

Literature Review : How to Examine the Mediating Factor of Government Role in Renewable Energy Adoption

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Abstract

Indonesia is a blessed country with abundant renewable resources and the potential to manufacture up to 419 GWh of clean electricity for its people. The government plays a crucial role in shaping and nurturing the proper environment to support RE adoption and transition toward a sustainable economy. Various tools and dimensions are available to observe the government's role in accelerating RE adoption. However, studies show that the metrics used to examine Indonesia's government regarding RE adoption are lacking. This provides an opportunity to improve the metrics by referring to countries worldwide that show success in the particular research field. The current study aims to address the challenge by presenting a literature review of studies on the government's role in RE adoption and extracting insight to develop improved metrics for examining Indonesia's government's role in RE adoption. Furthermore, we use data mining to visualize the research map of the current topic to provide an understanding of which areas are underexplored. Thus, future studies can refer to the results to contribute further to the literature.

Keywords: Renewable Energy, Government Role, Policy, Investment, Text Mining, Literature Review

I. INTRODUCTION

Sustainability has become a topic important to discuss and address in recent decades. This was proven from worldwide actions e.g., Kyoto Protocol, Copenhagen Accord, and the Paris Agreement which aimed to combat climate change by encouraging industries to reduce their gas emission and present call to action for society regarding the importance of sustainability. The raising public awareness of sustainability has been pushing industries and companies to convert their operations that promote positive impact based on the three bottom lines: people, planet, and profit (Correia, 2019). The effort to move the economy should not be based only on profit but also on the welfare of the people involved and its implications for the environment, hence, the name is sustainable economy. Additionally, the concept presents economic resilience while mitigating economy activities environmental implications (Handayani et al., 2019). To add into perspective, the current technology of renewable energy (RE) can produce clean electricity with lower total cost and price per unit of energy compared to oil and gas plants (Kåberger, n.d.). This means that industries and even households can benefit from sourcing their electricity from RE sources while joining action to combat climate change and promote sustainability.

Several factors implicating a nation's sustainability includes the government role, the wide application of RE adoption, and technological advancement. The government intervenes to sustainability as a policymaker of the RE sector with two forms of approaches: direct or indirect. The direct approaches such as financial support to RE manufacturer and distributor, tax incentive for companies achieving RE target, and subsidy

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program directed to poor household or residents of the rural area. In comparison, the indirect approach is meant to set quality and quantity standards related to RE sector which when achieved can present benefits such as mitigating climate change, reducing carbon emission, and economic growth. Both approaches employed by the government are meant to increase the RE adoption by household and businesses. In terms of sustainability, the government plays a crucial role since they have the capability to develop and employ certain policies for the RE sector which promote and facilitate RE ecosystem development. Through incentive based or price-based policies, the government can enforce households and businesses to convert into cleaner energy from RE sources. The government intervention in RE sector can be vary depending on factors such as cultural factor, economy motive, resource endowment, and politics (Gallagher, K. S., 2013). The nation's economic state (developing or developed country) can also maket he differences, since the government of developing countries tend to focus on clean energy access and economic development, which in contrast, the focus of the developed countries are to mitigate climate change and reduce carbon emission [5].

The current study aims to explore and examine government intervention in the RE domain. Accordingly, the findings contribute to the literature by providing a model which can be referred to by future studies in the same field. Furthermore, we provide a thorough mapping of sub-topics surrounding the discussion of government intervention in RE sector, highlighting future research opportunities to explore the discussion and spark more debatable topics.

Theoretical Background

The Government and Sustainability

Authorities worldwide has been scrutinizing the climate change topic and acted on it through various worldwide action such as Kyoto Protocol, Copenhagen Accord, and the Paris Agreement for the sole goal of providing a sustainable life for future generations. Following the concern, investment was being made to develop technologies and policies capable of supporting the sustainability goal. Hence, renewable energy sector has been important ever since to present sustainable solution capable to solve sustainability problem from three aspects: people, planet, and profit.

The RE sector stakeholder encompasses government, RE manufacturer, energy distributor/retail, and consumer. RE manufacturer is plants producing clean electricity from renewable sources e.g. wind, solar, geothermal, and hydropower. The retail company is responsible for transmitting clean electricity to the buying customers across the nation. The government plays a crucial role as the policy maker which facilitates and provides supportive ecosystem for RE solution implementation. Gallagher (Gallagher, K. S., 2013) mentioned that governments motivation in RE policies including economics, resource endowment, politics, and cultural factors. Meaning that other than sustainability goals, the government also has other aims such as ensuring economic growth or gaining good political image worldwide. Those motivation factors can affect a nation's RE policy characteristics. For example, the main driver to RE policies in developing countries are energy access and economic development, in contrast, advanced industrialized countries the main driver is to address

climate change [5]. We present literature review on both country types in the next section below to understand the differences.

Worldwide Government Intervention in Renewable Energy Sector

The current segment presents literature review of research articles discussing government role as policymaker in the RE sector. The articles collected were selected from various journals and research databases using the keyword ‘government’ and ‘renewable energy’ which resulting in 9 research articles. We addressed each study in the following paragraph below.

Previously, a study on 152 developing countries shows that in majority, the government and private entities provides direct investment to boost the nation’s RE sector, also subsidized the nation’s RE production (Osei et al., 2023). The approach was meant to support the development of proper RE ecosystem which is affordable for the people. The similar subsidy policy is also employed by government in southeast asia countries whereas the target is poor household and for businesses, a tax incentive was given to those participating to promote or consume the clean energy from RE sources (Khan & Gunwant, 2023). As comparison, in an industrialized country such as China, the subsidy policy is given to RE manufacturer and distributor (Zhu et al., 2019) ; furthermore, the government also intervene indirectly through setting the national RE consumption rate and macro-economy metrics [9]. We can infer that China’s government focus is not only mitigating the climate change but also ensure economic growth through RE sector. The same also applies to Iranian government which control and facilitate RE adoption through monetary policy i.e., money supply and interest rate which implicate government’s direct investment to the nation’s RE sector (Razmi et al., 2021).

The government of western countries has a mixed approach encompassing direct and indirect approaches. R. Leonhardt et. al., (Leonhardt et al., 2023) highlight the approach by Canadian government which provides an energy market as an instrument to facilitate its people to source RE product such as renewable energy certificates and perform auction on RE projects. In addition to that facility, there are price-based approaches including premium feed-in tariff scheme, net metering, power purchase agreement. Also, tax incentives and finansial supports were provided to facilitate RE project operation to meet the renewable portfolio standards. As the regulatory basis, the canadian government also employed land use controls, climate change, and greenhouse gas mitigation policies. In comparison to Canada, the European countries government provides a leeway to RE manufacturer by employing flexible feed-in tariff scheme, along with finansial support and incentives to achieve the national RE targets (Gatzert & Kosub, 2017). The USA government approach on RE adoption also use renewable portfolio standards and executive orders on RE sector, however, the approaches is heavily implicated by country’s political motivation [13, 14].

From the collected articles above, we can determine factors or method on how governments worldwide intervene in each nation’s RE sector. As policymaker, government can employ two types of policies i.e., price-based or quantity-based to grant supporting RE ecosystem. There were also significant differences in the developed policies based on the nation’s status as a developing or underdeveloped country.

II. RESEARCH METHODOLOGY

The government's main role in RE adoption is being the policy maker that provide and support suitable environment for industries and household to source clean energy. RE policies can be classified into two types: price-based, and quantity-based policies (Kilinc-Ata, 2015). For example, feed-in tariff and net metering which is a price-based policies whereas RE manufacturer can gain benefit from a set price by the government. On the contrary, government may also provide subsidies i.e., tax credits, grants or loans to encourage industries to invest on RE. To execute its role, government can use various approach such as coercive power, learning mechanism, present a normative emulation or competition effect (Zhou et al., 2019). Nevertheless, the current study aims to explore policies in RE sector employed by the government worldwide. Additionally, we present a research map encompassing sub-topics regarding government involvement in the RE sector which can be referred to by future studies to uncover debatable subjects in the RE research field.

The current study has two main methods to achieve the mentioned goals. First, we conduct rigorous literature review on studies encompassing various government policies in RE sector. The literature review also accounts for the country-subject discussed in the study, hence, we will gain abroad perspectives. Based on the literature review result, we developed a model which can be referred to by quantitative studies to examine drivers or determinants of government role in RE sector. For the second method, we collected research article's data that discuss about government and RE sector from Scopus database by using the following query syntax: Government AND Renewable AND Energy OR Mediating AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (EXACTKEYWORD , "Renewable Energy") OR LIMIT-TO (EXACTKEYWORD , "Renewable Energies") OR LIMIT-TO (EXACTKEYWORD , "Government")). Next, we perform text mining and extract clustered topics from the dataset which later will be called sub-topics since they represent a group of studies with similar synergies or subjects in the RE research field. Additionally, we developed an LDA map using the sub-topics to identify relationships between sub-topics which can present future research opportunities. The current study's research workflow is visualized in Figure 1 below.

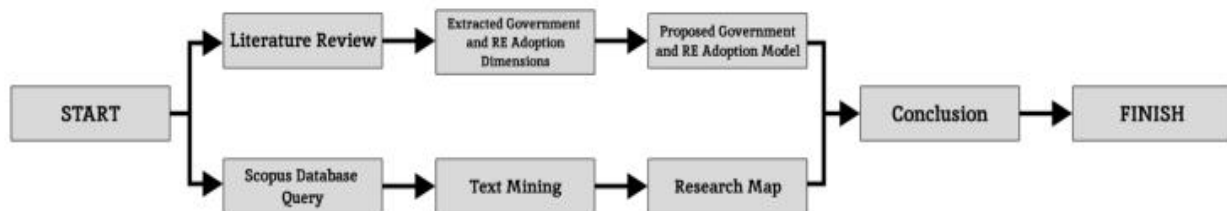


Figure 1 Research Workflow

III. RESULT AND DISCUSSION

Literature Review Result

The current study performs literature review aimed to present a broader view of worldwide governments' approach in RE sector. We extracted the government's policies in each study to develop dimensions implicating government's role in the RE sector. The extracted policies are presented in Table 1 below.

Table 1 Extracted Policies by Study

Author	Studied Country	Policies
Osei, Fiagbe, and Kulu	Combination of 152 developing countries	• Government Investment in RE Sector • Private investment in RE sector • Subsidized RE Production
Khan and Gunwant	Southeast Asia Countries	• Household subsidy policy • Tax incentive regulation
Z. Zhu et. al.	China	• RE manufacturer subsidy • RE retailer subsidy • Revenue Sharing Contract
R. Leonhardt et. al.	Canada	• RE auction or tender mechanism • Tax Incentives • Financial supports • RE Intermediaries supports • Energy Planning & efficiency • Land use controls • Renewable portfolio standard (RPS) • Climate Change and GHG Mitigation Policies • Energy Market Instrument • Net Metering • Renewable Energy Certificate • Power Purchase Agreement (PPA) • Feed in Tariff (FiT) • Feed in in Premium (FiP)
Lacouture and Roper	USA	• Executive orders on RE sector • Political motivation
X. Yang et. al. [9]	China	• Subsidy on RE-related sectors • Macro-economy performance metrics • National energy consumption rate
Gatzert and Kosub	European Countries	• Financial support and Incentives • Feed-in-tariff Flexibility
Razmi et al.	Iran	• Monetary Policy
Pastor	USA	• Renewable Portfolio Standard (RPS) Policy

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We can infer from the table above that there are similarities across countries, for example, the southeast asian countries and other developing countries RE policies leaning toward subsidies, incentives, and investments. While the advanced industrialized countries i.e., China, European countries, USA, and Canada has different approach which their RE policies focused on mitigating climate change and facilitating the developed RE sector through price-based (e.g., feed-in tariff and net metering) and quantity-based (e.g., renewable portfolio standard, GHG mitigation, and land use controls) policies; our findings confirms the policy characteristic based on the nation's status as developed or developing country as in [5]. Conversely, the government in the developed and advanced industrialized countries i.e., China, Canada, and USA use mixed of direct and indirect approach to support the RE sector development. This is different compared to government of Iran, southeast asian countries, and other developing countries which focused on the direct approach. Nevertheless, USA is the only identified country whom the government is influenced by political motive. Next, we grouped the identified policies into two groups: price-based and quality-based as mentioned in (Kilinc-Ata, 2015). Following that, the grouped policies can be determined as a dimension which implicate governments' role in the RE sector. The same applies to the identified incentives in the table above, we grouped them into one dimension as RE Incentives. We also recognize the importance of the government political motive since the stable political climate is one of the key for one's country to receive foreign investment in the RE sector (Gatzert & Kosub, 2017). However, we did not account the government approach in executing its role i.e., coersive power, learning mechanism, present a normative emulation or competition effect as in (Zhou et al., 2019). The result is presented in Figure 2 below.

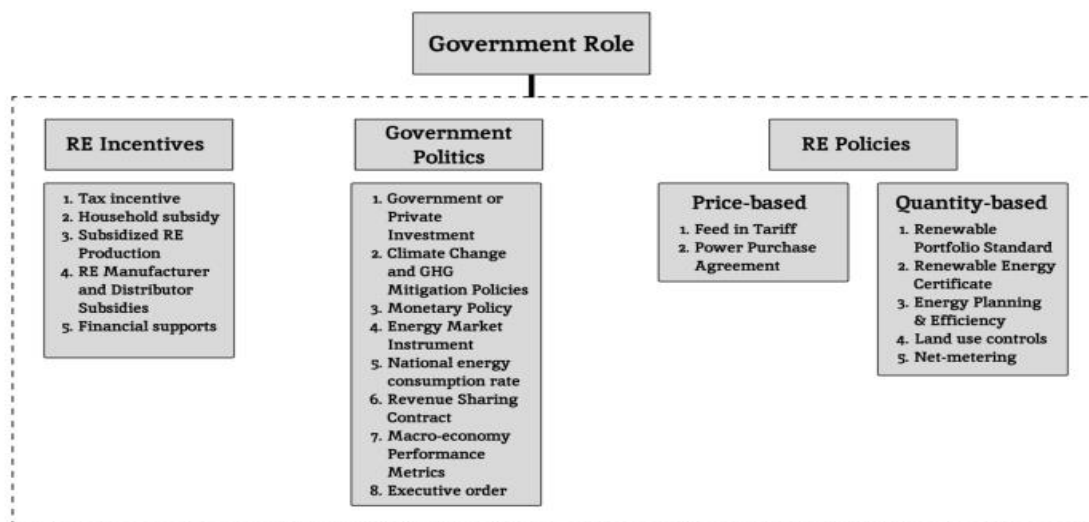


Figure 2 Proposed Government Role and RE Adoption Model

The figure above represents potential dimensions associated to government's role in the RE sector. Our proposed dimensions cover all the aspects of the government as policymaker in the RE sector, encompassing policy types, incentives program, and government's politics. Thus, we provide a thorough perspective in examining government's role in the RE sector.

The RE incentives dimension refers to government programs aimed directly to support RE stakeholders by lowering the entry barrier to RE transition. As for the government, politics are filled with policies or order which can affect the nation’s RE ecosystem significantly. For example, the energy martket instrument that can determine how the RE is traded domestically or internationally, also setting the macro-economy performance metrics as a goal to be achieved by the country can affect how government programs in RE sector will be held in the following period. In account to RE policies which are classified into two groups based on how the operational factor of the policy (price-based and quantity-based).

Text Mining Result

The query on the Scopus database using the mentioned syntax resulted in 3544 articles. We extracted the articles’ abstracts and proceeded with clustering the articles. To split the articles into their respectable clusters, we develop an LDA model and evaluate its performance using the CV coherence score. The best output from our LDA model is 8 clusters, which we later called sub-topics, and the evaluation shows a coherence score of 0,39. The coherence score indicates a reasonable coherence level in the identified topics. Clusters are visualized in Figure 2 below.

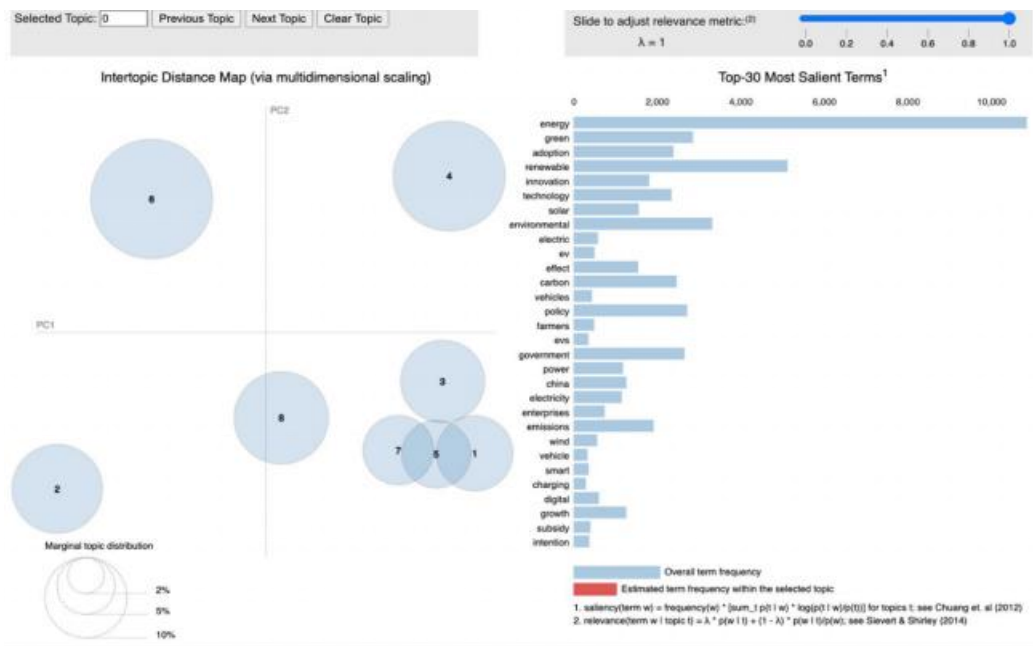


Figure 3 Clustered Articles

The size of clusters in the figure above is based on the volume of words they contain, and each cluster also has different word rankings based on its salient terms. The figure above shows that there are three overlapping cluster: cluster 1,5, and 7; indicating an overlapping synergy. In contrast, some clusters i.e., cluster 2, 4, and 6 are greatly distanced from the others, indicating distinguish subject or discussion by the clustered studies. We describe each cluster using the top 10 keywords in the ranking (salient terms) and present it in Table 2 below.

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Table 2 Cluster Description

Cluster Number	Keywords	Description
1	study, smart, adoption, factors, government, barriers, management, waste, analysis, supply	The cluster explores factors affecting the adoption of smart management strategies for waste and supply chain systems in renewable energy contexts. It examines government roles and barriers to implementation, using analysis to understand challenges and opportunities in effective resource management.
2	green, environmental, innovation, effect, development, china, government, impact, study, digital	The studies on the cluster focused on green innovation and environmental sustainability, particularly in China, this cluster examines the impact of digital development on renewable energy. Studies in this group analyze the government's role and environmental effects of green initiatives in advancing sustainable practices.
3	energy, study, renewable, solar, adoption, perceived, intention, factors, research, model	This cluster highlights renewable energy adoption studies, especially on solar energy. It focuses on factors that influence perceived intentions and individual adoption behaviors. Research models here often predict adoption trends based on various factors and motivations that drive renewable energy usage.
4	energy, renewable, solar, power, electricity, systems, system, generation, wind, technologies	Centered on renewable energy technologies, this cluster explores solar and wind power systems in electricity generation. It covers the technical systems and technologies involved, highlighting innovations in energy generation processes and the deployment of renewable power infrastructure
5	adoption, technology, farmers, technologies, study, biogas, diffusion, blockchain, factors, rural	This cluster investigates the adoption of renewable technologies in rural areas, focusing on biogas usage among farmers. Studies here analyze the diffusion of sustainable technologies and the potential application of blockchain to enhance rural adoption, considering the specific challenges in rural renewable energy transitions.
6	energy, renewable, emissions, environmental, study, countries, economic, development, carbon, growth	Focusing on the environmental and economic impacts of renewable energy, this cluster analyzes the role of countries in managing carbon emissions through sustainable development. It covers studies on balancing economic growth with carbon reduction, emphasizing renewable energy's role in environmental policy goals.
7	electric, ev, vehicles, energy, evs, government, adoption, vehicle, charging, model	This cluster addresses the transition to electric vehicles (EVs) and related charging infrastructure within renewable energy policies. Studies here focus on government support for EV adoption, examining models that predict market trends and policy implications for accelerating EV use as part of broader energy strategies.
8	policy, carbon, government, energy, green, study, policies, development, research, paper	Centered on policy research, this cluster examines government-led policies for carbon reduction and green energy development. Studies analyze policy effectiveness in meeting renewable energy targets, providing insights into research on policy formulation for sustainable energy growth.

Based on Table 3, we can infer that the overlapping clusters (cluster 1,5, and 7) were caused by similar discussion which is about adoption in the RE field. While the distanced clusters indeed have distinct subjects to discuss. Respectively, cluster 2 discusses government's intervention on sustainability through digital and

green innovation. In cluster 4, the discussed subject is about technology and system to generate clean electricity from RE sources. Lastly, studies in cluster 6 focused on examining the relationship between economic growth and sustainability. From size perspective, both cluster 4 and 6 have similar size, meaning that studies on the Scopus database in terms of RE adoption and government topic mainly discuss about RE technologies and its implication toward sustainability or countries' economic growth. On the contrary, cluster 5 and 7 share similar small size, indicating fewer studies that discussed blockchain and biogas technological adoption in farming industry and government intervention on EVs. In between the largest and smallest size clusters, there are cluster 3 and 8 which discussed RE adoption intention and government policies regarding RE and carbon emission respectively. We consider that the small size of cluster 5 and 7 caused by the recent development of blockchain technology and EVs compared to discussed subject in cluster 4 and 6 which has been explored for a longer time period.

Discussion

From the two sections above, we present the result of each main activities in the current study: literature review and text mining. Accordingly, we want to discuss our findings and compare it to the previous study. Hence, future studies can refer to this section to spark debatable topic or addressing the gap found in the current study. We discussed our findings in separate paragraphs below. First, the literature review result presents a model encompassing government dimensions influencing RE adoption. We put together dimensions from various studies related to RE adoption which are associated to the government. Hence, the model can cover various perspective represented by those dimensions.

Second, the text mining provides two interesting insights: various sub-topics from the government in RE sector and future studies opportunities on that main topic. Given the mapping result in Figure 3, there are 3 clusters overlapping one another indicating same synergies that is RE adoption and differs in its discussed subjects: waste management, blockchain in farming industry, and EVs. A future study should explore sustainability association with the mentioned subjects to determine which subject provides significant impact toward sustainability.

Alternatively, the study may also account how government intervention accelerates RE adoption or mitigate carbon emission to achieve sustainability. In addition, future study can examine the government's method to execute its role as policymaker e.g., coercive power, learning mechanism, present a normative emulation or competition effect as mentioned in (Zhou et al., 2019). This will provide insights of our model effectiveness to present the relationship and identify which dimension strongly associated to support RE adoption.

The current study contributes to the literature by presenting a model based on literature review which can be referred by future studies to examine government's role in RE sector. The implication to the finding is government influenced RE sector through factors encompassing RE policies, RE incentives, and government's politics. Accordingly, we present a thorough perspective covering governmental aspects in the RE sector.

IV. CONCLUSION

The current study has developed a model which can be referred to examine the association between government role as policymaker in RE sector. The model consists of dimensions compiled from various studies which provide and cover a thorough perspective and governmental aspect. Additionally, we present a research map consisting of sub-topics related to government role in RE sector. The insight from the map serves as encouragement for future study to claim the opportunity to conduct studies in the underexplored area e.g., government's role and environmental effects of green initiatives in advancing sustainable (cluster 2) and the diffusion of sustainable technologies and the potential application of blockchain to enhance rural adoption toward sustainability (cluster 5).

The approach used in this study is a literature review and text mining; both aim for the same objective: to extract insights from previous studies related to government's role in the RE sector. The literature review resources are studies of carefully selected papers by the author, while the text mining resource is from the Scopus database. Through text mining, we were able to identify research areas encompassing RE adoption in multi-domains, digital and green innovations in RE domain, clean electricity system and technology, also economic growth and sustainability relationship; the results are clusters presented in Figure 3. Limitations in the current study include the Scopus database and a few selected studies in the literature review section. Accordingly, the current study's findings are also limited due to our sources. In addition, studies used in the text mining are selected based on the keywords alone and do not consider its influence on other studies (for example, the paper's journal index and number of citations across platforms). Hence, future studies should provide a wider approach by including several research databases. Thus, the findings are more thorough and provide valuable insights, sparking new debatable topics. The current study also did not test nor experiment with the developed dimensions of government role in RE sector. Future studies should refer to our model to understand the implication of dimensions in government toward RE adoption and sustainability. Nevertheless, it's important for the study to account the country's demographic, since different characteristics of people can bring different results on the examined dimensions.

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