Stakeholder Engagement Analysis of Existing Buildings Retrofitting Projects

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Abstract: Retrofitting residential buildings is not a technical problem that can be solved by installing equipment and making logical decisions; rather, it is a complicated socio-technical issue that necessitates taking into account how physical arrangements encourage sustainable activities. Stakeholder plays a very important part in taking decision regarding retrofitting an existing building. There are different stakeholders involved in the process of retrofitting and analysing their influence can give a wider view on the challenges and come out with strategies to overcome. This study aims to analyse the stakeholders' level of influence involved in retrofitting. The study revealed that stakeholders influence on retrofitting projects are not limited. The importance stakeholders spreads to other groups, emphasizing the necessity of precise laws, rewards, and funding sources.

Keywords: Retrofitting, stakeholder influence, Stakeholders engagement, Stakeholder Salience Model.

1. Introduction

Authors talked on the idea of "green building" or "sustainable building," which describes structures with integrated design, sustainable practices, easy-to-use operations, and appropriate resource management(Rispoli & Organ, 2019)(Robichaud & Anantatmula, 2011). Over 30% of the energy used globally is used in buildings, and this share is expected to rise as a result of urbanization, climate change, and rising living standards(Berardi & Jafarpur, 2020). The International Energy Agency estimates that buildings in the US are responsible for 39%, 30%, and 68% of total energy use, greenhouse gas emissions, raw material consumption, waste, and water use(*2. Energy Consumption by Sector*, 2011).

Due to the construction sector's high energy use, residential energy demand must be decreased. Creating energy-efficient structures, remodelling old ones, or creating new structures that adhere to energy regulations are some solutions(Breakthrough & Report, 2023). New structures account for less than 5% of the building stock each year, and retrofitting is typically faster and less expensive than new construction. In the construction sector, this widely used approach can reduce the overall energy usage of households(https://www.horstconstruction.com/news-and-blog/renovating-vs-new-construction-which-is-better-for-your-project/).

This study aims to focus on retrofitting through the stakeholders' perspective. Stakeholders are an integral part of any project. Because of the relationships between the several stakeholders involved, the energy retrofit implementation process is fraught with dangers, particularly in China(Jia et al., 2020). The participation of several stakeholders is necessary for the residential building energy retrofit to be implemented successfully(Adegoke et al., 2024). Yang emphasized that stakeholders' perceptions of risks and rewards significantly influence their actions, including government, citizens, and retrofitting businesses(Yang et al., 2023). For BER projects to be managed effectively, active stakeholder participation is essential because it guarantees that all opinions are taken into account and that the project is in line with the interests of those impacted(Shen et al., 2024). Through addressing

stakeholders' motives and concerns, communication fosters a sense of commitment and ownership, which eventually leads to a more successful energy-saving retrofit(Madushika & Lu, 2023).

The planning, designing, and implementation of retrofit programs for individual homes and the wider housing stock involve a number of stakeholders, including users, leaseholders, occupants, and landlords(Retrofit, 2024). There is a need for more studies to involve more stakeholders for retrofitting projects and their involvement impact.

There are fewer studies connected on retrofitting in India from the stakeholders' point of view. The United Nations Development Programme (UNDP) in India is supporting the Building Energy Efficiency (BEE) in evaluating and recommending incentives for energy-efficient building materials production, commercialization, and retrofitting, as part of its fourth component(Sreekumar et al., 2022). The main factors influencing performance must be carefully examined, and the drivers and their connections must be measured. Furthermore, in addition to the effects on stakeholders, a thorough grasp of the diverse spectrum of effects brought about by business actions is necessary(Epstein & Roy, 2001). India's construction of two million residential buildings annually increases its environmental impact, prompting the Paris Agreement's ambitious goal of achieving net zero by 2050, a response to industry stakeholders' concerns about the sector's increased environmental impacts(Bansal et al., 2014)(Prabatha et al., 2020).This paper focused on the level of influence of the stakeholders of building retrofitting projects.

The study is structured as follows. In section 2. Literature review combining stakeholders of building retrofitting projects. In section 3. Methodology. Section 4 showed the collected data and their analysis. In section 5. The obtained results are discussed. Finally, the conclusion with limitation and future work are presented.

1. Literature Review
1.1. Building Retrofitting
The term "retrofit" describes the alteration and adaption of building elements to improve their structural performance, energy efficiency, or functionality(Farghaly & Hassan, 2019). Retrofits entail adding new features and technology to structures to improve the use of natural resources including materials, energy, and water(Dadzie et al., 2017)(Oguntona et al., 2019). Compared to traditional civil construction methods, sustainable building retrofit procedures have been shown to be more cost-effective(Liapopoulou & Theodosiou, 2020). According to Power, retrofitting has major advantages over destruction and rebuilding in terms of the environment, society, and economy(Public & Commission, 2008). Retrofitting is the process of improving old and dilapidated structures(Flourentzou & Roulet, 2002). Wilkinson added that retrofit can happen to any component of a building, including the entire building or only one or more floors of a high-rise structure(Wilkinson, 2012).

1.2. Stakeholders of Retrofitting
Stakeholder cooperation and support are essential for retrofit implementation, however there aren't many research on how stakeholders make decisions and the challenges of stakeholders' engagement. For energy-efficiency retrofit projects to be successful, numerous stakeholders must work closely together and provide support(Miller & Buys, 2008). Energy-efficiency retrofit projects are more complex and involve more stakeholders than new building projects(Liang et al., 2017)(Davies & Osmani, 2011). Stakeholders in energy-efficient retrofitting have been studied using various techniques like case studies(Yu et al., 2021)(Li et al., 2017)(Li et al., 2023), expert interviews(Bergman & Foxon, 2020)(Ensign et al., 2021), literature reviews(Jagarajan et al., 2017)(Krieske et al., 2015)(Liu et al., 2019)(Farid et al., 2024), social network analysis(Liang et al., 2015)(Liang et al., 2017)(Bevan et al., 2020), and game theory, but these studies only statically examine stakeholders without considering dynamic interaction effects. Organizations can improve

retrofitting by considering various stakeholders' perspectives and requirements. However, the energy efficiency sector faces challenges like prioritizing contributions and conducting thorough stakeholder research. Addressing these concerns is crucial for achieving efficiency goals and promoting retrofitting.

1.3. Stakeholders Analysis

With an emphasis on climate-specific solutions, CSF identification, stakeholder participation, and technological standards like EnerPHit, China is a major contributor to the Asia Pacific area. New Zealand's BER health impacts study and Singapore's green construction research are two more noteworthy contributions(Adegoke et al., 2024). Prior research has examined stakeholder influence from a variety of disciplines and theoretical perspectives, demonstrating that different people interpret it differently(Begum et al., 2021). The entire spectrum of impact has been overlooked in study, which has mostly concentrated on the dyadic link between stakeholders, businesses, and macroenvironmental factors(Mojtahedi & Oo, 2017)(Archana et al., 2019). Mitchell, Agle, and Wood created the salience stakeholder analysis paradigm, which groups stakeholders according to their power, legitimacy, and urgency. This paradigm, however, ignores the intricately entwined interests and relationships that exist within businesses(Mitchell et al., 1997). A multilateral stakeholder salience (MSS) model was developed in response to this issue, taking into account a multilateral stakeholder environment from both a conceptual and practical standpoint. According to the MSS model, a stakeholder's importance is impacted by the importance, attributes, authority, legitimacy, and urgency of other stakeholders as well as the impact of the stakeholder network(Bridoux & Stoelhorst, 2019). Stakeholder claims and their possible influence on project decisions are better understood thanks to this paradigm(Edward Freeman, 2010).

Three tactics are identified by Mathur and Lorenzoni in their investigation of stakeholder participation in sustainable building: managerial technique, ethical demand, and discourse for reciprocal social learning. Involving stakeholders, they contend, can result in social learning, awareness-raising, behaviour-influencing, and perspective-shifting(Mathur et al., 2008). Stern contends that habits, personal capacities, contextual influences, and attitudes all play a role in how people feel about environmental issues(P. Stern., 2000) (Blake, 2001).

2. Research Methodology

Stakeholders in building retrofit projects are identified and ranked in this study according to their degree of influence. The influence levels of various stakeholders are examined using a stakeholder salience model. After chosen stakeholders are interviewed, questionnaires are handed to them in order to collect data. Interviews are used to collect concerns, and fuzzy numbers are used to investigate relationships. Stakeholder concerns are examined using social network analysis, which identifies the main issues for every stage of the project. Experts are questioned regarding difficulties they encounter when working on the project's various phases.

2.1. Data Collection

The stakeholders were identified through a literature review, and the data were collected through a questionnaire from industry practitioners and retrofitting process participants. Based on the questionnaire survey, this paper divides the main stakeholders into six major groups, namely owner and investors, governments and regulators, architects and engineers, contractors and suppliers, occupants and users, community and public. The questionnaire were directly related to the existing building retrofitting projects.

The government representatives were selected from different level of government departments engaged with retrofitting projects. The owners and investors were those stakeholders who chose the retrofitting option for their own projects. Architects and engineers were the ones who were specialized

in retrofitting techniques and frequently engaged with retrofitting projects. The contractors and suppliers were very few who were focused on retrofitting criteria for their projects and familiar with retrofitting requirements of materials. Occupants and users were the one who availed the retrofitting facilities but mostly not implemented by them rather available for them to use those facilities. In the end communities and publics were the one involved in the process during the projects and also after the implementation on the projects are directly or indirectly related or affected the process. These interviewees described the duties and responsibilities of their respective stakeholder groups and went into detail about the issues and worries they ran into during the project's execution. They were also questioned about some proactive steps they had taken to reduce risk in the interim.

2.2. Model Formation

According to (Edward Freeman & Evan, 1990), "no stakeholder stands alone in the process of value creation" and "a series of multilateral contracts among stakeholders" comprise a firm's stakeholder environment, according to Freeman(Edward Freeman, 2010). In actuality, stakeholders rely on other stakeholders as well as the organization to fulfil their interests. These interests are inextricably linked to the system as a whole and can help create shared value if the focal firm attends to them(Vargo & Lusch, 2014)(Sachs & Rühli, 2011). This understanding goes with the reasoning given by (Edward Freeman, 2010) and (Mitchell et al., 2015) that salient stake holders are the complementary resource provider for a firm which is a value creating system(Barney, 2018)(Frooman, 1999)(Mitchell et al., 1997). So, the attributes of power legitimacy and urgency are the results of stake holder unique tangible and intangible resources who are the most critical part of farms value creations and achievement of competitive advantage.

This study adopted multilateral stakeholder salience model which considers that other stakeholder's salience and their attributes have influence on salience of certain stakeholder group. MSS model can be formulated as follows:

$$SAL_a = P_a + L_a + U_a + + \frac{\sum_{t \in I} SAL_t}{t \neq a} \qquad (1)$$

$a, i \in \{a \text{ group of major stakeholders}\} = I$

Where SALa is the salience of a particular stakeholder group which is influenced by its attributes of P_a (power), L_a (legitimacy) and U_a (urgency); and $\frac{\sum_{t \in I} SAL_t}{t \neq a}$ is the sum of the stakeholder's salience other than the stakeholder a.

3. Results

We used the (Agle et al., 1999) given instrument to measure the perceived salience of each primary stakeholders based on seven-point Likert scale. Stakeholders were asked to evaluate each primary stakeholder's salience by filling the questionnaire survey "The below stakeholder group have the highest level of influence on retrofitting projects" (7= strongly agree, 1= strongly disagree).

We analysed the variables of stakeholder attributes of power, legitimacy and urgency. I the analysis power represents stakeholder level of influence on retrofitting decision making. This was measured by stakeholder responses to the questionnaire survey to the statement, "The below stakeholder group has the capacity and ability to influence to take decisions according to the requirement of the stakeholder, ex. Owner" (7= strongly agree, 1= strongly disagree). Legitimacy represents the means of a set of socially defined norms and values through different point of views. It was measured by asking stakeholders to the extent of their agreement with the statement of, "the below group of stakeholders requirement and needs are considered which are accurate and appropriate by other stakeholders" (7= strongly agree, 1= strongly disagree). Urgency states the degree of stakeholder attention claims immediate attention. It was measured by the following statement analysis of "The

activity level of stakeholder group towards important demands" (7= strongly agree, 1= strongly disagree).

The following equations were used to test the proposed multilateral stakeholder salience model:

$$SAL_{OI} = \alpha_0 + \alpha_1\ POW_{OI} + \alpha_2\ LEGIT_{OI} + \alpha_3\ URG_{OI} + \alpha_4\ SAL_{GR} + \alpha_5\ SAL_{AE} + \alpha_6\ SAL_{CS} + \alpha_7\ SAL_{OU} + \alpha_8\ SAL_{CP} + \mathcal{E}_{OI} \qquad (2)$$

$$SAL_{GR} = \beta_0 + \beta_1\ POW_{GR} + \beta_2\ LEGIT_{GR} + \beta_3\ URG_{GR} + \beta_4\ SAL_{OI} + \beta_5\ SAL_{AE} + \beta_6\ SAL_{CS} + \beta_7\ SAL_{OU} + \beta_8\ SAL\ CP + \mathcal{E}_{GR} \qquad (3)$$

$$SAL_{AE} = \gamma_0 + \gamma_1\ POW_{AE} + \gamma_2\ LEGIT_{AE} + \gamma_3\ URG_{AE} + \gamma_4\ SAL_{OI} + \gamma_5\ SAL_{GR} + \gamma_6\ SAL_{CS} + \gamma_7\ SAL_{OU} + \gamma_8\ SAL_{CP} + \mathcal{E}_{AE} \qquad (4)$$

$$SAL_{CS} = \delta_0 + \delta_1\ POW_{CS} + \delta_2\ LEGIT_{CS} + \delta_3\ URG_{CS} + \delta_4\ SAL_{OI} + \delta_5\ SAL_{GR} + \delta_6\ SAL_{AE} + \delta_7\ SAL_{OU} + \delta_8\ SAL_{CP} + \mathcal{E}_{CS} \qquad (5)$$

$$SAL_{OU} = \lambda_0 + \lambda_1\ POW_{OU} + \lambda_2\ LEGIT_{OU} + \lambda_3\ URG_{OU} + \lambda_4\ SAL_{OI} + \lambda_5\ SAL_{GR} + \lambda_6\ SAL_{AE} + \lambda_7\ SAL_{CS} + \lambda_8\ SAL_{CP} + \mathcal{E}_{OU} \qquad (6)$$

$$SAL_{CP} = \theta_0 + \theta_1\ POW_{CP} + \theta_2\ LEGIT_{CP} + \theta_3\ URG_{CP} + \theta_4\ SAL_{OI} + \theta_5\ SAL_{GR} + \theta_6\ SAL_{AE} + \theta_7\ SAL_{CS} + \theta_8\ SAL_{OU} + \mathcal{E}_{CP} \qquad (7)$$

In the equation (2) to (7), SAL represents stakeholder salience, and the subscripts OI, GR, AE, CS, OU and CP respectively denote Owners & Investors, Governments & Regulators, Architects & Engineers, Contractors & Suppliers, Occupants & Users and Community and Public. Where POW, LEGIT and URG represents power, legitimacy and urgency of the respective stakeholders.

Table 1: Results of MSS model

Stakeholders	Attributes	Coefficient	R-square	Adj-R-Square	P-value
Owners & Investors	POW	0.1423	0.273	0.243	0.0242
	LEGIT	0.1591			0.0027
	URG	0.2353			0.0000
Governments & Regulators	POW	0.1588	0.398	0.373	0.0024
	LEGIT	0.1913			0.0001
	URG	0.1548			0.0008
Architects & Engineers	POW	0.2817	0.22	0.188	0.0001
	LEGIT	0.2116			0.0049
	URG	0.3341			0.0000
Contractors & Suppliers	POW	0.3494	0.347	0.319	0
	LEGIT	0.1912			0.0008
	URG	0.2792			0
Occupants & Users	POW	-1.2272	0.777	0.768	0
	LEGIT	0.0654			0.0318
	URG	-0.0588			0.0392
Community and Public	POW	0.3492	0.56	0.542	0
	LEGIT	-0.025			0.6517
	URG	-0.0241			0.6508

POW = power, LEGIT = legitimacy, and URG = urgency

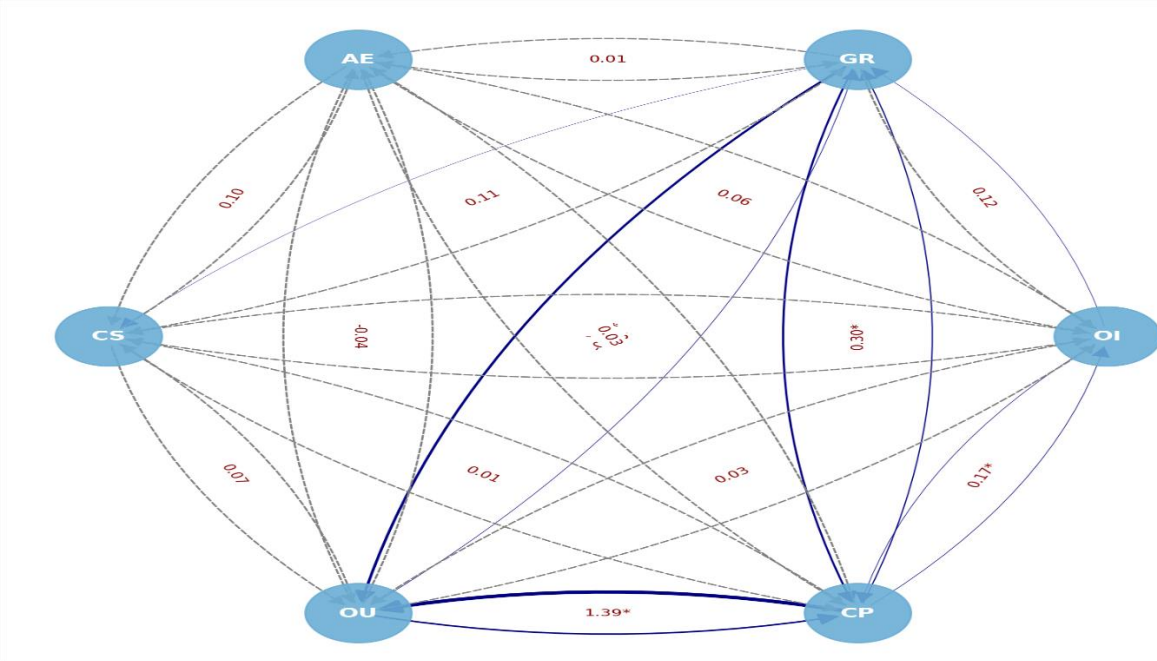Fig. 1: The Multilateral Stakeholder Salience Model (MSS)

Table 2 shows the results of stakeholder attributed impact on salience. The regression model of MSS framework shows the results for each stakeholder category which has a strong explanatory power. The r square values were consistently high which shows that the stakeholders attributes combinations and their cross- salience variables have substantial part of variance in stakeholder salience. The R-squared values were mostly in between 0.60 and .085. the explanatory strength of the model was validated by the values of adjusted R-squared which showed the inclusion of multiple predictors was not only the reason behind. F statistics among all models validated the joint contribution of the predictors towards the explanation of salience which was $p<0.001$. These results also confirmed the multilateral stakeholder salience framework robustness.

The stakeholder specific analysis also showed interesting results. Owners and investors play a vital role in the decision-making process and have a great influence on building retrofitting projects. These stakeholders derive salience mostly from their own power as they have decision making and financial control, as well as salience from government and regulators. The model captures the anchoring of owns and investors from financial and institutional perspective in retrofitting projects which was validated by the strong r-square value (0.273) this analysis also reveal their dual role as internally they play central decision makers role but externally are shaped by the regulatory frameworks.

The salience of governments and regulators are driven by their power to regulate, incentivize, and the approval initiative of retrofitting. They are also driven by the reinforcing effect of community and public salience., This also reflects a two relationship combined with top-down authority as well as a bottom-up legitimacy. The R-square value for government and regulators is 0.398, which indicates the explanatory power of the predictors for the stakeholder salience. This high value suggests that government are the initiators and responders in the retrofitting process.

Architects and engineers are strongly influence by their legitimacy, which comes from their technical expertise and professional credibility which is supported by owners and investors as they contract them and the contractors and suppliers who depend on their designs. This points out the connecting role architects and engineers play between the decision makers who are upstream and executors who are downstream. The result of the analysis where R-square value 0.22 lines up with the idea of architect and engineer's salience comes from their identified legitimacy not from power. On the other hand, contractors & suppliers salience derive from urgency which is time bound execution and

material delivery and salience of architects and engineers. Their salience shows operational stage of retrofitting as it depends on technical plans required to be converted into practical delivery plans. The strong interdependent relationship with architect & engineers represents the importance of coordination among design and construction.

Occupants and users are salient due to urgency and reinforcement by community and public salience. The urgency represents demand for comfort, safety and reduced energy bills. The sustainability transition literature emphasis on end user's role of accelerating adoption which is consistent with the occupants and users bottom-up pressure. So, occupancy and users salience arises from immediate, experience-based urgency. Community and public salience are driven by urgency and by the salience of government and regulators. Here urgency states activism, campaigns, environmental awareness, where government and regulators are those who amplify or respond to community concerns. Community and public stakeholder role highlights retrofitting through societal dimension by demonstrating how projects are embedded not just in technical systems but broadly in social legitimacy structure.

This multilateral stakeholder salience model highlighted various inter-dependent relationships between different stakeholders' categories. The regulatory salience consecutively spreads over owners which brings out the importance of compliance and incentive alignment. This analysis points out that the investors significantly impact design and delivery actor's salience which highlights the flow of authority. Architects & engineers and Contractors and suppliers show a reciprocal effect on each other which confirms a projects design and executions coupling. Occupants and community complement each other by explaining individuals' urgency combining legitimacy. A feedback loop is present between government and community. Government responds to the demands of the community where governments action brings out community salience.

The findings support (Mitchell et al., 1997) stakeholder salience framework as it confirms the centrality of power, legitimacy, and urgency. This study extends the previous framework in two ways: firstly, it explains the cross-stakeholders interdependencies' importance empirically by showing that salience is a phenomenon that is networked rather than its outcomes based on isolated attributes. And secondly, it highlights sector-specific dynamics of retrofitting projects as this analysis showed that technical legitimacy (AE), operational urgency (CS, OU and societal legitimacy (CP) communicated with institutional power (GR, OI). This layered structure adds new knowledge to stakeholder theory in sustainability transitions.

The results also present some managerial implications. This study suggests that governments and owners should use their role as connectors for initiating retrofitting, but they need to stay sensitive towards the bottom-up demands coming from OU and CP to maintain legitimacy. cy. AE and CS actors need to strengthen their inner coordination as their salience reinforce each other. Occupants and communities need to have active engagement by raising awareness and different participation programs, as their urgency not only comes from their own salience but also increases the salience of the regulators. Policy makers need to recognise salience as a dynamic network that targets both institutional actors and grassroot drivers to accelerate adoption of retrofitting.

4. Conclusion

In the recent times in retrofitting research stakeholder challenge comes up as one of the most important factors causing barriers retrofitting projects. This study identified specific retrofitting stakeholders for existing buildings and their level of influence on each other's. The result of the study has been presented multilateral stakeholder salience framework which presents unique opportunity for the actioners to see not only the level of influence of stakeholders on retrofitting projects but also the interdependence of each stakeholder on each other. The results shows that the stakeholders are not only influenced by their own attributes but also by other stakeholder's attributes. High R-squared value represents that the model has captured a substantial portion of the variance in stakeholder's

salience while the adjusted R-squared value represented the level of complexity of the model. Six categories were used to estimate the multilateral stakeholder salience model: Owners & Investors (OI), Governments & Regulators (GR), Architects & Engineers (AE), Contractors & Suppliers (CS), Occupants & Users (OU), and Community & Public (CP). The results indicated that the variables jointly accounted for a substantial proportion of variance in stakeholder salience within retrofitting projects, with R-squared values between 0.65 and 0.82 and F-tests significant at the one percent level. These findings validate that the integration of attribute- and network-based methodologies provides a comprehensive and reliable framework for understanding stakeholder prominence in sustainability-oriented scenarios.

The stakeholder focused analysis revealed distinct patterns. In case of owners and investors salience was dominated by their own power which is financial substance and decision-making authority but was also positively affected by salience of governments and regulators which indicates the ownership priorities can be framed by institutional policies. By depicting a bidirectional feedback chain between top-down power and bottom-up power community and public salience further legitimise government and regulators increased salience which is directed towards them due to their nature of power as institution. Architect and engineer's salience is driven by legitimacy which is due to their expertise and credibility which is crucial to their authority. Owner and investors and contractors and suppliers farther highlight their importance as they play the role of a connector between designing and building. Contractor and supplier's salience depend on urgency as they emanated the immediate building operations and also influenced by architects and engineers who finalize the design quality and also are the on-site performance receiver.

These results supported (Mitchell et al., 1997) and extended the stakeholder salience framework by presenting that power, legitimacy, and urgency remain the most essential things, but are not efficient enough to fully present the stakeholder prominence. Instead of that, salience comes out as a multilateral, networked occurrence that is impacted by both individual attributes and also cross-stakeholders' interdependencies. The observed pathways, for example GROI, OI→AE, and CS, AE↔CS, OU↔CS and GR↔CP shows how salience falls across institutional, technical and social domains. The future works can be focused on tracking salience across different phases of retrofitting projects. Also, this model can be applied on different policy, cultural and geographical contexts to reveal variation among various stakeholder salience drivers. By using interviews, focus group study and case study methodology with other quantitative models more deeper insights into stakeholder salience can be learned.

This study contributes methodologically, theoretically, and practically to the investigation of stakeholder salience in retrofitting projects. It shows the value of multilateral modelling, emphasizes the significance of both top-down and bottom-up dynamics, and lays the groundwork for further research at the nexus of sustainability, construction management, and stakeholder theory. Pathways to further develop, broaden, and contextualize these contributions are provided by the future research agenda presented here.

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