

Uncertain Supply Chain Management

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Factors affecting renewable energy supply chain link: A case of solar power in Vietnam

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ABSTRACT

Solar power is a mature and fast-growing field based on single crystal silicon wafer technology. Although China, Europe and the US are the main markets, 80 percent of the modules are manufactured in Asia. In Vietnam, modules are manufactured in collaboration with Chinese and American manufacturers. In 2017, there were 5 GW of solar panels produced in Vietnam, accounting for 7% of the global market. The domestic solar market is expected to peak at around 1.8 GW/year according to the targets set out in the revised PDP 7. The domestic module production capacity, currently devoted entirely to export, is around 5.2 GW/year, three times the expected maximum capacity of the domestic market. In that context, due to the normal size of factories, only a few parts factories can sell to the domestic market, while the majority still must rely on exports. But it is important to map out a clear roadmap for 12 GW of solar power that will encourage the formation of EPC companies and other domestic service companies in Vietnam to build factories according to the plan. Construction, operation, maintenance, and production for the domestic market has the potential to increase Vietnam's GDP by about 0.25% by 2030 and create more than 25,000 jobs.

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1. Introduction

Vietnam's competitiveness in solar power generation was assessed based on four parameters to compare with selected base countries (China, Malaysia, Philippines, Thailand, and the United States). Those four parameters are: (i) factors of production (availability and cost of materials, labor force and capital); (ii) demand factors (domestic and export markets); (iii) risk and stability factors (country risk, inflation, regulatory framework for renewable energy); (iv) business enablers (infrastructure, industry position in the economy, innovation, and competitiveness). Vietnam's competitiveness lags China, Malaysia, and Thailand in all fields of solar power except framework and structure. Vietnam's main strengths are factors of production, especially the labor market, availability of raw materials for the solar power industry (especially steel), and affordable energy costs for the industry. industrial consumers. The production of modules, photovoltaic cells, silicon wafers/wafers, and finally inverters is mainly for export and will develop independently from the construction of solar power projects in the country. Structures and services (such as project development, engineering, design, and O&M) will develop to serve the domestic market. Renewable energy depends a lot on natural conditions as well as technology and production costs. Therefore, to promote the development of renewable energy, it is necessary to have more specific supporting policies on: quota mechanism, fixed price mechanism, bidding mechanism and certification mechanism; implementing projects to release renewable energy capacity is urgent, creating favorable conditions for power plants to generate full capacity. Recently, renewable energy is one of the potential investment fields and is rapidly growing globally. Statistics show that the total investment capital for renewable energy in the world increased from about 50 million USD in 2004 to 2.6 billion USD in 2019. However, this

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investment capital accounts for only a small proportion compared to the need for economic restructuring to address climate change issues. The World Bank forecasts that by 2030, the investment demand for renewable energy will be about 30 billion USD per year.

Vietnam has emerged as the largest investor in renewable energy development in Southeast Asia since 2017. The total capacity of solar power consumed by EVN in the first 6 months of 2020 is up to 4.71 billion kWh and there are currently hundreds of investors queuing up to register for investment with a total capacity of up to hundreds of GW. The exploitation and application of renewable energy to create electricity supply is a common trend of many countries around the world, to ensure energy security and sustainable development. Leading industry experts say that effective investment for sustainable development of renewable energy is not only for businesses but also has a positive impact on the environment. The energy sector needs to mobilize great resources from many economic sectors, making important contributions to promoting socio-economic development, ensuring national defense and security in many localities and countries.

2. Literature review

Based on the development of the concept of supply chain linkage in both practice and theory, Bechtel and Jayaram (1997) divided four different schools of thought about supply chain linkage: (1) logistics school. /link (the “linkage/logistics school”), claiming that supply chain linkage is linking logistics activities; (2) the “information school”, which implies linking information flows both inside and outside the enterprise; (3) the “integration/process school”, the concept of linking business processes between businesses in the supply chain; (4) the school of functional chain awareness (the “functional chain awareness school”), which divides supply chain links into external links (links between businesses) and internal links (links between businesses). Table 1 presents details of the variables used for the proposed model of this paper.

Table 1
Research models

	Symbol	Description	Reference
Collaborativeness	CT1	The elements in the chain plan together the activities of the chain	Simatupang & Sridharam (2008), Fisher (1997); Simchi-Levi & Zhao (2003)
	CT2	The actors in the chain regularly evaluate the collaborative process	
	CT3	Chain members always collaborate to develop new markets and products	
	CT4	Elements in the chain always collaborate to perform chain operations	
	CT5	Elements in the chain frequently share information	
Trust	TN1	Our partners (suppliers and importers) are always open and do not hide their business goals	Doney and Cannon (1997), Moberg et al. (2002), Abullad and Musa (2013), Andaleeb (1995), Ha et al. (2011)
	TN2	Our partners always have a positive attitude in mutual agreements	
	TN3	I trust my partners to be honest	
	TN4	Components in the chain always respect each other	
Powerful	QL1	The actors in the chain have equal power when making decisions about chain operations (production, distribution, sales, research and development, etc.)	Hart and Saunders (1997), Sawhney and Parikh (2001), and Wu and Chen (2014)
	QL2	Suppliers and importers both influence our decisions (about production, distribution, sales, research and development, etc.)	
	QL3	We all have influence over the decisions of our partners (about production, distribution, sales, research and development, etc.)	
Co-operate	HT1	The members of the chain all hope to continue the relationship in business	Lee et al. (2010), Bensaou (1997) and Wu and Chen (2014), Abullad and Musa (2013).
	HT2	The members in the chain all want to expand their relationships with partners	
	HT3	We spend a lot of time building relationships with partners	
	HT4	We invest a considerable budget to build relationships with partners	
	HT5	Relationships with partners are more important than short-term profits	
Cultural	VH1	We have similar cultures (in terms of language, needs, habits, ...)	Lee et al. (2010)
	VH2	We easily understand the terms and ways of doing business of partners	
	VH3	We always agree with partners' solutions to solve problems	
Business strategy	KD1	Components in the chain together develop a common business goal for the renewable energy supply chain	Lusch and Brown (1996), Pereira, A. (1997), Mentzer et al. (2001)
	KD2	The components in the chain are highly in agreement with the common business goals of the renewable energy supply chain	
	KD3	The members in the chain all understand the business goals of the partner	
	KD4	Partners all understand their rights and obligations in the operation of the renewable energy supply chain	
State support	HTNN1	Does the Vietnamese government implement policies and special projects to support businesses?	Lee et al. 2010
	HTNN2	The State of Vietnam provides the necessary information in a timely manner	
	HTNN3	The State of Vietnam provides financial support for businesses	
	HTNN4	The State supports other resources for businesses	

Research philosophy includes important assumptions about how the researcher views the world. Assumptions in research philosophy will form the basis of research strategy and methods. The views and attitudes of researchers about the worldview often differ and this affects their research strategies and methods. Research philosophy consists of two basic components: epistemology and ontology (Hart & Saunders, 1997). First, the research model and assumptions are determined from existing studies and theories on the relationship between supply chain linkages, premises and results, and the author uses an interpretive research method (Creswell, 2003).

3. Method

The scales were synthesized from the study review. They are then analyzed and compared to select the scales that best match the research objectives and context. Since most of the scales are highly abstract, the scale is used in this study to increase the choice of the subjects being investigated. The official questionnaire has 29 items, including 24 items for the scale of factors affecting collaboration in the supply chain, and 5 items for the dependent variable. The content of the scales is synthesized by the author from officially published studies, then translated into Vietnamese and discussed with a group of enterprises participating in expert interviews to adjust some concepts to suit well suited. However, in the process of conducting the survey, the author also had to explain to the respondents the ideas that the content of the question did not convey. To record the respondent's assessment of the questions, the author uses a 5-point Likert scale as follows: 1: Completely disagree; 2: Disagree; 3: No opinion/neutral; 4: Agree; 5: Totally agree.

The overall research is experienced and knowledgeable managers in the management of activities in the renewable energy - solar energy supply chain. Based on the population definition, the next step is to determine the appropriate sample size. There are different ways to determine sample size. The sample size should be equal to the number of variables multiplied by 10. The number of variables in this study is 13, so the sample size should be $13 \times 10 = 130$.

4. Results

4.1. Cronbach's alpha

All 7 scales have the satisfactory Cronbach's Alpha coefficient since they are greater than 0.6, the correlation coefficients of the total variables are higher than 0.3; all remaining observations for 7 scales were retained for EFA analysis.

Table 2

Cronbach's alpha results

STT	Observed variables	Cronbach's alpha results
1	Trust	0.879
2	Powerful	0.688
3	Co-operate	0.868
4	Cultural	0.790
5	Business strategy	0.789
6	State support	0.819
7	Collaborativeness	0.839

Source: calculated by the author

4.2. Hypothesis testing research model with Pearson correlation analysis and multivariable linear regression

As mentioned, the scales of research concepts have been preliminarily evaluated through Cronbach's Alpha reliability coefficient and exploratory factor analysis EFA. Next, we conduct Pearson correlation analysis to check the linear relationship between these scales.

Table 3

Pearson correlation analysis results

		CT	QL	KD	TN	HT	VH	HTNN
CT	Pearson Correlation	1	.662**	.592**	.692**	.506**	.420**	.358**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000
QL	Pearson Correlation	.662**	1	.301**	.559**	.307**	.389**	.120
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.161
KD	Pearson Correlation	.592**	.301**	1	.357**	.312**	.145	.265**
	Sig. (2-tailed)	.000	.000		.000	.000	.090	.002
TN	Pearson Correlation	.692**	.559**	.357**	1	.361**	.351**	.226**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.008
HT	Pearson Correlation	.506**	.307**	.312**	.361**	1	.259**	.120
	Sig. (2-tailed)	.000	.000	.000	.000		.002	.162
VH	Pearson Correlation	.420**	.389**	.145	.351**	.259**	1	.013
	Sig. (2-tailed)	.000	.000	.090	.000	.002		.878
HTNN	Pearson Correlation	.358**	.120	.265**	.226**	.120	.013	1
	Sig. (2-tailed)	.000	.161	.002	.008	.162	.878	

** Correlation is significant at the 0.01 level (2-tailed).

Source: calculated by the author

The results show that the linkage variable in the supply chain is correlated with the remaining variables with the p-value = 0.000 significance level, in which trust and strength have a stronger correlation with linkage than other variables. On the other hand, cooperation agreements and supply chain linkages are less correlated.

Next, we conduct linear regression analysis to test hypotheses and research models with supply chain linkage as the dependent variable and the factors trust, strength, cooperation agreement, culture, business strategy and state support are six independent variables. The following results:

Table 4
Evaluate the fit of the model

Model	R	R square	R squared corrected	Model Summary ^b	
				Estimated error of standard deviation	Durbin-Watson coefficient
1	.886 ^a	.768	.799	.29025	1.972

a. Predictors: (Constant), TN, QL, HT, VH, HTNN, KD

b. Dependent Variable: CT

Source: calculated by the author

The adjusted R squared reflects the influence of the independent seas on the variation of the dependent variable, in this case 7 factors influence 76.8% of the change in connectivity, 29.3% due to factors other than the model and random error. The Durbin-Watson coefficient is 1,972, in the range of 1.5 - 2.5, so there is no first-order sequence autocorrelation. Then continue to test the fit of the model to check whether this regression model is suitable with the collected data set and has applied significance through ANOVA test as follows:

Table 5
ANOVA results

Model	Sum of Squares	Df	Mean Square	F	Sig.	
1	Regression	25.673	6	4.568	68.325	.000 ^b
	Residual	8.204	135	.063		
	Total	33.876	141			

a. Dependent Variable: CT

b. Predictors: (Constant), TN, QL, HT, VH, HTNN, KD

Source: calculated by the author

Sig test $F = 0.000 < 0.05$, so the regression model is significant.

Table 6
Multiple regression results with partial regression coefficients in the model

Model	Unnormalized coefficients		Normalized coefficient	T-value	Sig.	Multicollinearity statistics		
	B	Std. Error	Beta			Tolerance	VIF	
(Constant)	.029	.188		.109	.917			
QL	.202	.036	.300	5.538	.000	.630	1.588	
VH	.098	.037	.115	2.406	.018	.805	1.242	
1	KD	.294	.036	.288	5.965	.000	.791	1.264
	HT	.179	.036	.160	3.535	.001	.904	1.106
	TN	.229	.037	.282	5.064	.000	.597	1.676
HTNN	.133	.029	.173	3.621	.000	.807	1.239	

a. Dependent Variable: CT

Source: calculated by the author

The t-test of the regression coefficients of the independent variables are all less than 0.05, so all the independent variables are significant to explain the dependent variable and no variable is excluded from the model. The VIF coefficients of the independent variables are all less than 2, so there is no multicollinearity phenomenon (Anderson & Gerbing, 1988). The unnormalized regression coefficients are all greater than 0. Thus, the 6 independent variables included in the regression analysis all have a proportional impact on the associated dependent variable. Based on the size of the unnormalized regression coefficient Beta, the three factors of power, trust, and business strategy have more influence, while the remaining three factors are culture, cooperation agreement and cooperation. State support has less influence on the connectivity in the renewable energy - solar power supply chain in Vietnam. The multiple regression equation is expressed in the following form:

$$VT = 0.2 QL + 0.098 VH + 0.294 KD + 0.179 HT + 0.229 TN + 0.133 HTNN$$

5. Discussion

Regarding the influence of the research factors on the linkage in the supply chain, the results of the multivariable linear regression show that all 6 factors explain about 74.7% of the linkage in the supply chain, in the three factors of credibility,

power, and business strategy have a greater influence than the other three factors. While previous studies have all confirmed the significant effects of trust and strength on supply chain linkages. The study reaffirms that issue but adds and affirms strategic factors. Business strategy has a greater influence than the other two factors on the linkage in the renewable energy - solar power supply chain in Vietnam. Chain members believe that they will link well with each other if they have a common business goal in the chain and each member's business strategy is like the business strategy of the whole chain.

The remaining three factors have less influence on the connectivity in the renewable energy - solar power supply chain in Vietnam, of which two new factors have been introduced into the study: cooperation agreement and cooperation state support. Although the factor of cooperation agreement is quite interesting by surveyed enterprises (the average score of this factor is 3.96), the degree of influence on the linkage is not high (beta coefficient = 0.179). This also shows the cooperative culture of Vietnamese businesses, they may agree to a cooperation agreement but then for other reasons may change quickly, no longer attaching importance to previous agreements. Moreover, they can be easily changed, maybe because there are not strong enough sanctions in these agreements, so when other benefits are offered, they are easy to change. This is also a point to be noted to have solutions related to the culture of cooperation in order to strengthen the connection between the components in the chain. The factor of state support is also confirmed to have a positive impact on connectivity, although it has the lowest influence on connectivity in the supply chain of renewable energy - solar power in Vietnam.

In conclusion, the regression results demonstrate that the role of factors in enhancing collaboration is clearly hierarchical. Therefore, solving the construction and development of the supply chain must be based on the results of the test of several factors affecting the collaboration in the renewable energy supply chain. In other words, to improve the level of cooperation in the current Vietnamese renewable energy supply chain, the industry has focused on improving several factors in terms of trust, power, cooperation agreements, and strategy. business, culture, and state support. In which, the industry needs to pay special attention to building a solution to improve the level of credibility, power, and business strategy, because these are the three factors that have the greatest influence on the full level of collaboration in the entire chain.

6. Conclusion

To overcome the above shortcomings and limitations, in the coming time, it is necessary to implement the following solutions synchronously:

Firstly, the Government will soon issue macro-orientations related to the Strategy for Development of the Energy Sector in general and the Power Sector in particular, including: (i) National Strategy for Energy Development to 2030, vision look to 2050; (ii) Strategy for development of Vietnam's electricity sector to 2030, with a vision to 2045; (iii) National electricity development plan for the period of 2021-2030, with a vision to 2045 (Power planning VIII). This is an important legal basis of decisive significance to realize Resolution No. 55/NQ-TW dated February 11, 2020, of the Politburo on "Vietnam's national energy development strategy to 2030, vision to 2045".

Secondly, to study, amend and supplement in time the Petroleum Law, Electricity Law, Mineral Law and a number of other relevant laws in the direction of: (i) Limiting the overlap and contradiction between the laws, by making it so that specialized law governs all activities in the field of that discipline; (ii) Emphasizing the legal management of state management agencies and minimizing the intervention of the State (ministries, branches, localities) in the production field of electricity entities, coal, oil and gas; (iii) Minimize "interpretation of the law" documents, as well as overlapping guiding circulars of ministries and branches; (iii) Clearly identify a focal point responsible to the Party, Government and People for national energy security to ensure consistency in the management and organization of the implementation of the energy development strategy; (iv) There is a clear mechanism and strong enough sanctions to bind the responsibilities of stakeholders in the process of law observance and implementation of the direction of the Government and state management agencies in the supply chain. - power bridge. Attach the responsibility of the investors in the implementation of the schedule, ensuring the quality of the assigned projects. Specifying the responsibilities of local leaders for compliance with the electricity development planning to avoid the situation of planning being broken due to local causes.

Third, to promote the formation of a competitive energy market under the market price mechanism in the spirit of Resolution No. 55/NQ-TW, which is: Stable and sustainable development of electricity, coal, oil, and gas industries; against all forms of monopoly; create competition in the production and trading of electricity, coal and oil and gas; and transparency in energy management.

Fourth, innovate thinking, approaches and methods of energy planning and implementation. Attach the responsibilities of line ministries to the feasibility of energy plans. Stop planning just to "permit", manage planning in the style of "harmony of the whole village", etc.

In short, promoting the development and use of renewable energy sources and increasing domestic energy supply will contribute to the achievement of the country's socio-economic - environmental goals, ensuring security. energy, response to climate change, environmental protection, and sustainable growth.

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