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Article

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Managing Sustainability of Energy Transition among Expert Engineers: Co-creating Technopreneurial Orientation

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ABSTRACT

Purpose: Research to improve co-creation in engineering and technopreneurial orientation is required to support the energy transition toward sustainability. This challenge is aimed at power system expert engineers, whose central role in the electricity sector is becoming increasingly complicated by the possibility of stranded assets, intermittency paradigms, and new patterns of energy flow. This research explains the importance of the co-creation process as a mediator to enable the utilization of the technopreneurial orientation among expert engineers in supporting the sustainability of the electricity sector.

Design/methodology/approach: The survey method was carried out to collect data from expert power system engineers with more than ten years of experience in the national electricity sector. The quantitative method with structural equation modeling analysis and a partial least square approach was used in this research.

Findings: Empowering expert engineers in a technopreneurial orientation can encourage them to co-create by prioritizing dialogue that allows for accessibility and transparency when taking risks, which is an important aspect that boosts the co-creation effect in the energy transition to sustainability. The strong behavior of experts in utilizing technopreneurial orientation and the co-creation process has been demonstrated to be capability of adopting the three aspects contained in the energy trilemma index, energy security, energy equity, and environmental sustainability, which are modified to reflect a strong tendency to achieve sustainability in the electricity sector.

Research limitations/implications: Although this study's respondents are limited to expert engineers in the electricity sector, the findings have implications for the management of experts in other strategic and large-scale sectors. The limited number of respondents to expert engineers with more than ten years of work experience makes millennials excluded.

Originality/value: The measurement indicator becomes novelty in this study. Sustainability was adopted and modified from the energy trilemma index. Technopreneurial orientation adopted from Lumpkin & Dess (1996) was modified by the addition of technological expertise. Then, co-creation as a mediator is taken from the DART of value co-creation.

Keywords: Sustainability, Co-creation, Technopreneurial Orientation, Energy Transition, Expert Engineer

I. Introduction

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The Covid-19 pandemic could serve as a catalyst for the greater use of new and renewable energy

(NRE). Massive activity restrictions have resulted in a downward trend in global carbon emissions as a result of reduced energy consumption. Even so, developing NRE is a difficult task. Social restrictions during a pandemic are a challenge from the supply chain perspective, as is the interaction of workers, to the financial situation. Meanwhile, the competitive situation caused by fluctuating global fossil-fuel prices, which makes them more economically profitable, is a challenge in and of itself. Similarly, coal-fired power plants remain stalled due to investment contracts. Therefore, it is an important priority for the formation of a renewable energy framework (energy transition) towards electricity sustainability in the new world after the COVID-19 pandemic.

Indonesia, which has pledged to reduce global CO₂ emissions as part of the Paris Agreement, is also a part of the energy transition. By 2025, Indonesia wants to achieve a 23 percent NRE utilization rate in its national energy mix. Indonesia's commitment to reduce emissions by 29 percent by 2030 is seen as a step toward a cleaner and more sustainable energy system, despite the fact that it is not ambitious enough. Until 2020, the country's total installed power generation capacity was 71 GW. Coal-fired power plants, on the other hand, continue to dominate, with NRE plants accounting for only 14.69 percent of total installed capacity (MEMR, 2021).

The next consideration for the formation of a renewable energy framework in the new world after the pandemic is the changing pattern of electrical energy consumption. The shift in the burden of electrical energy to the residential sector is also a separate consideration. As is known, the characteristics of household electricity consumption are very unique, depending on the activities of the occupants and the unique behavior of the occupants (Zohar, Parag, & Ayalon, 2020). Also as a consideration, the characteristics of the load (consumption) of electricity, it is not fully in accordance with the characteristics that supply (production) it, namely the majority of types of coal-fired power plants with a population of around 63.9% (Mulyana & Rahmawati, 2020).

The energy transition towards the use of renewable

energy also needs to consider the characteristics of renewable energy plants, the majority of which have a strong dependence on the natural conditions in which they are located. This causes the operation of renewable energy power plants to be influenced by natural activities (Harjanne & Korhonen, 2019). Moreover, Indonesia, which is in a tropical climate, is currently experiencing uncertain natural conditions due to global climate change (Djalante & Thomalla, 2012; Sugiawan & Managi, 2016). Therefore, the above will be very complicated if it has to meet the target of reliability of electricity production.

Another consideration is the emergence of the use of micro-scale power plants used in housing. Roof-top Solar power generation can indeed help achieve the energy transition towards the use of renewable energy. However, the characteristics of this type of generator also require separate considerations. Intermittency due to dependence on nature, the potential for its scattered location, unique household consumption patterns, coupled with the emergence of small household-based industries, all of which must be important points that must be taken into account.

All these complexities require the active role of power system experts to engineer the solution. Since the electricity sector relies on high technology in almost all areas, this role must be increasing. The factors that must be faced include technological developments that are challenged from an economic perspective, the intermittency of NRE power plants which are strongly influenced by changes in weather and climate, the dependence of NRE power plants on the state of local natural resources as well as environmental changes and the dynamics of the local community which has a variety of characteristics as well. It is a challenge for power system experts in planning a reliable electricity system. Thus, to accommodate the energy transition towards electricity sustainability, the power system experts must be able to overcome these complexities.

Since sustainability is the main goal of the energy transition and everything is based on three basic aspects: people, profit, planet, harmonization will be needed to make it happen. Harmonization is needed so that other parties also take an active role in realizing overall

sustainability through the energy transition in the electricity sector (Buana, Mursitama, Abdinagoro, & Pradipto, 2021). Therefore, the various complexities that occur above become the starting point of this research, namely the management of engineering activities carried out by power system experts in the field of electricity to new horizons.

The article continues with a literature review on energy sector sustainability as the main framework by modifying the Energy Trilemma Index as an indicator. Then, co-creation will be a means to accommodate the forms and characteristics of cooperation between parties. Meanwhile, technopreneurship orientation will drive the tendency of power system experts to utilize their expertise. The results of the analysis of the quantitative method will discuss trends that will have implications for the management of engineering activities that prioritize sustainability, as well as include them in future research.

II. Literature Reviews

A. Sustainability in a Value of Energy Trilemma

Sustainability performance as measured through the three-pillar approach to sustainability (triple bottom line/TBL) has become a widely accepted perspective (Lacy, Gupta, & Hayward, 2019). Measurement of sustainability performance has become the basis for control processes in business, one of which is used to measure organizational performance, whether sustainability-oriented or not, using three indicators, namely, economic, social, and environmental (Hourneaux Jr, Gabriel, & Gallardo-Vázquez, 2018). In support of that, the measurement will be carried out on electrical energy, which is the final form of energy that is best suited to achieving the energy transition to sustainability (Henbest, 2020). Therefore, the sustainability of electricity cannot be separated from the sustainability of energy as a whole (Goldrath, Ayalon, & Shechter, 2015).

According to the World Energy Council, sustainability in the energy context can be evaluated in the form

of a more general sustainability index (WEC, 2018). The World Energy Council defines energy sustainability in the form of the Energy Trilemma Index, which includes three dimensions, namely energy security, energy equity, and environmental sustainability at the national level (WEC, 2017). The Energy Trilemma Index is an official indicator to measure energy sustainability performance in terms of a country's ability to provide a sustainable energy system through three balanced dimensions, namely, energy security, energy equity (accessibility and affordability), and environmental sustainability (Song, Fu, Zhou, & Lai, 2017).

B. Co-creation in Generating Value

Harmonization of various roles in creating sustainability requires an embodied process. Harmonizing various complexities in an engineering activity requires a good orchestration process. Departing from previous research which says that the complexity in the energy transition to sustainability comes from economic, social, and environmental factors (Grubb, McDowall, & Drummond, 2017). There is another statement about the complexity of the energy transition that actually comes from a non-technical side (Tainter, 2011). Until the finding that the complexity of the energy transition stems from the difficulty of the process to participate, participate and cooperate effectively among the experts involved (Johnson, 2007). So this study uses a value co-creation approach where a collaboration process that is more than just an interaction relationship between interested parties can jointly create a strategic function (Prahalad & Ramaswamy, 2004).

The conceptual journey of value co-creation has progressed in all directions. One of them is used to reduce information asymmetry between parties who have mutual interests (Prahalad & Ramaswamy, 2001). For this reason, indicators that are in the concept of dialogue, accessibility, risk, and transparency become a means of approach to assessing its success (Taghizadeh, Jayaraman, Ismail, & Rahman, 2016). Dialogue is a flow of information that requires deep involvement in lively interactivity with an empathic understanding

and is based on the desire of both parties to act on the information received. Accessibility is formulated as freedom (right) to use facilities for dialogue, active participation, or joint use of resources in the value creation process. Meanwhile, risk has the meaning of being dependent between parties who have an interest in creating value together by upholding the values of honor and trust. Transparency is implemented as the availability of reliable, up-to-date information, and can facilitate and empower users to create quality value (Albinsson, Perera, & Sautter, 2016).

C. Technopreneurial Orientation

Since this study uses expert engineers as survey objects, a combination of technology-based expertise and entrepreneurial-based skill utilization is used in this study. Therefore, the term technopreneurship is used since it is still latent and has not been condensed by this term (Fowosire, Idris, & Elijah, 2017). The use of this term suggests the existence of innovative technology mastery skills, individual scientific insight, and technical knowledge, followed by the ability to create and manage businesses and take financial risks to achieve their goals and perspectives (Dolatabadi & Meigounpoory, 2013). So that it is felt to be compatible with the relationship of influence on the innovation ecosystem variable in this study. The concept of entrepreneurial orientation which contains elements of aggressiveness towards competitors and a tendency to act independently refers to the processes, practices, and decision-making activities that lead to a desire to innovate, take risks, and a tendency to be proactive towards market opportunities (Lumpkin & Dess, 1996).

The argument for using the technopreneurship variable here also departs from the assumption that not all people who are technically intelligent (engineers) and have high technical skills have skills in managing opportunities in entrepreneurial thinking. It is also emphasized that there are engineers who have high technical skills but few skills in business and entrepreneurial thinking (Prodan, 2007). Therefore, this study proposes the concept of technopreneurial

orientation as a combination of entrepreneurial and tech-savvy orientation. So that there are three aspects, namely innovativeness, proactiveness, the courage to take constructive risks (Miller, 2011), two aspects of namely independence and competitive aggressiveness (Lumpkin, Brigham, & Moss, 2010), and added tech-savvy aspects, namely understanding modern technology and using their expertise to take advantage of the technology (Fowosire et al., 2017).

III. Development of Research Hypothesis

The energy transition opens up opportunities for the involvement of various parties to bring about changes for the better and more harmonious among electricity people (Szulecki, 2018). The co-creation process can improve sustainability performance that prioritizes togetherness in sustainability. Social, economic, and environmental harmonization as the foundation for collectively shaping the future, is shaped by togetherness in value creation (Ma et al., 2019). The increase in sustainability caused by the increase in co-creation behavior stems from the balance between the provider and beneficiary components in a harmonious environment (Kuenkel & Gruen, 2018). That the sustainability performance of the energy transition can be jointly directed to renewable energy, requires greater togetherness in making it happen (Jenkins, 2019). The increase in co-creation behavior which will be followed by an increase in sustainability is also supported by the statement that the creation of shared value affects the high joint success to realize sustainable development (Kruger, Caiado, França, & Quelhas, 2018). Based on that, that sustainability is a value that is embodied in the balance of the three main social, economic and environmental pillars that can be created jointly by interested parties, the proposed hypothesis is:

- H1:** The co-creation has a significant effect on the achievement of sustainability performance.

Technopreneurship can increase company growth because of the role of the actors who are good at empowering technology as a company resource (Dolatabadi & Meigounpoory, 2013). This is because technopreneurs can create new values that can sustain economic growth (Nurdiyanto, 2018). Because technology can drive the market to transform into a network that allows the process of creating shared value (Breibach & Maglio, 2016). The interaction process for value creation is facilitated by the expertise of the actors in mastering the technology (De Silva & Wright, 2019). Due to technology is only a tool, so an entrepreneurial perspective and initiative are still needed to proactively and productively co-create value (Shams & Kaufmann, 2016). If entrepreneurs have personal characteristics that can involve themselves in every social and cultural structure (Gbadamosi, 2019), then value co-creation emphasizes mutually beneficial collaboration among stakeholders (Kohtamäki & Rajala, 2016). So the argument is following the opinion that the co-creation of value is supported by an entrepreneurial orientation (Marcos-Cuevas, Nätti, Palo, & Baumann, 2016). Based on that, value creation can be built jointly by the technopreneurial orientation shared by the entire strategic environment. So the proposed hypothesis is as follows:

H2a: The co-creation is affected significantly by the technopreneurial orientation.

H2b: The co-creation significantly mediates technopreneurial orientation on the achievement of sustainability performance.

Entrepreneurship has a positive relationship with sustainable development in the presence of innovation and high technology (Youssef, Boubaker, & Omri, 2018). Technology-based entrepreneurship has the opportunity to play a greater role in promoting sustainable development (George, Merrill, & Schillebeeckx, 2020). Therefore, technology-based entrepreneurship becomes important when issues related to sustainable development occur (Nilsson, Jansson, Vall, & Modig, 2018). An entrepreneurial approach to sustainability generates themes that are closely related to great uncertainty and ignorance (Sung &

Park, 2018). This affects the ability of actors to predict the future effectively to avoid the effects of its degradation (Dorion et al., 2018). To find out that sustainability is a manifestation of the balance of the three main pillars of sustainability, namely social, economic, and environmental which are influenced by technopreneurial orientation, the researcher proposes the following hypothesis:

H3: Technopreneurial orientation has a significant effect on the achievement of the sustainability performance.

IV. Methodology

In this study, an explanatory survey was conducted to determine the characteristics of the research object which can be identified from a series of analytical activities and research samples (Leedy & Ormrod, 2015). The data from this quantitative study were obtained from the results of distributing online questionnaires at one time (cross-sectional). A total of 149 answers from expert engineers in the main islands in Indonesia, reflecting 33 indicators of the variables of technopreneurship, co-creation, and sustainability. The indicator uses a 7-point Likert scale response, ranging from strongly disagree with a score of 1, to strongly agree with a score of 7. A Likert scale with 7 categories ensures a higher quality of the information in the data collection phase (Tarka, 2017). Scale 7 also provides a more accurate measure of electronically distributed and unsupervised questionnaires (Finstad, 2010) and is more suitable for use on respondents with high cognitive abilities (Weijters, Cabooter, & Schillewaert, 2010).

In this study, the variable technopreneurial orientation was measured using seven indicators by adopting from previous studies. The indicator is a combination of the two. First, from Lumpkin & Dess, (1996) for activeness in perfecting a new method/method/solution, intensity of activity in identifying opportunities, efforts to minimize risk to get opportunities, competitive

activity in delivering solutions, independence to think and act in developing, produce and implement new ideas. Second, from Fowosire et al., 2017) for expertise in using technology to find opportunities, expertise in using technology to create opportunities.

Value creation is a strategic function of the interaction of parties whose shared interests contribute to creating a unique experience. Based on this, the DART model, namely Dialogue, Access, Risk, and Transparency, was developed as a necessary element for the creation of shared value (Taghizadeh et al., 2016). In this study the DART model was developed into 13 indicators; starting from the perception of the desire to have a dialogue with each other in sharing ideas/ideas, active dialogue with each other, the level of support for dialogue with each other, the availability of facilities for access, the opportunity to access, ease of access, the existence of control from both parties on access, understanding for each other. sharing risk, mutual respect in decisions related to risk, mutual trust in the risks borne, perceptions of the importance of information disclosure, information disclosure, perceptions of the quality of disclosure in information disclosure.

Furthermore, sustainability performance as measured through a three-pillar approach to sustainability (triple bottom line/TBL) has become a widely accepted perspective. Based on the TBL, economic, social, and environmental, the measurement of sustainability performance in this study uses 13 indicators (WEC, 2019); efforts to improve electrification/access to electricity connections, increase the affordability of electrical energy, availability of quality electrical energy, the relationship between companies and the community, management of the electricity system, reliability of the electricity system, resilience of the electricity system, flexibility of electricity infrastructure against trends of change, level of community prosperity, efficiency efforts of the entire electricity system, efforts to decarbonize the entire electricity system, efforts to use new and renewable energy, aesthetics of transmission and distribution networks.

This study uses structural equation modeling (SEM) analysis with partial least-squares (PLS) approach.

The aim is to examine the relationship between variables in this case how the respondents' technopreneurship orientation through the co-creation process to create sustainability. SEM-PLS analysis in research using ADANCO software. The first stage is to test confirmatory factor analysis to obtain the validity and reliability of the constructs and their respective indicators. The second stage examines the structural model of the relationship between the variables. The value of the coefficient of determination is used to predict the contribution of the influence of the exogenous latent variable to the endogenous latent variable. Then the path coefficient value is used to determine the pattern of the effects caused by the exogenous latent variable on the endogenous latent variable. This study defines sustainability as an endogenous latent variable, co-creation as an intervening latent variable, and technopreneurial orientation as an exogenous latent variable.

V. Result

All indicators of measuring this variable are valid and reliable, as shown in Figure 1 on the loading factor value of each indicator, and Table 1, the brief descriptive output results of the ADANCO software. Figure 1 shows the coefficient of determination (R^2) 0.5139 which indicates 51.39% of the variance in the co-creation variable explained by the technopreneurial orientation variable.

While the value of the coefficient of determination (R^2) is 0.5826, indicating 58.26% of the variance in the sustainability variable explained by the co-creation and technopreneurial orientation variable. The results of the software output for the structural model show values such as Table 3. The path coefficient test results in this model have a value of 0.7169 on the path of the relationship between technopreneurial orientation and co-creation, indicating the higher the technopreneurship orientation among expert engineers in a collaboration, then co-creation will increase by 71.69% or more co-creation among engineers. Likewise,

the path coefficient value of 0.5679 on the relationship between co-creation and sustainability, indicates that sustainability will increase by 56.79% due to co-creation that occurs among engineers. Meanwhile, the path coefficient value of 0.2455 on the direct relationship between technopreneurship orientation and sustainability, is still lower than the value of the indirect effect of 0.4071, proving that the co-creation process mediates technopreneurship orientation among expert engineers to achieve sustainability. The complete results are shown in Tables 3 and 4. In this study, an indication of the size of the influence between variables

is shown by the value of Cohen's f^2 . The value of 1.0573 on the relationship between technopreneurial orientation and co-creation, and 0.3755 on co-creation and sustainability prove the magnitude of the influence between each. Meanwhile, the value of 0.0702 ignores the direct relationship between technopreneurial orientation and sustainability (Hair, Hult, Ringle, & Sarstedt, 2017).

The path coefficient value to be confirmed, the ADANCO software bootstrap 999 samples, and 5% confidence. The results obtained a t-value of 17.7863 and a p-value of 0.0000 on the relationship between

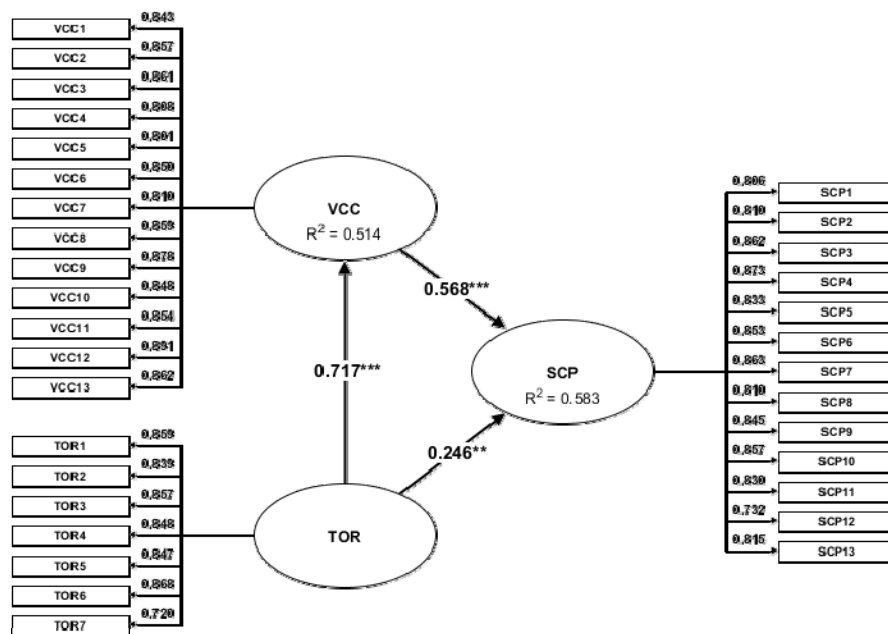


Figure 1. The software output indicates the validity and reliability of the indicators, the R^2 value and the path coefficient of each relationship

Table 1. Descriptive statistic, loading factor, and variance inflation factor

Variable	Indicators	Mean	LF (>0.5)	VIF (<0.5)
Technopreneurial Orientation (TOR)	TOR1	6,1208	0,8590	4,0440
	TOR2	6,1879	0,8389	3,1170
	TOR3	6,1812	0,8571	3,2891
	TOR4	6,0000	0,8485	2,7361
	TOR5	6,0000	0,8467	2,9988
	TOR6	6,1007	0,8677	2,9840
	TOR7	6,0336	0,7201	2,0645

Table 1. Continued

Variable	Indicators	Mean	LF (>0.5)	VIF (<0.5)
Value Co-creation (VCC)	VCC1	6,2349	0,8434	3,7701
	VCC2	6,1141	0,8572	3,9038
	VCC3	6,1544	0,8612	4,2368
	VCC4	5,8926	0,8075	2,9036
	VCC5	6,0067	0,8014	3,0315
	VCC6	5,9732	0,8502	3,5199
	VCC7	6,0470	0,8105	2,7512
	VCC8	5,9060	0,8590	4,0834
	VCC9	6,0604	0,8780	4,4378
	VCC10	5,9396	0,8482	4,2066
	VCC11	6,0067	0,8544	4,3793
	VCC12	6,0134	0,8909	4,0196
	VCC13	6,0000	0,8623	4,0081
Sustainability (SCP)	SCP1	6,4027	0,8055	3,3782
	SCP2	6,3826	0,8105	3,6155
	SCP3	6,4094	0,8619	4,6030
	SCP4	6,4228	0,8735	4,3481
	SCP5	6,3893	0,8326	4,1750
	SCP6	6,3758	0,8525	4,2141
	SCP7	6,4228	0,8628	4,1414
	SCP8	6,1946	0,8098	2,7871
	SCP9	6,3490	0,8446	3,7816
	SCP10	6,3356	0,8573	3,4671
	SCP11	6,2148	0,8302	4,0583
	SCP12	6,2215	0,7319	2,6850
	SCP13	6,2416	0,8151	3,2196

VIF: Variance Inflation Factor
 LF: Loading Factor

Table 2. Construct validity and reliability

Construct	AVE (>0.5)	ρ_A (>0.7)	Cronbach- α (>0.7)
Technoprenurial Orientation (TOR)	0.6978	0.9317	0.9272
Co-creation (VCC)	0.7198	0.9683	0.9675
Sustainability (SCP)	0.6900	0.9637	0.9624

AVE: Average variance extracted
 ρ_A : Dijkstra-Henseler's coefficient

Table 3. Output of structural model path

R ²	Path	Path coefficient	Cohen (f ²)	t-value (t > 1.96)	p-value (p < 0.05)
VCC : 05139	TOR - VCC	0.7169	1.0573	17.7863	0.0000
SUS : 0.5826	VCC - SCP	0.5679	0.3755	5.4244	0.0000
-	TOR - SCP	0.2455	0.0702	2.7642	0.0029

R²: Coefficient of determination
 Cohen (f²): Effect size

Table 4. Bootstrap output of path modelling

Path	Direct effect	Indirect effect	Total effect	t-value (t > 1.96)	p-value (p < 0.05)
TOR - VCC	0.7169	-	0.7169	17.7863	0.0000
VCC - SCP	0.5679	-	0.5679	5.4244	0.0000
TOR - SCP	0.2455	0.4071	0.6526	11.8228	0.0000

technopreneurial orientation and co-creation, and this proves the significance of the influence between them. In the relationship between co-creation and sustainability, the t-value is 5.4244 and the p-value is 0.0000, so there is also a significant effect on the relationship. On the direct influence between technopreneurship orientation and sustainability, there is also a significant relationship, as evidenced by the t-value of 2.7641 which is greater than 1.96, or the p-value of 0.0058 which is smaller than 0.05 (Hair et al., 2017). The significance test result of the direct and indirect effect (total effect) which obtained a t-value of 11.8228 and a p-value of 0.0000, on the relationship between technopreneurial orientation to sustainability through the co-creation process proved to be greater than the t-value of 2.7642 and p-value of 0.0029 on the direct relationship between technopreneurship orientation and sustainability. With this, it is proven that the intervening role of the co-creation variable is significant. Although all hypotheses are accepted, it still proves the important role of co-creation in mediating the influence of technopreneurship orientation on sustainability. The results of this total effect also prove that a series of process stages that must be met such as the hypothesized model is recommended. Thus, the results of this research have the interpretation that the expert power system engineers who have a strong technopreneurial orientation will be more in need of a co-creation process to realize the high value of its sustainability performance.

VI. Discussion

Practically, this study confirms the importance of

successful sustainability in the electricity sector through co-creation activities that are preceded by a technology-based orientation to the experts. Various organizations and companies in the electricity sector or other energy sectors that focus on the three pillars of global and regional sustainability, often encounter difficulties when they have to carry out activities that involve the active role of all parties, even though they are held in a sense of togetherness. This happened because of the lack of technopreneurial orientation among the expert engineers. As is known, the energy sector always involves high technology to achieve high efficiency. So it is necessary to guarantee the success of each stage of its activities with parameters that can be interpreted from something complicated to easy to understand for laymen. Therefore, the role of the expert engineer who understands the technical aspects must be improved in his entrepreneurship orientation from the beginning of the initiation of his program of activities so that it becomes the key to success in the long term.

This research has succeeded in adopting sustainability aspects from the energy trilemma index, which is then applied to the investigation of the behavior of expert engineers towards sustainability. Therefore, the operational implications of these aspects must refer to the perception of the expert engineers on how to plan activities that contain an entrepreneurial mindset so that they can work together with interested parties in the electricity sector in achieving sustainability goals in energy. trilemma index, namely according to its three dimensions, energy security, energy equity, and environmental sustainability. The behavior of togetherness in achieving energy security goals can be seen clearly from the efforts to achieve significant electrification targets. Efforts to make electrical energy affordable in a fair manner to remote areas are also

significantly implemented. Likewise, the provision of quality energy has always been a common achievement target. This is also in line with the togetherness of steps from all parties which is reflected in the strong relationship of good togetherness with all levels of the local community. It seems that the strong efforts of the expert engineers to be able to continue to be able to jointly create value for electricity sustainability in achieving energy equity are implied by the shared goal of achieving the fulfillment of electrical energy needs in the future. Likewise, in concerted efforts to eliminate systemic disorders in duration and frequency. The recovery mechanism quickly and independently must also get guarantees from all parties together. So, if the three previous aspects are successfully pursued, then it could have implications for increasing people's prosperity because of consuming electrical energy. The implications of joint efforts to achieve environmental sustainability according to the priority of achieving efficiency, as well as efforts to decarbonize the entire electricity system by seeking the use of renewable energy in the form of an energy mix, can minimize losses due to stalling of coal-fired power plant assets that have been built.

The proof of a positive paradigm that co-creation can realize sustainability theoretically supports previous research which says that the balance of social, economic, and environmental as the basis for forming a collective future, is shaped by togetherness in value creation (Ma et al., 2019). The increase in sustainability caused by the increase in co-creation behavior is shaped by a balance between the provider and beneficiary components in a harmonious environment (Kuenkel & Gruen, 2018). Similarly, the statement that the sustainability performance of the energy transition can be jointly directed to renewable energy, thus requiring greater togetherness in making it happen (Jenkins, 2019). The increase in co-creation behavior which will be followed by an increase in sustainability is also supported by the statement that the creation of shared value affects the high joint success to realize sustainable development (Kruger et al., 2018). Based on the arguments above, that is why the value co-creation (VCC) variable acts as an important mediator in achieving sustainability.

By confirming the desire of the key respondents to devote time to the establishment of an interactive collaboration (co-creation), it is seen that the expert engineers are very enthusiastic to spend their time on every electricity technology event. On that occasion, it was revealed that expert engineers always took the time to satisfy their curiosity about the progress and development of up-to-date electricity technology, which occurred because of the co-creation earlier (Gbadamosi, 2019). Likewise, the explanation of the reason for the strong curiosity in co-creation with technology activists was also answered by the strong desire of the expert engineer for the development of scientific and technological progress (De Silva & Wright, 2019). They are also very proactive and productive in initiating entrepreneurship from a value co-creation perspective (Shams & Kaufmann, 2016). The results of this study are also proven to support previous research that technopreneurship is able to create new value that can sustain economic growth (Kohtamäki & Rajala, 2016; Nurdyanto, 2018). Because technology can drive the market to transform into a network that allows the process of creating shared value (Breibach & Maglio, 2016). This research will lead to mutually beneficial co-creation for the sustainability of the electricity sector in entrepreneurial attitudes, which have their characteristic which can be involved in all social and cultural structures.

Theoretically, this research contribution adds to the literature on the mediating role of value co-creation in the DART dimensions (dialogue, accessibility, risk, and transparency) in empowering engineering-skill-based entrepreneurial orientation, which in this study is termed technopreneurial orientation, in order to achieve sustainability. Furthermore, the practical contribution of this research is on how to manage electric power engineers in facing the challenges of decarbonization. The condition of the large number of fossil fuel power plants that are still of economic age requires their role. Excavation efforts that put forward an entrepreneurial orientation from maximizing the function of their technical expertise are carried out by means of collaborative creation for the sake of achieving sustainability in the electricity sector.

VII. Conclusion

In general, this study proves that the characteristics of power system expert engineers who carry out strategic planning in the national scope can achieve good performance in realizing sustainability as a value from the results of co-creation. This study was successful in empirically proving a management model in a national-scale strategic company that prioritizes sustainability as a performance benchmark. The significance of expert engineers in achieving electricity sustainability in Indonesia cannot be separated from the complexity and dynamics involved in achieving such sustainability. As a result, we require a strong technopreneurship orientation from expert engineers in order to engage in co-creation and achieve electricity sustainability.

The technopreneurship orientation of expert engineers is proven to support the realization of electricity sustainability through the co-creation process. However, several factors require more in-depth research to improve the sustainability performance of the electricity sector. The first suggestion that can be proposed as a recommendation for engineering management in the electricity sector is the need for action from the management to improve the situation of togetherness in dialogue that provides mutual access to openness to minimize risk perceptions together. The second suggestion for the management, especially those dealing with the strategic electricity industry, is the need to pay attention to the aspects that are used as indicators of the co-creation model for sustainability in this research. The third suggestion from this research is for stakeholders to consider facilitating experts in their respective fields to contribute to the three pillars of sustainability through dialogue by having transparent access and awareness of the risks borne by each party.

Before generalizing the findings of this study, it is necessary to consider its limitations. Respondents in this study were limited to working years of more than ten years, so the millennial generation was excluded. Although the data was collected anonymously, self-report behavior measurement allows social desirability bias to occur due to the tendency of responding

inappropriately.

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