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Leveraging Stakeholder Engagement Dimensions for Solar Photovoltaic (PV) Project Success: A Case Study in Pahang, Malaysia

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Abstract
Purpose: The main aim of this study is to investigate the effect of stakeholder engagement dimensions on the success of Solar PV projects in Pahang
Design/methodology/approach: The study started with a qualitative phase to create a conceptual framework, followed by a survey of solar PV firms registered with SEDA. The survey data were analyzed using PLS-SEM to explore the relationships between different stakeholder engagement dimensions. RII Analysis was then used to rank the importance of each dimension and determine which factors most influenced the success of solar PV projects in Pahang.
Findings: The findings revealed that all stakeholder engagement dimensions—stakeholder relations, stakeholder communication, stakeholder learning, and stakeholder integration—positively and significantly contributed to the success of solar PV projects. Among these, stakeholder relations scored the highest, followed by stakeholder communication, stakeholder integration, and, finally, stakeholder learning.
Research limitations/implications: The study is limited by its focus on solar PV projects in Pahang, Malaysia, which may not apply to other regions. It involved a small sample size of 85 respondents, which might not capture the full diversity of the industry.
Practical implications: The determinants of stakeholder engagement dimensions will benefit renewable energy players and aid regulatory bodies in policy-making, supporting Malaysia's target to achieve a 70% renewable energy share of installed capacity by 2050.
Originality/value: This study focuses on how various aspects of stakeholder engagement influence the success of solar PV projects in Pahang, Malaysia. This topic has been underexplored in this context. It provides valuable insights for local firms and policymakers, utilizing advanced methods like PLS-SEM and RII Analysis to evaluate and rank these engagement factors.

Keywords: Solar photovoltaic (PV) project success, stakeholder engagement, stakeholder relations, stakeholder communication, stakeholders' learning, and stakeholder integration

Introduction
In recent years, the global solar photovoltaic (PV) industry has experienced significant growth. This is driven by decreasing costs, technological advancements, and increasing environmental awareness (IRENA, 2024). According to the International Renewable Energy Agency (IRENA), the global installed capacity for solar PV surpassed 1 terawatt (TW) in 2022, making it one of the fastest-growing renewable energy (RE) sources. It reported that solar PV could

provide up to 25% of the world's electricity by 2050, underscoring its critical role in transitioning to a low-carbon energy system (IEA,2023). The solar PV sector in Malaysia has also grown, with the government actively promoting renewable energy through various policies and incentives. In 2023, the National Energy Transition Roadmap (NETR) was launched, aiming to accelerate the energy transition and improve climate resilience. The NETR includes the Responsible Transition (RT) Pathway 2050, which seeks to shift Malaysia's energy systems from fossil fuel-based to greener and low-carbon systems. Malaysia is endowed with substantial renewable energy resources, with an estimated technical potential of nearly 290 gigawatts (GW), including 269 GW from solar PV alone. However, despite this potential, only a small fraction has been realized, with just over 9 GW of installed capacity, leaving more than 95% untapped.

Since 2011, solar PV has been the most promising segment of the Malaysian renewable energy landscape. With an installed capacity compound annual growth rate (CAGR) of 48%, Malaysia is expanding from 0.1 gigawatts (GW) to 2.6 GW by 2023 (NETR, 2023), making it a leader in solar energy in Southeast Asia. Malaysia has also established itself as a major international hub for solar PV component manufacturing, becoming a globally recognized player in the green energy industry. Six out of the world's ten largest solar PV companies operate in Malaysia, positioning the country as one of the top exporters in the global solar PV industry (SEDA, 2024). According to NETR (2023), renewable energy will constitute the majority share of installed capacity by 2050 to achieve 70% of the total generation mix. Figure 1 shows the projected installed capacity mix by 2050 from all energy sources available in Malaysia. Compared to hydro, bioenergy, oil, gas, and coal, the growth of solar PV is projected will significantly contribute by 58%, with 59 GW of installed capacity by 2050.

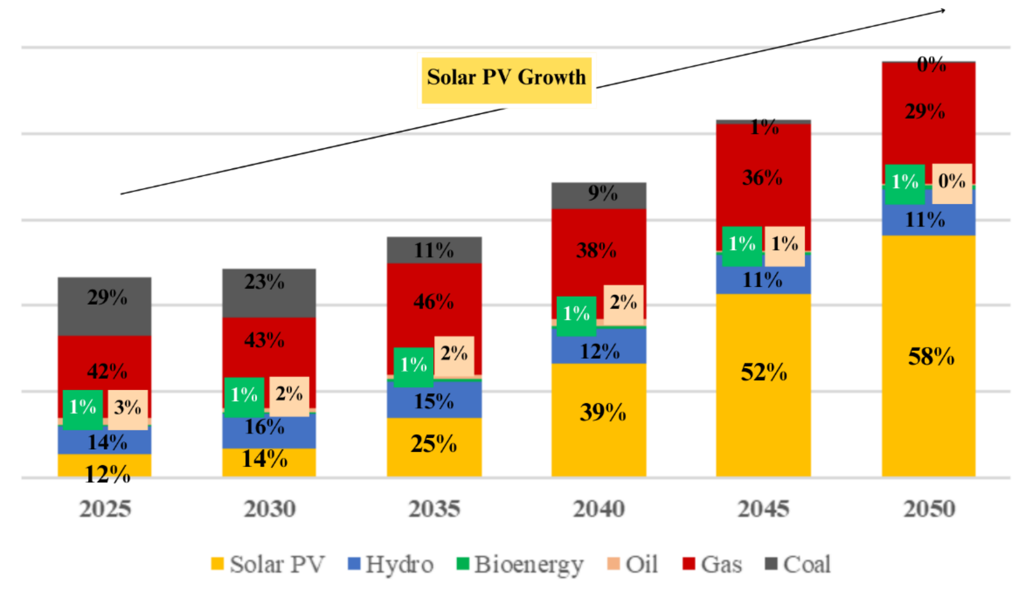

Figure 1: Projected Installed Capacity Mix 2050 (NETR, 2023)

In Pahang, the state government has been actively promoting sustainable electricity generation through solar energy for both domestic and commercial use. Notable projects include the UiTM Large Scale Solar (LSS) PV Solar Farm in Gambang, with a capacity of 50 MW, and the Solar Farm LSS3 in Pekan, with a capacity of 155 MW. Recently, a 2-gigawatt (2 GW) solar farm project has been introduced, which will involve the construction of ground-mounted solar arrays, floating solar farms, and battery energy storage systems (BESS) across multiple sites, including suitable lands, dams, and lakes throughout Pahang (The Star, 2023). According to the Energy Commission, the progress of the LSS project in Pahang for the first quarter of 2024 has reached 68%, with an installed capacity of 209.916 MW. However, despite the state government's commitment, challenges such as prolonged land acquisition processes, fragmented development approaches, and lengthy permitting procedures have hindered the potential of these LSS projects to significantly contribute to renewable energy efforts (NETR, 2023; Seetharaman et al., 2019; Hooi, 2018). These challenges underscore the need for streamlined solutions, particularly through enhanced stakeholder engagement. Effective stakeholder engagement can help address these issues by fostering better communication, collaboration, and coordination among all involved parties, thereby facilitating smoother project implementation and overcoming barriers to development.

Stakeholder engagement is widely recognized as a valuable strategy for aligning an organization's goals with a competitive edge, ultimately adding value to project success (PMI, 2021). In the context of RE projects, particularly solar PV projects, researchers have highlighted the limited utilization of stakeholder engagement practices among practitioners (Baudry et al., 2017; Kahla, 2017; Perlaviciute et al., 2021). Furthermore, there has been little research to assist solar PV firms and local state governments in adapting the tools and methods provided by stakeholder engagement research. Previous studies indicate a lack of decision-making frameworks and models applied to real-life problem-solving processes (Perlaviciute et al., 2021; Rühli et al., 2017; Sovacool, 2013a). Moreover, diverse terminology and unstandardized metrics are often used to measure stakeholder engagement practices, making it challenging for solar PV firms and local state governments to integrate these practices into strategic decision-making effectively (Yehong Li et al., 2017).

The objective of this study is to investigate the effect of stakeholder engagement dimensions on the success of Solar PV projects in Pahang. The findings may provide valuable insights for the top management of solar PV firms on how to engage various stakeholders effectively and efficiently. Successful stakeholder engagement can build trust and foster significant relationships among stakeholders, enhancing the firm's reputation. A strong reputation, in turn, benefits the life cycle of renewable energy firms, particularly in securing government grants and funding. By addressing this research gap, the study aims to offer critical insights for both solar PV firms and the local state government. This study is organized as follows: Section 2 presents a literature review on the success factors of Solar PV and stakeholder engagement dimensions. Section 3 outlines the study's methodology and the data collection process. Section 4 discusses the analytical results, including quantitative analysis using Smart-PLS 4.0 and Relative Importance Index (RII) Analysis. Finally, Section 5 presents the conclusions of the study, its limitations, and recommendations for future research.

Literature Review

Renewable Energy Project Success Factors

The criteria for project success have changed dramatically over time. Various definitions of project success have evolved starting in the 1960s and continuing into the twenty-first century (Jugdev & Muller, 2005; Atencio, 2013). In the context of project management, generally, project success is measured by the extent to which project performance (time, money, and scope) was met, as well as the influence the project had on the organization's strategic objective (Cleland & Ireland, 2002). However, it has been suggested that conventional project management approaches in determining project success are insufficient. As a result, every industry must design and implement particular, well-defined criteria for success aspects to monitor and provide project success on a proactive basis. In the context of renewable energy projects, specifically Solar PV projects, very few studies address the issues particular to these projects.

Previous research has focused on the potential challenges and roadblocks to the successful completion of renewable energy projects, but none have identified the success factors for these projects (Maqbool & Sudong, 2018). There are differences in how significant factors contributing to the success of renewable energy projects have been measured. While researchers have identified various factors that add value to the success of these projects, it is generally agreed that success should be measured based on specific objectives: fulfilling the project scope, staying within the budgeted cost, adhering to the scheduled timeframe, meeting the desired quality, and achieving stakeholder satisfaction (Maqbool & Sudong, 2018; Azlan, 2022). The study's findings indicate that five critical success factors—communication, team dynamics, technical aspects, organizational structure, and environmental considerations—are essential for the success of renewable energy projects. Therefore, this study will adapt the project success factors identified by Maqbool & Sudong (2018) to assess the development of a successful Solar PV project in Pahang.

Stakeholder Engagement Dimensions

Stakeholder engagement, rather than stakeholder management, has recently been emphasized as having a substantial effect on project success. In the last two decades, stakeholder engagement has grown in popularity as a research subject (Mok et al., 2015). A trend and growing approaches in project stakeholder engagement can be observed in the project management discipline. Since projects with a high degree of change necessitate active engagement and participation, the concept of stakeholder engagement has been studied for agile contexts (PMI, 2021). Additionally, PMI (2021) underlined that, as new definitions of stakeholders are developed, stakeholder engagement is a critical approach to dealing with the larger stakeholder community and the complexity of stakeholder relationships in a project. The roots of stakeholder engagement are derived from stakeholder theory, which will be used as the basis of this study. Most studies utilize stakeholder theory as the prominent theoretical support (Bendell & Nesij Huvaj, 2018; Erkul et al., 2020; Freeman et al., 2017; Lehtinen et al., 2018; Rajablu et al., 2017; Stephenson et al., 2018) agree that stakeholder theory is more than capable of conceptualizing and comprehending firms in the fields of strategy and management. Existing studies on stakeholder engagement have used various indicators to determine how effective stakeholder engagement practices impact project performance. However, the range of indicators used in scholarly work is often too narrow and not comprehensive enough for different contexts (Azlan, 2022). Therefore, this study adapts and modifies the dimensions of stakeholder engagement from Freeman et al. (2017), which offers a more universal measurement applicable to any research context. The Freeman et al. (2017) framework is well-suited for this study and can represent stakeholder engagement dimensions in solar PV projects. Figure 2 illustrates the conceptual framework of this study, which highlights four stakeholder engagement dimensions: stakeholder communication, stakeholder integration, stakeholder learning, and stakeholder relations.

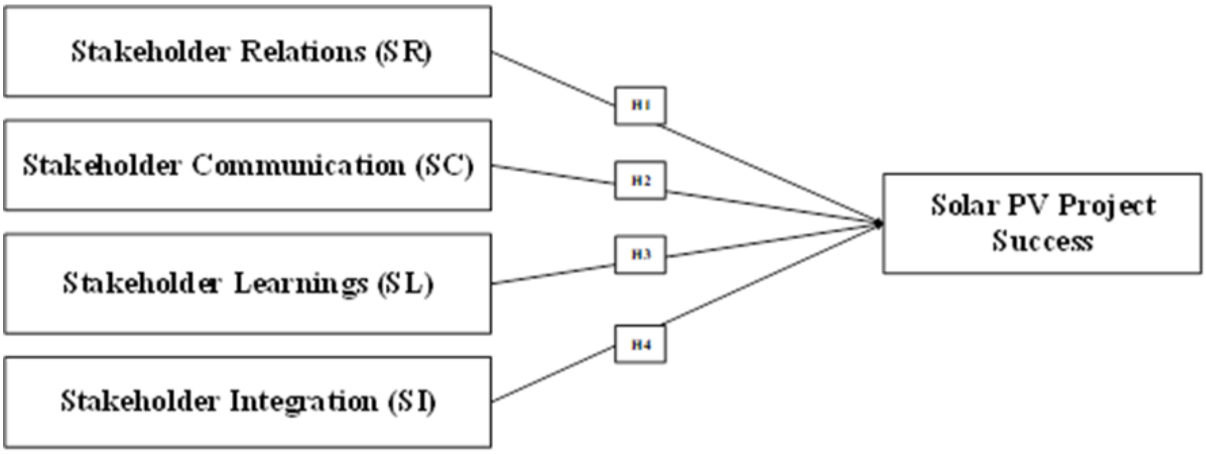

Figure 2: Conceptual Framework

Stakeholder communication (SC)

Stakeholder communication is crucial in stakeholder engagement. It is important to provide effective communication, which consists of conveying the proper and exact information to the necessary stakeholders by employing appropriate communication methods and explaining the project objectives (Sadhukhan et al., 2018; White et al., 2018). Particularly for Solar PV projects, as it ensures that all parties are informed, engaged, and aligned with project goals. Clear communication helps stakeholders understand project objectives and timelines, aligning their expectations and minimizing misunderstandings. Regular updates keep stakeholders involved, facilitating better collaboration and support. A feedback loop allows stakeholders to express concerns and suggest improvements, helping resolve issues quickly and preventing escalation (Erkul et al., 2020). Transparent communication builds trust and credibility, encouraging stakeholder support and enhancing the project's reputation. Therefore, this study hypothesized that:

H1: *Stakeholder communication (SC) has a positive effect on the solar photovoltaic (PV) project success*

Stakeholder Integration (SI)

Integrating stakeholders effectively into the process of engagement is crucial for the success of Solar PV projects, as it fosters a collaborative environment where diverse perspectives and interests are considered. By involving stakeholders early and continuously, project developers can identify potential concerns, address issues proactively, and build strong relationships with key parties (San-Jose, Retolaza, & Freeman, 2017; Senaratne & Ruwanpura, 2016). This inclusive approach not only enhances the project's social acceptance and reduces resistance but also improves the alignment of project goals with local needs and expectations. Consequently, stakeholder integration can lead to more informed decision-making, smoother project implementation, and ultimately, a higher likelihood of achieving project success. Therefore, it can be hypothesized that:

H2: *Stakeholder integration (SI) has a positive effect on the solar photovoltaic (PV) project success*

Stakeholder Learning (SL)

Stakeholder learning can be defined as the capacity of firms to seek internal and external information to further develop their routines and procedures and increase their value-creation opportunities (Rühli et al., 2017). Stakeholder learning plays a pivotal role in the engagement process, by facilitating opportunities for stakeholders to learn about the technology, its implementation, and its benefits, project developers can address knowledge gaps and dispel misconceptions. The context of the Solar PV project ensures that all parties involved gain a comprehensive understanding project's objectives, benefits, and potential impacts. This informed perspective helps stakeholders make more informed decisions, align their expectations with project realities, and contribute constructively to the project's development (Freeman et al, 2020; Danso et al., 2020). As a result, enhanced stakeholder learning can lead to greater support, smoother collaboration, and a higher probability of project success by fostering a well-informed and engaged stakeholder community. Based on the literature discussed above, the following hypothesis is developed:

H3: *Stakeholder learning (SL) has a positive effect on the solar photovoltaic (PV) project success*

Stakeholder Relations

Stakeholder relations are described as the process of interacting with individuals or groups of people who share a similar interest that results in reciprocal benefits. Positive stakeholder relations facilitate open communication, encourage feedback, and promote collaborative problem-solving (Kujala et al., 2016; Joshi, 2018). By actively nurturing these relationships, project developers can better understand stakeholder concerns, address issues promptly, and align the project with community values and needs. This proactive approach helps mitigate conflicts, enhances project acceptance, and fosters a supportive environment, ultimately contributing to the successful implementation and long-term sustainability of Solar PV projects. Therefore, the following hypothesis is developed:

H4: *Stakeholder relations (SR) have a positive effect on the solar photovoltaic (PV) project's success*

Method

This study applied the exploratory sequential method, which employed a quantitative design. The four independent variables are Stakeholder Communication (SC), Stakeholder Learning (SL), and Stakeholder Relations (SR). The constructs of stakeholder engagement dimensions are investigated to ascertain their direct impact on Solar PV project success. All variables were reflectively measured using five ordinal measures from one (1) to five (5) according to the level of importance and categorized into multi-item measures. Table 1 indicates the measurement development for both variables. The questionnaire was comprised of three sections and assessed the respondents' background, the stakeholder engagement dimensions were adapted from H. Heravi (2018), El-Sawalhi & Hammad (2015), A. H. Heravi (2014), Molwus (2014), Sheriff (2012), and El-Gohary et al. (2006). The attributes of Solar PV Project Success were adopted from Maqbool & Sudong (2018).

Table 1: Measurement development

Variables	Construct	References
Stakeholder Engagement	Stakeholder Communication (SC)	A. H. Heravi (2014); Sheriff (2012)
	Stakeholder Learning (SL)	El-Gohary et al. (2006) and Sheriff (2012)
	Stakeholder Integration (SI)	El-Sawalhi & Hammad (2015)
	Stakeholder Relations (SR)	H. Heravi (2018) and Molwus (2014a)
Solar PV Project Success		Maqbool & Sudong (2018)

The study intends to analyze the present breadth of stakeholder engagement practices in solar PV projects in Pahang to provide a bird's-eye view of the practices among solar PV firms. Thus, the unit analysis of this study is at the individual level. Data is collected from the registered solar PV firms in Malaysia that have professional experience in managing solar PV projects in Pahang. These firms are registered with the Sustainable Energy and Development Authority (SEDA) Malaysia and the Energy Commission (EC) and currently maintain their license to acquire contracts for renewable energy projects. According to the official data from the EC, 38 total registered solar PV firms specifically execute solar projects in Pahang. Thus, random probability sampling was used, and by using G*Power software version 3.1, a minimum 85 sample size was utilized in this study. The targeted respondents come from each of the three management levels (top, middle, and lower) in the firm. For top management, the example is the CEO/President and the executives of the company; the middle management level is the senior managers (operations and project managers); and the low management level is the supervisors, junior managers, and site inspectors.

The pilot test was conducted for content validity, reliability, and brevity. Face-to-face interviews were used to get fast and clear feedback from the respondents during the pre-testing phase, and six respondents were selected who came from academicians and practitioners who were well-versed in project management. The results of the pilot test provide an overall satisfactory depiction of the questionnaires. The majority of the participants found the survey questions clear and easy to respond to. Nevertheless, a few changes are required in some of the questions, and after modifications, the survey questions were finalized. All data were collected, firstly using SPSS Version 23 software which was used to analyze the descriptive statistics. Secondly, the Smart-PLS 4.0 software was used for testing the goodness of the model and hypothesis testing.

Findings

Out of the 200 distributed questionnaires, 85 questionnaires were returned, indicating a response rate of 42.5%. Table 2 shows the demographic information of the respondents. The number of male respondents was higher than female respondents, with male respondents at 76.5% and 20 female respondents at 23.5%. Most of the respondents held a degree or professional qualification (64.7%), followed by a high school and postgraduate (17.6%). In terms of years of experience in the renewable energy sector, particularly in solar PV projects, 41.2% of them have less than five years of experience. Meanwhile, 24.7% of respondents have 11 to 15 years of work experience, 23.5% of respondents with 6 to 10 years of experience, 9.4% of respondents with 16 to 20 years, and lastly, one respondent has more than 21 years of experience (1.2%).

Next, the results show the highest frequency of respondents' positions as the CEO/Director (35.3%), followed by the position of the executive (22.4%) and senior manager (19.6%). Others, project managers (11.8%) and other positions (2.4%). Overall, the results confirmed that the majority of firms were led by males compared to females, and most of them have positions in top management as CEO or Director of the company. Apart from that, most of the respondents have less than 5 years of experience, which is consistent as the renewable energy sector has only been introduced in Malaysia in 2008. For the RE training, most of the respondents agreed that they attended a few courses related to the RE. These courses are usually organized by the Sustainable Environment Development Authority (SEDA) throughout the year. The firms must attend the training or courses first before they can be recognized as SEDA members.

Table 2: Respondents' Profile

Demographic variables	**Category**	**Respondents (N = 85)**	
		Frequency	**Percentage (%)**
Gender	Male	65	76.5
	Female	20	23.5
Education	High school or below	5	5.9
	Diploma	10	11.8
	Degree or professional qualification	55	64.7
	Postgraduate	15	17.6
Years of experience in Solar PV Project	< 5 years	35	41.2
	6 to 10 years	20	23.5
	11 to 15 years	21	24.7
	16 to 20 years	8	9.4
	> 21 years	1	1.2
Position in Company	CEO/ Director	30	35.3
	Executive	19	22.4
	Project Manager	10	11.8
	Senior Manager	14	16.5
	Manager	10	11.8
	Other	2	2.4
RE training	Yes	65	76.5
	No	20	23.5

Measurement and Structural Model Analysis
Structural equation modeling (SEM) was used for data analyses, and Smart-PLS Version 4.0 software was chosen mainly due to its ability to model the latent constructs both formatively and reflectively (Sarstedt, Ringle, & Hair, 2018). The measurement model was first assessed, and this was followed by the assessment of the structural model. In assessing the measurement model, it is important to test the reliability, convergent validity, and discriminant validity of the measuring items. The convergent validity was assessed by considering the factor loadings, average variance extracted (AVE), and composite reliability (CR) (Joseph F. Hair, Babin, et

al., 2017). Table 3 indicates the details of convergent validity. The cut-off value for outer loadings must be higher than 0.50, AVE values must be more than 0.50, and CR values must be above 0.70 (Hair Jr., Matthews, Matthews, & Sarstedt, 2017; Hair, Hollingsworth, Randolph, & Chong, 2017). The assessment of the measurement model shows that the outer loadings ranged from 0.583 to 0.918, AVE was in the range of 0.535 to 0.686, and CR was from 0.880 to 0.945, which indeed exceeded the recommendation value of 0.50. Hence, shows that the construct convergent validity is adequate in this study.

Table 3: Convergent Validity

Constructs	Items	Outer Loadings	Composite Reliability (CR)	Average Variance Extracted (AVE)
Solar PV Project Success	SPPS1	0.907	0.945	0.686
	SPPS2	0.767		
	SPPS3	0.903		
	SPPS4	0.800		
	SPPS5	0.706		
Stakeholder Communication (SC)	SC1	0.679	0.880	0.537
	SC2	0.806		
	SC3	0.836		
Stakeholder Integration (SI)	SI1	0.817	0.929	0.535
	SI2	0.889		
	SI3	0.583		
Stakeholder Learning (SL)	SL1	0.756	0.915	0.564
	SL2	0.918		
	SL3	0.807		
Stakeholder Relations (SR)	SR1	0.740	0.898	0.603
	SR2	0.763		
	SR3	0.732		

Table 4 indicates the results of the Heterotrait-monotrait ratio (HTMT) criterion, which confirms the construct validity of the measurement model. The HTMT criteria were created by Jorg Henseler et al. (2015). The results show that all constructions meet the HTMT 0.90 (Gold et al., 2001) and HTMT 0.85 (Gold et al., 2001) requirements (Kline, 2011). The results were less than 0.90, indicating adequate and good discriminant validity.

Table 4: HTMT Criterion Results

	SPPS	SC	SI	SL	SR
SPPS					
SC	0.856				
SI	0.639	0.570			
SL	0.822	0.702	0.572		
SR	0.675	0.478	0.565	0.566	

Table 5 reports the results of the structural model of this study. The results revealed that the stakeholder engagement dimensions, which were stakeholder communication, stakeholder integration, stakeholder learning, and stakeholder relations, had positively influenced the solar PV project's success. Figure 3 presents the results of path analysis (using a bootstrapping procedure) of the direct relationship of the structural model. The bootstrapping is set to a 0.05 significance level, one-tailed test, and 500 subsamples (more than 122 subsamples used in this study). Ramayah, T., Cheah, J., Chuah F., Ting, H., Memon, M. (2018) further explained the values for a significance level of 1% (α =0.01), 5% (α =0.05 and 10% (α =0. 1) are 2.33, 1.645 and 1.28, respectively for the one-tailed test. For the t-test, relationships are found to have t-values relationships are found to have t-value ≥ 2.33, thus a significant 0.01 level of significance. The predictors of SC (β=0.232, t-value=2.935, p<0.01), SI (β=0.181, t-value=2.368, p<0.01), SL (β=0.413, t-value=4.320, p<0.01) and SR (β=0.169, t-value=2.133, p<0.01) show that the constructs of SC, SI, SL, and SR are positively related to solar PV project success.

Table 5: Structural Model Results

Hypotheses	Relationship	Coefficient (β)	Std. Error	t-value	p-value	Decision
H1	SC → SPPS	0.232	0.080	2.935	p<0.01	Supported
H2	SI → SPPS	0.181	0.072	2.368	p<0.01	Supported
H3	SL → SPPS	0.413	0.093	4.320	p<0.01	Supported
H4	SR → SPPS	0.169	0.072	2.133	p<0.01	Supported

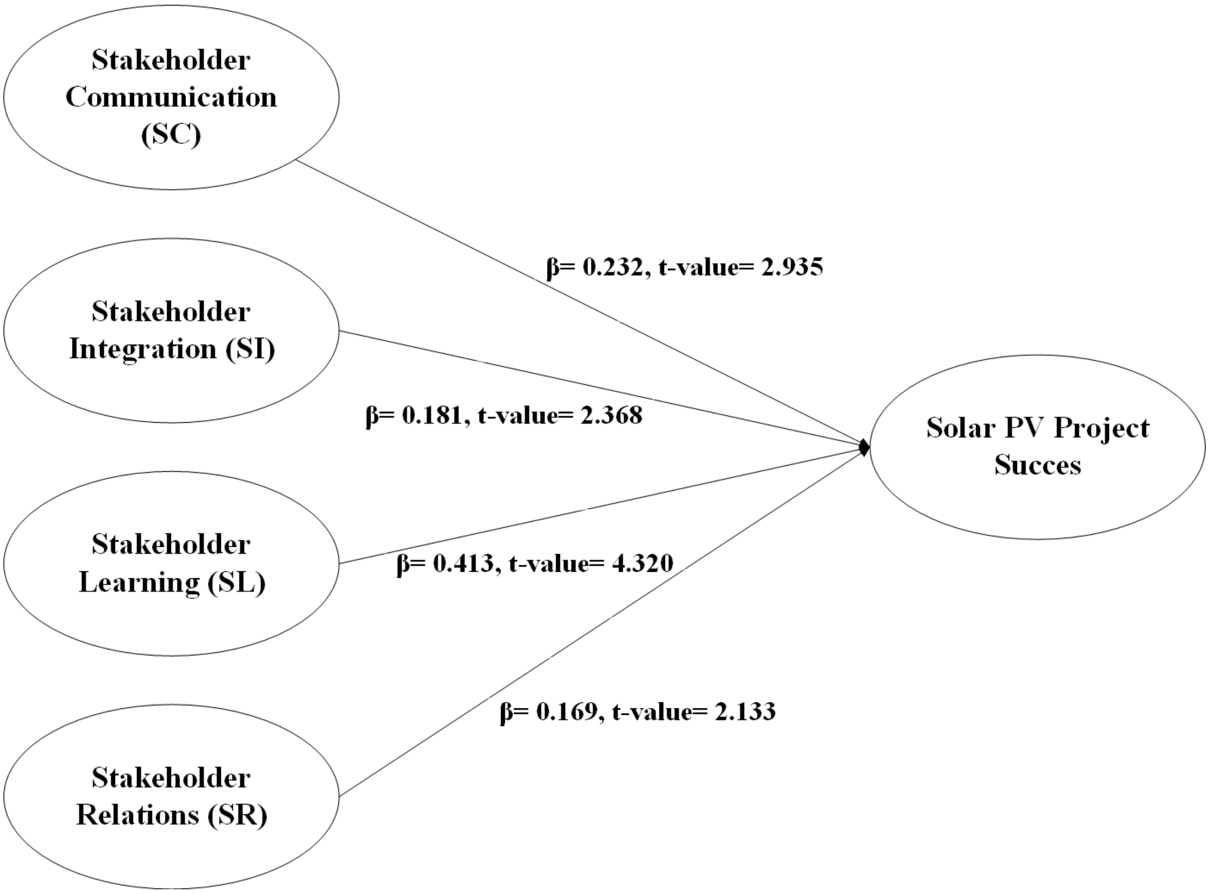

Figure 3: Results of Testing Model

Relative Importance Index (RII) Analysis

After the results confirm that all stakeholder engagement dimensions have a positive impact on the solar PV project's success, the next step is to rank the stakeholder engagement dimensions. In achieving this, the Relative Importance Index (RII) Analysis was adopted. Equation 1 depicts RII Analysis as follows (Johnson & LeBreton, 2004; A. Khan et al., 2019), where the weighted scores are obtained in the first phase and then compared with the corresponding significance ranking of the variable.

Equation 1: RII Analysis

$$RII = \frac{\sum w}{A \times N} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5 \times N}$$

In this study, the respondents were given a Likert scale (1 -5) to answer the importance of all stakeholder engagement indicator items in the questionnaires. The RII value ranges from 0 to 1, with 0 not inclusive. Thus, if the value of RII is higher, then the percentage of the items of SEI will also be higher. Table 6 shows the RII of the stakeholder engagement dimensions in Solar PV projects along with the corresponding ranking. The ranking was done at two levels: first, within the items of individual dimensions, then between four stakeholder engagement dimensions constructs, and last, the mean index of individual dimensions was computed and ranked appropriately.

Table 6: RII Analysis and Ranking of Stakeholder Engagement Dimensions items

Stakeholder Engagement Dimensions		**RII**	**Mean index of dimension**	**Overall Ranking**	**Ranking within the dimension**	**Ranking within the construct**	**Importance Level**
Stakeholder Communication	SC1	0.748	0.740	3	1	2	H-M
	SC2	0.746		4	2		H-M
	SC3	0.734		8	4		H-M
	SC4	0.731		7	3		H-M
Stakeholder Integration	SI1	0.674	0.689	15	3	4	H-M
	SI2	0.672		16	4		H-M
	SI3	0.720		12	1		H-M
	SI4	0.687		14	2		H-M
Stakeholder Learning	SL1	0.723	0.728	10	3	3	H-M
	SL2	0.743		6	1		H-M
	SL3	0.721		11	4		H-M
	SL4	0.725		9	2		H-M
Stakeholder Relations	SR1	0.759	0.748	2	2	1	H-M
	SR2	0.705		13	4		H-M
	SR3	0.744		5	3		H-M
	SR4	0.785		1	1		H-M

It was observed from the ranking table that all 16 items were identified as “High-Medium” (H-M), and the RII is in the range of 0.672 – 0.785. These 16 items are developed under four (4) main constructs, which were stakeholder relationship (SR), stakeholder integration (SI), stakeholder communication (SC), and stakeholder learning (SL). Even though all dimensions were rated with 'High-Medium (H-M)' importance levels, the results indicate that SR is the highest mean index with an RII value of 0.748, as compared to other stakeholder engagement dimensions. This is followed by SC with an RII value of 0.740, SL with an RII value of 0.728, and lastly, SR with an RII value of 0.689.

Discussion and Conclusion

This research aimed to assess the impact of stakeholder engagement dimensions on the success of solar PV projects in Pahang, Malaysia. A conceptual framework was developed based on a comprehensive literature review and was empirically tested to examine the relationships and hypotheses. The findings revealed that the independent variables—stakeholder relationship, stakeholder integration, stakeholder communication, and stakeholder learning—positively influenced the success of solar PV projects. These outcomes offer both a theoretical framework and strategic insights for the renewable energy sector in Pahang.

The first hypothesis, H1: Stakeholder communication positively affects solar PV project success, was supported by the findings. In the renewable energy industry, frequent and effective communication helps to swiftly resolve pre-contract disputes and aligns the diverse stakeholders involved. This is particularly critical during the early stages of project development, such as the preparation of tender and contract documents from SEDA. Effective communication among policymakers, decision-makers, project teams, and beneficiaries is essential for managing expectations, providing accurate information, and facilitating joint decision-making, thereby contributing to the successful establishment of solar PV projects.

The second hypothesis, H2: Stakeholder integration positively affects solar PV project success, was also validated. Previous research has emphasized the importance of stakeholder integration for effective engagement (Brown et al., 2016; Plaza-Ùbeda et al., 2010; Harrison et al., 2010). Solar PV firms must develop strong stakeholder orientations to address conflicts early in the planning phase, ensure a common understanding of project success, and appoint competent project leaders. These strategies are crucial since solar PV firms are the primary owners of these projects.

The third hypothesis, H3: Stakeholder learning positively affects solar PV project success, was similarly confirmed. According to Zwikael (2019), stakeholders must fully understand each component of the development process to contribute effectively to project success. Consistent with previous studies (Freeman et al., 2017; Sachs & Rühli, 2021), the findings underscore the importance of stakeholder learning strategies that gather internal and external information from stakeholders. Such strategies can enhance the ongoing development of routines and processes, thereby creating value for the organization.

Lastly, the fourth hypothesis, H4: Stakeholder relations positively affect solar PV project success, was accepted. Projects often face challenges due to the diverse needs, demands, and expectations of various stakeholders, leading to conflicting viewpoints that can unnecessarily prolong project stages. According to Heravi et al. (2018), businesses may be reluctant to involve multiple stakeholders in planning due to these conflicts. This study's results indicate that inadequate stakeholder engagement strategies during the planning phases can negatively impact project outcomes. Therefore, organizations should view stakeholder relations as a source of social value creation, especially in complex renewable energy projects (Kujala et al., 2021).

The theoretical and practical implications of this study are significant for both solar PV firms and the state government of Pahang. The study provides a comprehensive framework linking stakeholder engagement dimensions directly to project success, enhancing the understanding of how communication, integration, learning, and relations contribute to effective solar PV implementation. These dimensions offer a novel metric for evaluating engagement

effectiveness and serve as a benchmark for future research. The empirical validation of the hypotheses strengthens the theoretical models proposed in the literature. Practically, solar PV firms can use these findings to develop better engagement strategies, reduce conflicts, and enhance project outcomes. The state government can leverage these insights to streamline processes, addressing challenges such as prolonged land acquisition and lengthy permitting procedures. By adopting the stakeholder engagement dimensions and strategies highlighted in this study, higher project completion rates, increased efficiency, and greater community support can be achieved. Additionally, the study's framework aids in strategic planning and development, ensuring that all stakeholders are aligned and contributing positively. Emphasizing stakeholder relations fosters an environment of trust and cooperation, creating social value and promoting sustainable and socially responsible energy projects in Pahang.
In conclusion, the significance of this study lies in its potential to attract investments in the renewable energy sector, particularly in Pahang State. By leveraging stakeholder engagement dimensions, the study provides a valuable tool for renewable energy players to assess and enhance their engagement strategies, ultimately improving project success rates. These dimensions also assist regulatory bodies in policy-making, supporting Malaysia's ambitious target of achieving a 70% renewable energy share of installed capacity by 2050. Furthermore, this study aligns with Pahang's goal of achieving NetZero 2030 aspirations by providing a structured approach to stakeholder engagement that can drive sustainable development. The insights and practical strategies derived from this research not only foster better communication, integration, learning, and relations among stakeholders but also create a conducive environment for investment. By addressing critical challenges and promoting effective stakeholder engagement, this study contributes to the broader renewable energy objectives of both Pahang State and Malaysia as a whole.

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References
El-Gohary, N. M., Osman, H., & El-Diraby, T. E. (2006). Stakeholder management for public-private partnerships. *International Journal of Project Management*, *24*(7), 595–604. https://doi.org/10.1016/j.ijproman.2006.07.009
El-Sawalhi, N. I., & Hammad, S. (2015). Factors affecting stakeholder management in construction projects in the Gaza Strip. *International Journal of Construction Management*, *15*(2), 157–169. https://doi.org/10.1080/15623599.2015.1035626
Energy Commission. (2024). *Malaysia Energy Statistics Handbook 2022* (Vol. 1).
Freeman, R. E., Kujala, J., & Sachs, S. (2017). *Stakeholder Engagement: Clinical Research Cases* (R. Edward Freeman, J. Kujala, & S. Sachs (Eds.); Issues in, Vol. 46). Springer International Publishing. https://doi.org/10.1007/978-3-319-62785-4
Freeman, R. E., Phillips, R., & Sisodia, R. (2020). Tensions in Stakeholder Theory. *Business and Society*, *59*(2), 213–231. https://doi.org/10.1177/0007650318773750
Hair, Joseph F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., & Thiele, K. O. (2017). Mirror, mirror on the wall: A comparative evaluation of composite-based structural equation modeling methods. *Journal of the Academy of Marketing Science*, *45*(5), 616–632. https://doi.org/10.1007/s11747-017-0517-x
Heffron, R., Connor, R., Crossley, P., Mayor, V. L. I., Talus, K., & Tomain, J. (2021). The identification and impact of justice risks to commercial risks in the energy sector: post-COVID-19 and for the energy transition. *Journal of Energy and Natural Resources Law*,

0(0), 1–30. https://doi.org/10.1080/02646811.2021.1874148

Heravi, A., Coffey, V., & Trigunarsyah, B. (2018). Evaluating the level of stakeholder involvement during the project planning processes of building projects. *International Journal of Project Management*, *33*(5), 985–997. https://doi.org/10.1016/j.ijproman.2014.12.007

IEA (2023), World Energy Outlook 2023, IEA, Paris https://www.iea.org/reports/world-energy-outlook-2023, Licence: CC BY 4.0 (report); CC BY NC SA 4.0 (Annex A)

IRENA (2024), Renewable energy statistics 2024, International Renewable Energy Agency, Abu Dhabi.

Kujala, J., Lehtimäki, H., & Myllykangas, P. (2016). Toward a Relational Stakeholder Theory: Attributes of Value-creating Stakeholder Relationships. *Academy of Management Annual Conference 2016*, 1–31.

Maqbool, R. (2018). Efficiency and effectiveness of factors affecting renewable energy projects: an empirical perspective. *Energy*, *158*, 944–956. https://doi.org/10.1016/j.energy.2018.06.015

Maqbool, R., & Sudong, Y. (2018). Critical success factors for renewable energy projects: empirical evidence from Pakistan. *Journal of Cleaner Production*, *195*, 991–1002. https://doi.org/10.1016/j.jclepro.2018.05.274

Mok, K. Y., Shen, G. Q., & Yang, R. J. (2017). Addressing stakeholder complexity and major pitfalls in large cultural building projects. *International Journal of Project Management*, *35*(3), 463–478. https://doi.org/10.1016/j.ijproman.2016.12.009

Muhammad Waris, Zarith Sufia Azlan, Puteri Fadzline Muhamad Tamyez, Mehfooz Ullah, and Asadullah Khan, (2019), "Analyzing the Constructs of Stakeholder Engagement towards Renewable Energy Projects Success in Malaysia: A PLS Approach" in *FGIC 2nd Conference on Governance and Integrity 2019*, KnE Social Sciences, pages 818–843. DOI 10.18502/kss.v3i22.5090

Oh, T. H., Hasanuzzaman, M., Selvaraj, J., Teo, S. C., & Chua, S. C. (2018). Energy policy and alternative energy in Malaysia: Issues and challenges for sustainable growth – An update. *Renewable and Sustainable Energy Reviews*, *81*(May 2016), 3021–3031. https://doi.org/10.1016/j.rser.2017.06.112

Pemer, F., & Skjølsvik, T. (2018). Adopt or adapt? Unpacking the role of institutional work processes in the implementation of new regulations. *Journal of Public Administration Research and Theory*, *28*(1), 138–154. https://doi.org/10.1093/jopart/mux020

Perlaviciute, G., Steg, L., & Sovacool, B. K. (2021). A perspective on the human dimensions of a transition to net-zero energy systems. *Energy and Climate Change*, *2*(June), 100042. https://doi.org/10.1016/j.egycc.2021.100042

Peter Andreasen, K., & Sovacool, B. K. (2014). Energy sustainability, stakeholder conflicts, and the future of hydrogen in Denmark. *Renewable and Sustainable Energy Reviews*, *39*(2014), 891–897. https://doi.org/10.1016/j.rser.2014.07.158

Phillips, R. A. (2004). Stakeholder theory and organizational ethics. *Choice Reviews Online*, *41*(08), 41-4764-41–4764. https://doi.org/10.5860/choice.41-4764

PMI. (2021). *A guide to the project management body of knowledge (PMBOK guide)* (Seventh). Project Management Institute, Inc.

Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. (2012). Sources of Method Bias in Social Science Research and Recommendations on How to Control it. *Annual Review of Psychology*. https://doi.org/10.1146/annurev-psych-120710-100452

Rajablu, M., Hamdi, S., Marthandan, G., & Wan Yusoff, W. F. (2017). Managing for stakeholders: Introducing stakeholder metrics-integrated model to lead project ethics and success. *International Journal of Project Organisation and Management*, *9*(1), 31–56.

https://doi.org/10.1504/IJPOM.2017.083124

Rajablu, M., Marthandan, G., & Yusoff, W. F. W. (2014). Managing for stakeholders: The role of stakeholder-based management in project success. *Asian Social Science*, *11*(3), 111–125. https://doi.org/10.5539/ass.v11n3p111

Ramayah, T., Cheah, J., Chuah F., Ting, H., Memon, M., A. (2018). Partial least squares structural equation modelling (PLS-SEM) using SmartPLS 3.0. In *an updated guide and a practical guide to statistical analysis*.

Sachs, S., Stutz, C., Mcsorley, V., & Schneider, T. (2017). A Case Study on the Implementation of Stakeholder Management in Organizational Practice. *Issues in Business Ethics*, *46*, 369–388. https://doi.org/10.1007/978-3-319-62785-4_16

Sadhukhan, J., Martinez-Hernandez, E., Murphy, R. J., Ng, D. K. S., Hassim, M. H., Siew Ng, K., Yoke Kin, W., Jaye, I. F. M., Leung Pah Hang, M. Y., & Andiappan, V. (2018). Role of bioenergy, biorefinery and bioeconomy in sustainable development: Strategic pathways for Malaysia. *Renewable and Sustainable Energy Reviews*, *81*(August 2016), 1966–1987. https://doi.org/10.1016/j.rser.2017.06.007

Sarstedt, M., Diamantopoulos, A., & Salzberger, T. (2016). Should we use single items? Better not. *Journal of Business Research*, *69*(8), 3199–3203. https://doi.org/10.1016/j.jbusres.2016.02.040

Sarstedt, M., Ringle, C. M., & Hair, J. F. (2018). *Partial Least Squares Structural Equation Modeling* (Vol. 267). https://doi.org/10.1007/978-3-319-71691-6

Seetharaman, Moorthy, K., Patwa, N., Saravanan, & Gupta, Y. (2019). Breaking barriers in the deployment of renewable energy. *Heliyon*, *5*(1), e01166. https://doi.org/10.1016/j.heliyon.2019.e01166

Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill-building approach* (Seventh Ed). John Wiley & Sons.

Sekaran, Uma. (2003a). *Research Methods for Business: A skill Skill-Building Approach* (Fourth Edition). John Wiley & Sons, Inc. https://doi.org/10.1017/CBO9781107415324.004

Seki, Y., Sutrisna, M., & Olanipekun, A. O. (2020). Integrating a rich picture diagram and a causal loop diagram to model stakeholder engagement in building refurbishment projects. *Engineering, Construction and Architectural Management*, *28*(7), 1929–1951. https://doi.org/10.1108/ECAM-05-2020-0342

Senaratne, S., & Ruwanpura, M. (2016). Communication in construction: a management perspective through case studies in Sri Lanka. *Architectural Engineering and Design Management*, *12*(1), 3–18. https://doi.org/10.1080/17452007.2015.1056721

Zarith Sufia Azlan, Muhammad Waris, Puteri Fadzline Muhamad Tamyez (2020). Investigating the Stakeholder Engagement Indicators towards RE Projects' Success in Malaysia. Horizon Journal of Humanities and Social Sciences Research (JHSSR). Vol. 2 (1) Mar. 2020. https://www.futureacademy.org.uk/files/images/upload/ICBSI2018FA17.pdf