Contingency Theory posits that organizational outcomes, including innovation, are contingent upon the alignment between environmental conditions and internal processes [10]. In high-uncertainty environments, the need for adaptive strategies and individual initiative becomes paramount. SDT provides insights into the motivational mechanisms driving individual innovation, emphasizing the role of intrinsic motivation, autonomy, and perceived competence in promoting creative behaviors [11]. Sense of urgency can be seen as an extrinsic motivator that interacts with environmental cues to enhance individual innovation. Based on the literature, the following hypotheses are proposed:

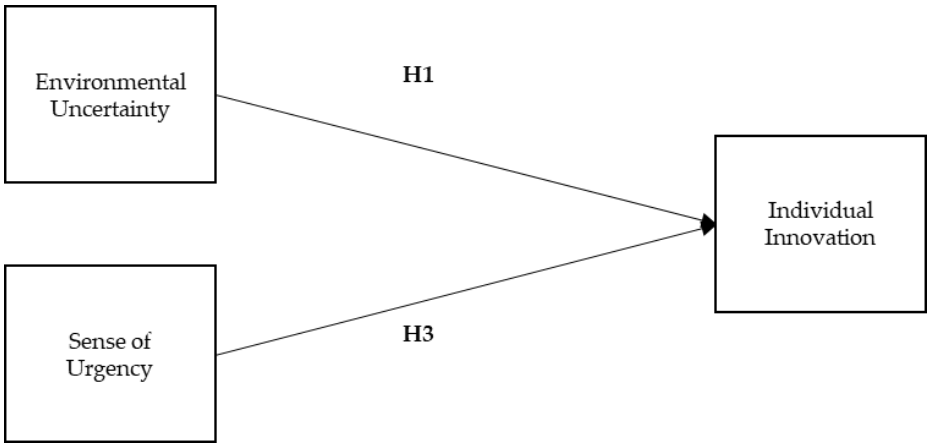

Figure 1. Conceptual Framework

3. METHODS

This study employs a quantitative research design to examine the effects of environmental uncertainty and sense of urgency on individual innovation in renewable energy startups in Bali. Quantitative research allows for systematic measurement and analysis of variables using structured instruments, facilitating the identification of patterns, relationships, and causal effects among constructs [12]. A cross-sectional survey approach was used, collecting data at a single point in time from individuals actively involved in renewable energy startups, including companies engaged in solar, wind, biogas, and micro-hydro energy solutions. The accessible population consisted of approximately 200 employees, founders, and key personnel, from which 130 respondents were selected using purposive sampling to ensure relevant experience and active involvement in decision-making or operational activities related to innovation. This sample size is sufficient for Structural Equation Modeling with Partial Least Squares (SEM-PLS 3), which is recommended for moderate-complexity models with 100–200 observations [13].

Data were collected using a structured questionnaire based on validated scales from prior literature. Environmental Uncertainty (EU) was adapted from [8], [14] and measured with six items covering state, effect, and response uncertainty. Sense of Urgency (SU) was adapted from [4], [9] and measured with five items assessing the perception of the critical need to act promptly. Individual Innovation (II) was adapted from [2], [3] and measured with six items assessing idea generation, promotion, and implementation. All items used a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The questionnaire was reviewed by academic experts and pilot-tested with 15 respondents from similar startups to ensure clarity, relevance, and reliability. Data collection was conducted over a four-week period through email, WhatsApp, and in-person visits, with confidentiality assured to encourage honest responses. Responses were coded and entered into SPSS for preliminary screening before being imported into SmartPLS 3 for SEM analysis.

Data analysis was conducted using SEM-PLS 3, suitable for exploratory and predictive research involving latent variables and small-to-moderate sample sizes [15]. The analysis included two main stages: measurement model assessment (outer model) and structural model assessment (inner model). For the measurement model, convergent validity was evaluated using factor loadings (>0.70) and Average Variance Extracted (AVE >0.50), while reliability was assessed using Composite Reliability (CR >0.70) and Cronbach's alpha (>0.70). The structural model was evaluated through path coefficients estimating relationships among environmental uncertainty, sense of urgency, and individual innovation, along with significance testing via bootstrapping with 5,000 resamples to obtain t-values and p-values. Additionally, the model's explanatory power was assessed using R^2, effect size (f^2), and predictive relevance (Q^2) through blindfolding procedures, providing a

comprehensive understanding of the relationships among constructs in the context of renewable energy startups in Bali.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

Descriptive statistics provide an overview of the characteristics of the respondents and their responses, offering insights into the perceptions of environmental uncertainty, sense of urgency, and individual innovation among participants in renewable energy startups in Bali. The study surveyed 130 respondents, comprising founders, co-founders, and employees directly involved in operational or managerial activities. Of these, 55% were founders or co-founders, and 45% were employees engaged in innovation or project execution. Respondents ranged in age from 22 to 45 years, with an average age of 32, reflecting a predominantly young and entrepreneurial workforce. The average work experience in startups was 4.5 years, ranging from 1 to 10 years, indicating a mix of early-career professionals and experienced entrepreneurs capable of driving innovation. In terms of education, 72% held at least a bachelor's degree, 18% had a master's degree, and 10% had vocational or associate-level qualifications.

Respondents reported a moderate to high perception of environmental uncertainty, with a mean score of 3.78 (SD = 0.62), reflecting the dynamic and unpredictable nature of the renewable energy sector in Bali. Specifically, state uncertainty averaged 3.82 (SD = 0.61), effect uncertainty 3.74 (SD = 0.63), and response uncertainty 3.79 (SD = 0.60). The sense of urgency was generally high, with an overall mean of 4.12 (SD = 0.58), including time-sensitive awareness (4.15, SD = 0.56), proactive mindset (4.09, SD = 0.60), and motivation for immediate action (4.11, SD = 0.59), indicating that participants are motivated to respond quickly to challenges and opportunities. Individual innovation was reported at a moderate level (mean = 3.85, SD = 0.65), with subdimensions of idea generation (3.88, SD = 0.64), idea promotion (3.79, SD = 0.66), and idea implementation (3.87, SD = 0.63), suggesting that while employees and founders are proactive, constraints such as limited funding, technology access, and market readiness may influence the extent of innovative activities.

4.2 Measurement Model Assessment

The measurement model evaluates the reliability and validity of the constructs before testing the structural relationships in SEM-PLS 3, ensuring that the indicators accurately measure their respective latent variables and that the constructs are distinct from each other. Convergent validity was assessed using factor loadings and Average Variance Extracted (AVE), while reliability was evaluated using Cronbach's alpha and Composite Reliability (CR), with the results of the measurement model presented in Table 1.

Table 1. Measurement Model

Variable	Code	Loading Factor	Cronbach's Alpha	Composite Reliability	Average Variant Extracted
Environmental Uncertainty	EU.1	0.854	0.887	0.922	0.748
	EU.2	0.923			
	EU.3	0.894			
	EU.4	0.784			
Sense of Urgency	SU.1	0.871	0.868	0.910	0.718
	SU.2	0.890			
	SU.3	0.860			
	SU.4	0.763			
Individual Innovation	IN.1	0.849	0.903	0.928	0.721
	IN.2	0.851			
	IN.3	0.874			

IN.4	0.834
IN.5	0.836

Source: Data Processing Results (2025)

All factor loadings exceeded the recommended threshold of 0.70, indicating strong indicator reliability. The Cronbach's alpha values ranged from 0.868 to 0.903, and Composite Reliability ranged from 0.910 to 0.928, exceeding the minimum requirement of 0.70. The Average Variance Extracted (AVE) values were all above 0.70, confirming adequate convergent validity. These results indicate that the constructs—Environmental Uncertainty, Sense of Urgency, and Individual Innovation—are measured reliably by their respective indicators.

Discriminant validity was assessed to ensure that each construct is empirically distinct from the others. The Fornell-Larcker criterion was applied, comparing the square root of the AVE for each construct with its correlations with other constructs. Table 2 presents the discriminant validity results.

Table 2. Discriminant Validity

	EU	IN	SU
Environmental Uncertainty	0.865		
Individual Innovation	0.601	0.849	
Sense of Urgency	0.479	0.704	0.848

Source: Data Processing Results (2025)

The square roots of AVE for all constructs (0.865, 0.849, 0.848) are greater than the correlations between constructs, confirming discriminant validity. This demonstrates that each construct captures unique variance not explained by other constructs, ensuring that Environmental Uncertainty, Sense of Urgency, and Individual Innovation are empirically distinct.

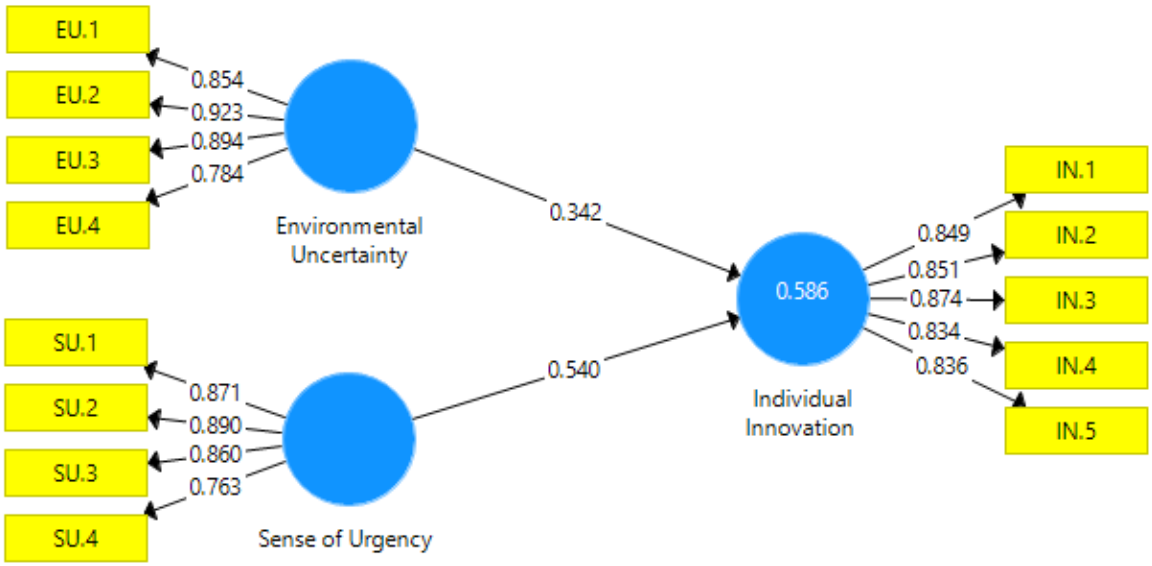

Figure 2. Model Results

Source: Data Processed by Researchers, 2025

4.3 Structural Model Assessment

The structural model examines the relationships between Environmental Uncertainty, Sense of Urgency, and Individual Innovation. This stage evaluates the predictive accuracy of the model, the significance of path coefficients, and the overall model fit. Model fit was assessed using multiple indices, including Standardized Root Mean Square Residual (SRMR), d_ULS, d_G, Chi-Square, and Normed Fit Index (NFI). Table 3 summarizes the results.

Table 3. Model Fit Results Test

	Saturated Model	Estimated Model
SRMR	0.073	0.073
d_ULS	0.480	0.480
d_G	0.214	0.214
Chi-Square	151.314	151.314
NFI	0.865	0.865

Source: Process Data Analysis (2025)

The SRMR value of 0.073 is below the recommended threshold of 0.08, indicating a good fit between the model and the observed data, while the Chi-Square value and NFI of 0.865 suggest that the estimated model adequately represents the data, confirming that the structural model is appropriate for hypothesis testing. The explanatory power of the model was further assessed using R^2 and Q^2 values, as shown in Table 4.

Table 4. Coefficient Model

	R Square	Q2
Individual Innovation	0.586	0.579

Source: Data Processing Results (2025)

R^2 value of 0.586 indicates that Environmental Uncertainty and Sense of Urgency jointly explain 58.6% of the variance in Individual Innovation, which is substantial in social science research, while the Q^2 value of 0.579 confirms that the model has strong predictive relevance, suggesting that the constructs reliably predict innovation behavior in renewable energy startups; hypothesis testing was conducted using bootstrapping with 5,000 resamples to assess the significance of path coefficients, with the results presented in Table 5.

Table 5. Hypothesis Testing

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values
Environmental Uncertainty -> Individual Innovation	0.342	0.346	0.085	4.016	0.000
Sense of Urgency -> Individual Innovation	0.540	0.540	0.076	7.129	0.000

Source: Process Data Analysis (2025)

H1: Environmental Uncertainty → Individual Innovation is supported, as the path coefficient ($\beta = 0.342$, $t = 4.016$, $p < 0.001$) is positive and statistically significant, indicating that higher perceived environmental uncertainty motivates individuals to engage in innovative behaviors, while H2: Sense of Urgency → Individual Innovation is also supported, with a path coefficient ($\beta = 0.540$, $t = 7.129$, $p < 0.001$) that is positive and significant, confirming that a stronger sense of urgency directly enhances individual innovation.

Discussion

The findings of this study provide significant insights into the mechanisms through which environmental uncertainty and sense of urgency influence individual innovation in renewable energy startups in Bali, integrating empirical results with theoretical perspectives and practical implications. The study confirms that environmental uncertainty positively affects individual innovation, aligning with contingency theory, which posits that organizational and individual behaviors must adapt to the demands of a dynamic environment [10]. In renewable energy startups,

uncertainty arises from volatile market demand, rapidly evolving technologies, and fluctuating regulatory frameworks, and individuals perceive uncertainty not merely as a risk but as an opportunity to innovate, prompting proactive idea generation and implementation.

This finding is consistent with previous research by [14], [16], who noted that uncertainty in technological and market conditions can stimulate creativity by forcing individuals to develop adaptive solutions. For Bali's renewable energy startups, environmental uncertainty encourages experimentation with novel energy solutions, optimization of existing processes, and the adoption of creative business models to meet emerging demands. The results further indicate that sense of urgency has a strong positive effect on individual innovation, suggesting that urgency is a critical motivator in high-uncertainty environments. According to [4], urgency mobilizes attention, accelerates decision-making, and stimulates rapid implementation of ideas, ensuring that innovative initiatives are not delayed and that opportunities are captured promptly.

The stronger effect of urgency compared to environmental uncertainty highlights the role of psychological drivers in innovation. While uncertainty provides the stimulus, urgency translates perception into action, motivating employees and founders to respond actively to market and regulatory pressures. In Bali's renewable energy startups, this combination ensures that individuals not only generate ideas but also advocate for and implement innovative solutions, enabling their firms to remain competitive, adaptive, and capable of leveraging opportunities in a dynamic and uncertain environment.

Theoretical Implications

This study contributes to the literature in several ways by extending contingency theory to the context of renewable energy startups in emerging markets, highlighting how individuals adapt their innovative behavior to uncertain environments, integrating self-determination theory by demonstrating that sense of urgency serves as an extrinsic motivator that interacts with environmental cues to enhance individual innovation, and providing empirical evidence on the mediating role of urgency, suggesting that psychological mechanisms are critical in converting external pressures into innovative behavior, a dimension often overlooked in prior studies focusing solely on organizational-level innovation.

Practical Implications

For practitioners and policymakers, the findings offer actionable insights, suggesting that startup managers should proactively monitor environmental changes and communicate their implications to team members to enhance awareness and urgency, cultivate a sense of urgency through clear goals, deadlines, and incentive systems to accelerate the translation of ideas into tangible innovations, and that policymakers can support startups by providing timely information, flexible regulations, and incentives to foster innovation adoption, ensuring that the renewable energy sector in Bali remains dynamic and sustainable.

CONCLUSION

This study confirms that environmental uncertainty and sense of urgency are critical determinants of individual innovation in renewable energy startups in Bali. Environmental uncertainty acts as a stimulus, encouraging individuals to develop creative solutions to navigate unpredictable market and regulatory conditions, while sense of urgency has a stronger impact, functioning as a motivational mechanism that converts awareness of environmental pressures into proactive innovation behaviors. Additionally, the mediating role of urgency demonstrates that psychological factors amplify the influence of external uncertainty on innovation outcomes.

From a theoretical perspective, the study extends contingency theory and self-determination theory by highlighting how environmental conditions interact with motivational mechanisms to drive individual innovation in entrepreneurial settings. Practically, the findings suggest that startup

managers should cultivate a culture of urgency, set clear targets, and encourage rapid decision-making, while policymakers should provide timely regulatory guidance and support to stimulate innovation. Overall, fostering both environmental awareness and a sense of urgency enables renewable energy startups to generate, promote, and implement innovative ideas effectively, enhancing their adaptability, competitiveness, and contribution to sustainable energy development in Bali.

REFERENCES

[1] G. F. Davis, *Managed by the markets: How finance re-shaped America*. OUP Oxford, 2009.
[2] T. M. Amabile, "Creativity in Context," *Westview Press*, 1996.
[3] X. Zhang & Bartol K. M., "Linking empowering leadership and employee creativity: The influence of psychological empowerment, intrinsic motivation, and creative process engagement," *Academy of Management Journal*, 2010, doi: https://doi.org/10.5465/amj.2010.48037118.
[4] J. P. Kotter, "A Sense of Urgency," *Harvard Business Press*, 2008.
[5] F. J. Milliken, "Three types of perceived uncertainty about the environment: State, effect, and response uncertainty," *Academy of Management Review*, 1987, doi: https://doi.org/10.5465/amr.1987.4306502.
[6] H. I. Ansoff, "Strategic Management," *Palgrave Macmillan*, 1979.
[7] G. G. Dess & Beard D. W., "Dimensions of organizational task environments," *Adm Sci Q*, 1984, doi: https://doi.org/10.2307/2393080.
[8] R. B. Duncan, "Characteristics of organizational environments and perceived environmental uncertainty," *Adm Sci Q*, 1972, doi: https://doi.org/10.2307/2392145.
[9] J. P. Meyer Becker T. E. & Vandenberghe C., "Employee commitment and motivation: A conceptual analysis and integrative model," *Journal of Applied Psychology*, 2011, doi: https://doi.org/10.1037/a0023183.
[10] L. Donaldson, "The Contingency Theory of Organizations," *Sage Publications*, 2001.
[11] R. M. Ryan and E. L. Deci, "Intrinsic and extrinsic motivations: Classic definitions and new directions," *Contemp Educ Psychol*, vol. 25, no. 1, pp. 54–67, 2000.
[12] J. W. Creswell and J. D. Creswell, *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications, 2017.
[13] J. F. Hair, C. M. Ringle, and M. Sarstedt, *A Primer on Partial Least Squares Structural Equation Modelling (PLS-SEM). 2e Edition*. USA: SAGE Publications, 2017.
[14] J. J. P. Jansen Van Den Bosch F. A. J. & Volberda H. W., "Exploratory innovation, exploitative innovation, and performance: Effects of organizational antecedents and environmental moderators," *Manage Sci*, 2006, doi: https://doi.org/10.1287/mnsc.1060.0576.
[15] J. Hair and A. Alamer, "Partial Least Squares Structural Equation Modeling (PLS-SEM) in second language and education research: Guidelines using an applied example," *Research Methods in Applied Linguistics*, vol. 1, no. 3, p. 100027, 2022.
[16] M. Hughes Rigtering J. P. C. Covin J. G. Bouncken R. B. & Kraus S., "Innovative behaviour, trust and perceived workplace performance: Exploring the relationships among leaders and followers," *J Bus Res*, 2018, doi: https://doi.org/10.1016/j.jbusres.2018.06.024.