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ASSESSING THE ROLE OF HYDROPOWER ENERGY IN SUSTAINABLE DEVELOPMENT OF MYANMAR

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Abstract:

The power generation of Myanmar is not enough for demand, the most of state and region except Nay Pyi Taw are faceing power load shed in their daily life. Hydropower is a potential alternative to overcome this problem currently occurring in Myanmar. The objectives of the study were to investigate the role of hydropower in sustainable development of Myanmar and to analyze the role of hydropower effecting national power sector development.

There were three factors required to balance the power sector development such as requirement of more electricity supply from various types of power generation, cost effectiveness and energy sustainability. Assessing the role of hydropower for sustainable development of Myanmar was analyzed by Likert Scale and descriptive method was used for data analysis based on primary and secondary data. Except 50 respondents of Kyitaung Village, 100 respondents of government staff and officers, 50 respondents of Asia World company were surveyed using systematic random sampling method. The correlation analysis and multiple regression analysis were used to examine the variables that influence the role of hydropower impacting the national power sector development of Myanmar. It indicated that respondents favour the tangibility factors which influenc trust and satisfaction on social and economic benefit with hydropower percentage value 95.1% and others were 90% over except willingness to pay was 60.1%. The correlation coefficient between environmental protection and national development was 0.950, which was the strongest link seen among independent factors and national development. The coefficients of power quality and environmental protection exhibited complete significance at a 1% level. Conversely, the coefficient of cost effectiveness demonstrated significance at a 5% level. Government should make efforts for public awareness in hydropower which is clean renewable energy for balancing the

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power generation and distribution load. Public involvement in hydropower projects will succeed to fulfill large generation requirements and industrial development in Myanmar.

***Keywords*:** more electricity, cost effectiveness, sustainability, environment, power sector, national development.

Introduction:

Although Myanmar proves abundant in natural resources for electric power generation, it nevertheless does not produce enough power for domestic consumption and moreover loses money when it tries. This study seeks to examine the reasons for this dilemma, as well as point the way forward a more successful path of sustainable energy production.

Nearly everyone in Myanmar faces problems related to load sheds from the power supply in their daily life (except Nay Pyi Taw) so they tend to be unhappy with power system supply and distribution services. Likewise, industrial customers also require more electricity to achieve production efficiency. Power generation is not adequate to supply the entire country, because the reliability and stability of Myanmar's power supply remains low. And the coverage by Myanmar power grids is limited to only about 52% of the populace getting electricity, with construction of new power supply systems few and far between, especially in rural areas (MOEP).

Consequently, the Myanmar power sector needs to achieve profitability from electricity generation, transmission, and supply services to allow for the construction of new generation plants, substations, transmission systems, and distribution lines, as well as for the upgrading of older power plants, substations, and grids, and the implementation of smart metering (to allow for public transparency), improved operations, and protection system renovations.

Therefore, the cost of electricity power generation from hydropower was significantly less than all other generation technologies. Additionally, hydropower's carbon emission is also lower. Therefore, this dissertation seeks to assess the potential role of hydropower in developing a more sustainable energy source for Myanmar.

Objectives of the study:

The objectives of the study were to investigate the role of hydropower in sustainable development of Myanmar such as financial, environmental, social, and technical skills and to analyze the role of hydropower effecting national power sector development of Myanmar.

Method of study:

In this study, descriptive methods were used based on both primary and secondary data. The primary and secondary data were collected from the structured and unstructured questionnaires by systematic random sampling. The sample included 100 correspondents from government staff and deputy staff officers. Additionally, 50 correspondents participated from Kyitaung village, Zayarthiri Township, Nay Pyi Taw Union at Lower Paung Laung hydropower project area. More than 50 respondents were selected from independent power producer (IPP). The study employed

correlation analysis and multiple regression analysis to examine the variables that influence the role of hydropower impacting the national power sector development.

Scope and limitation of the study:

Assessing the role of renewable energy to support the sustainable development of Myanmar analyse the secondary and primary data based on the explorer to the institution required a thorough examination of the power sector project. The institutions in charge of implementation the policy strategies and plans, were asked to provide primary data by answering question and participating in interviews about the impact of hydropower generation project in Myanmar power sector, including the development and resettlement conditions adjudicated by the government Ministries, potential investors, and Myanmar taxpayers from Kyitaung Village. A sample data 200 were collected such as 50 respondents of kyitaung village (out of 250 villagers), 75 respondents from department of hydropower implementation, electric power generation enterprise and department of electric power planning, 25 respondents from irrigation and water utilization management department, Ministry of agriculture, livestock and irrigation and 50 respondents from asia world company limited.

The role of hydropower:

The landscape of Myanmar is high in northern and low in southern, it includes many mountains, plateaus, plans, deltas, coasts, and other areas. There have six main rivers in Myanmar which are north to south flowing. Therefore, Myanmar has many rivers, rich resources for hydropower generation in northwest-north-east territories. But Myanmar just used 3% of their hydropower resources for electric power generation.

Present power system of Myanmar electricity generated from 52 power plants, including 28 hydropower stations, 21 gas-fired plants, 6 solar power plants and one coal power plant. The largest hydropower generation is Yeywa hydropower which is owned by government and Paunglaung hydropower is the second largest installed capacity in Myanmar. On the other hand, Baluchaung is the first hydropower plant in Myanmar.

Research methodology:

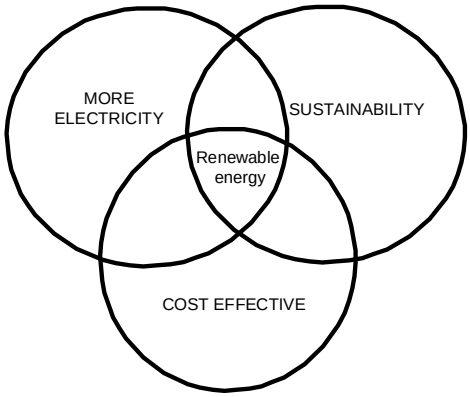

Fig (1) Research Methodology Framework

There are three factors required to balance the power sector development of Myanmar such as required more electricity supply from various types of power generation, cost effectiveness and sustainability. Achieving a balance between these three factors are considered essential for achieving Myanmar national power sector development. Thus, Natural resources were limited, the environment was protected therefore renewable energy was vital for power generation increasement. Myanmar economy was not harmed by power sector therefore benefit from financial statement of Myanmar power sector was required for economic and industrial development, upgrade the quality of life for citizen. To balance the energy and environmental impacts, assessing the role of hydropower in sustainable development of Myanmar was very important.

Data analysis:

Socioeconomic Characteristics of the Respondents

Socioeconomic characteristics of the respondents were social and demographic factors which include gender, age, education level, occupation and monthly income level in each respondent. The socioeconomic characteristics of the respondents were shown in Table (1).

Table (1) Socioeconomic Characteristics of the Respondents

No	Factors	Number of Respondents	Percentage
1	**Gender**		
	Male	121	60.5
	Female	79	39.5
	Total	**200**	**100**
2	**Marital Status**		
	Single	40	20
	Married	160	80
	Total	**200**	**100**
2	**Age Distribution**		
	20 – 40	102	51.0
	41 – 60	78	39.0
	Above 61	20	10
	Total	**200**	**100**
3	**Education Level**		
	Primary School	0	0
	Middle School	17	8.5
	High School	26	13
	Undergraduate	1	0.5
	Bachelor	64	32
	Master	92	46
	Others	0	0
	Total	**200**	**100**
4	**Occupation**		
	Dependent	0	0
	Student	1	0.5
	Government Staff	100	50
	Company Staff	50	25

No	Factors	Number of Respondents	Percentage
	Self – Employment	32	16
	Agriculture and livestock	17	8.5
	Fisherman	**0**	0
	Total	**200**	**100**
5	**Monthly Income**		
	≤ 100,000	12	6
	100,001 – 200,000	15	7.5
	200,001 – 300,000	38	19.0
	300,001 – 400,000	93	46.5
	Above 400,001	42	21.0
	Total	**200**	**100**

Assessing the role of hydropower for sustainable development in Myanmar

Power quality, cost effectiveness, benefits, socioeconomics development, willingness to pay, public income, energy sector, employment, environment protection and national development were studied in this section. Each statement is assessed using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Moreover, if the average scores surpass 3, it is plausible to regard the respondents' opinions as positive. Conversely, if the average score falls below 3, it can be inferred that the respondents' perceptions were unfavorable. The following figures were SPSS graph analysis result of the study.

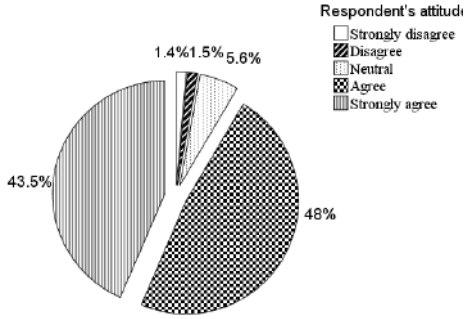

Fig (2) Percentage of respondent's opinion on power quality improvement

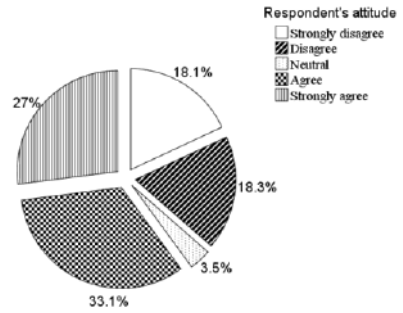

Fig (6) Percentage of respondent's opinion on willingness to pay

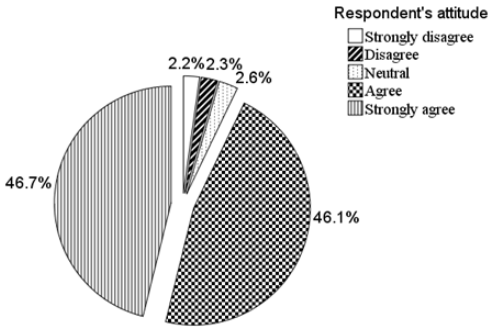

Fig (3) Percentage of respondent's opinion on cost effectiveness

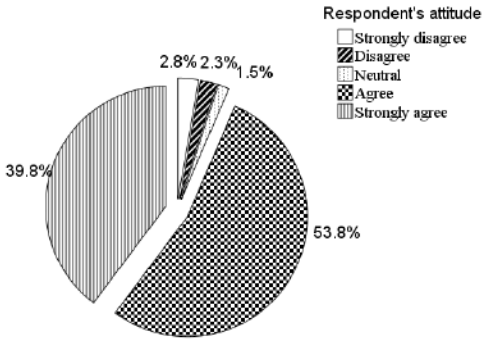

Fig (7) Percentage of respondents' opinion on public income

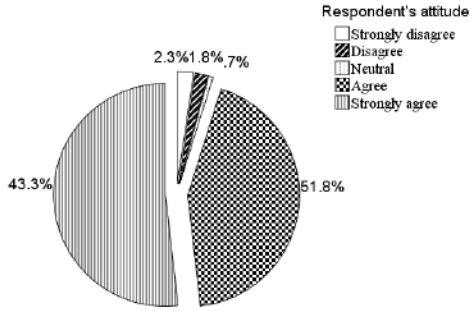

Fig (4) Percentage of respondent's opinion on benefit of hydropower

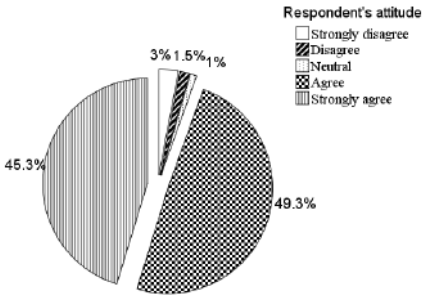

Fig (8) Percentage of respondent's opinion on energy sector

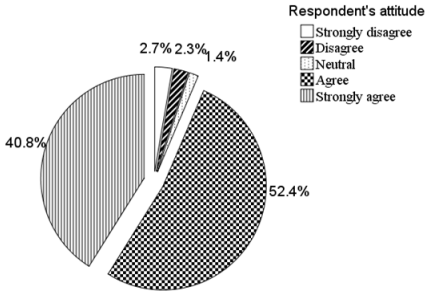

Fig (5) Percentage of respondent's opinion on socioeconomics development

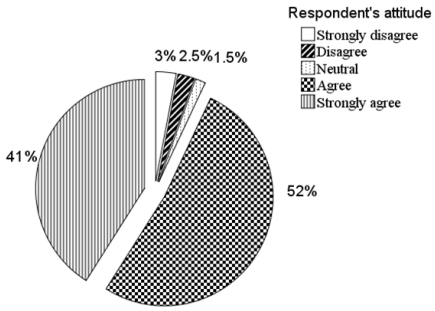

Fig (9) Percentage of respondent's opinion on employment

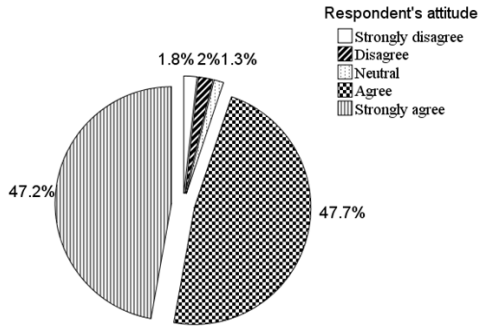

Fig (10) Percentage of respondent's opinion on environment protection

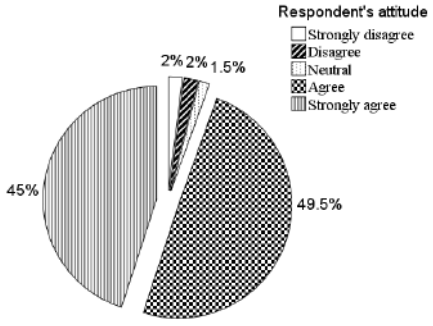

Fig (11) Percentage of respondent's opinion on national development

(1) Effects of power system quality with hydropower

Figure (2) presented the opinion of respondents on power system quality with hydropower such as cheap and clean large power generation, balance of supply and demand, frequency stability, voltage quality development, reduce CO_2 emission. The percentage of respondent's opinion on power supply quality with hydropower the range of percentage value 48% agreed and 43.5% strongly agreed. It indicated that respondents favour with the tangibility factors which influence the respondents trust and satisfaction on power quality improvement with hydropower percentage value 91.5% which are greater than average value. Conversely, 5.6% of respondnent were neutral and 2.9% of respondnent were unfavorable.

(2) Effects of Cost Effectiveness of hydropower generation

Figure (3) showed the opinion of respondents on cost effectiveness compared with solar, wind, geothermal, gas turbine, steam turbine, coal and others storage technology. The percentage of respondent's opinion on cost effectivenes of hydropower generation the range of percentage value 46.1% agreed and 46.7% strongly agreed. It indicated that respondents favour with the tangibility factors which influence the respondents trust and satisfaction on cost effectiveness of hydropower generation percentage value 92.8% which are greater than average value. Conversely, 2.6% of respondnent were neutral and 4.5% of respondnent were unfavorable.

(3) Social and Economic Benefit with hydropower

Figure (4) showed the opinion of respondents on social and economic benefit with hydropower in Myanmar power system such as reducing the electricity power losses, providing both energy and water supply services, uplifting of disaster relief capacity, energy efficiency. The percentage of respondent's opinion on social and economic benefit with hydropower the range of percentage value 51.8% agreed and 43.3% strongly agreed. It indicated that respondents favour the tangibility factors which influence the respondents trust and satisfaction on social and economic benefit with hydropower percentage value 95.1% which are greater than average value. Conversely, 0.7% of respondnent were neutral and 4.1% of respondnent were unfavorable.

(4) Effects of Socioeconomics Development with hydropower

Figure (5) showed the opinion of respondents on socioeconomics development with hydropower such as stable power supply of local industry and household needs, bringing construction management technology, healthcare development in local areas, improving the national income and housing standards of local people, improving the infrastructure, speed up the Myanmar's reform process and opening international market. The percentage of respondent's opinion on socioeconomics development with hydropower generation the range of percentage values 52.4% agreed and 40.8% strongly agreed. It indicated that respondents favour with the tangibility factors which influence the respondents trust and satisfaction on socioeconomics development with hydropower generation percentage value 93.2% which are greater than average value. Conversely, 1.4% of respondnent were neutral and 5% of respondnent were unfavorable.

(5) Willingness to pay for hydropower

Figure (6) presented the opinion of respondent's percentage on willingness to pay hydropower implementation in Myanmarnar such as investing with government budget for socioeconomics development, support the local area economic development, promote the tourism, protect the geological hazard, agriculture technology renovation, promote industrial zone development. The percentage of respondent's opinion on willingness to pay hydropower range of percentage value 33.1% agreed and 27% strongly agreed. It indicated that respondents favour with the tangibility factors which influence the respondents trust and satisfaction on willingness to pay hydropower percentage value 60.1% which are greater than average value. Conversely, 3.5% of respondnent were neutral and 36.4% of respondnent were unfavorable.

(6) Effects of public income development with hydropower

Figure (7) showed the opinion of respondent's percentage on public income development such as making new taxes from local and foreign suppliers, from electricity sales, and increasing income with the region's investment attractiveness. The percentage of respondent's opinion on public income development with hydropower generation the range of percentage value 53.8% agreed and 39.8% strongly agreed. It indicated that respondents favour with the tangibility factors which influence the respondents trust and satisfaction on public income development with hydropower generation percentage value 93.6% which are greater than average value. Conversely, 1.5% of respondnent were neutral and 5.1% of respondnent were unfavorable.

(7) Effects of energy sector development with hydropower

Figure (8) showed the opinion of respondent's percentage on energy sector development such as fast responding, high inertia and flexible power, an important role for black start services. The percentage of respondent's opinion on energy sector development with hydropower generation the range of percentage value 49.3% agreed and 45.3% strongly agreed. It indicated that respondents favour with the tangibility factors which influence the respondents trust and satisfaction on energy sector development with hydropower generation percentage value 94.6% which are greater than average value. Conversely, 1% of respondnent were neutral and 4.5% of respondnent were unfavorable.

(8) Effects of employment with hydropower

Figure (9) presented the opinion of respondent's percentage on employment with Hydropower such as new high-quality employment areas for the development of hydropower and infrastructure, construction and operation. The percentage of respondent's opinion on employment with hydropower generation the range of percentage value 52% agreed and 41% strongly agreed. It indicated that respondents favour with the tangibility factors which influence the respondents trust and satisfaction on employment with hydropower generation percentage value 93% which are greater than average value. Conversely, 1.5% of respondnent were neutral and 5.5% of respondnent were unfavorable.

(9) Effects of Environmental Protection on hydropower

Figure (10) presented the opinion of respondent's percentage on environmental protection such as support strengthening the skill of environment management, increasing the investment in environmental development and strengthening the management of water resource skills. The percentage of respondents' opinion on environmental protection the range of percentage value 47.7% agreed and 47.2% strongly agreed. It indicated that respondents favour with the tangibility factors which influence the respondents trust and satisfaction on environmental protection percentage value 94.9% which are greater than average value. Conversely, 1.3% of respondnent were neutral and 3.8% of respondnent were unfavorable.

(10) Effects of National development with hydropower

Figure (11) showed the opinion of respondent's percentage on national development with hydropower such as international full-scale project implementation, higher education and upgrading healthcare system, high-tech industries development and more convenient transportation and infrastructure. The percentage of respondent's opinion on national development the range of percentage value 49.5% agreed and 45% strongly agreed. It indicated that respondents favour with the tangibility factors which influence the respondents trust and satisfaction on national development with hydropower percentage value 92.8% which are greater than average value. Conversely, 1.5% of respondnent were neutral and 4% of respondnent were unfavorable.

Table (2) Summary of the role of hydropower in sustainable development

No	Effect	N	Min	Max	Mean	Std
1	Effects of power quality with hydropower	200	1.60	5	4.307	0.546
2	Cost effectiveness of hydropower	200	1.16	5	4.318	0.649
3	Benefit hydropower in Power System	200	1	5	4.405	0.677
4	Effects of Socioeconomics Development	200	1.11	4.78	4.27	0.658
5	Willingness to pay for hydropower	200	1	5	3.89	0.995
6	Effects of public income development	200	1	5	4.255	0.767
7	Effects of energy sector development	200	1	5	4.322	0.732
8	Effects of employment with Hydropower	200	1	5	4.25	0.857
9	Effects of Environmental Protection	200	1.333	5	4.363	0.665
10	Effects of National development	200	1.3	5	4.335	0.664
Overall Mean					4.2715	

N= Number of respondents, Std = Standard Deviation

According to Table (2), the range of mean value ranged from 4.405 to 3.89. It indicated that respondents strongly agreed with the tangibility factors which influence respondents trust and satisfaction since the overall mean value is 4.2715 which is greater than the statistical average 3. Standard deviations are lower than 1 that means data are less deviate from the mean and the result of survey data were more acceptable. Overall mean value is high level of perception.

Relationship between Influencing Factors and National Development

To examine the link between independent variables and dependent variables, the study employed correlation and regression analyses. This study investigates the relationship between several factors such as power quality, cost effectivness, benefits, development, willingness to pay, public income, energy sector, employment and national development. Table (3) presents the correlation between the average scores of influencing variables' effectiveness and national development.

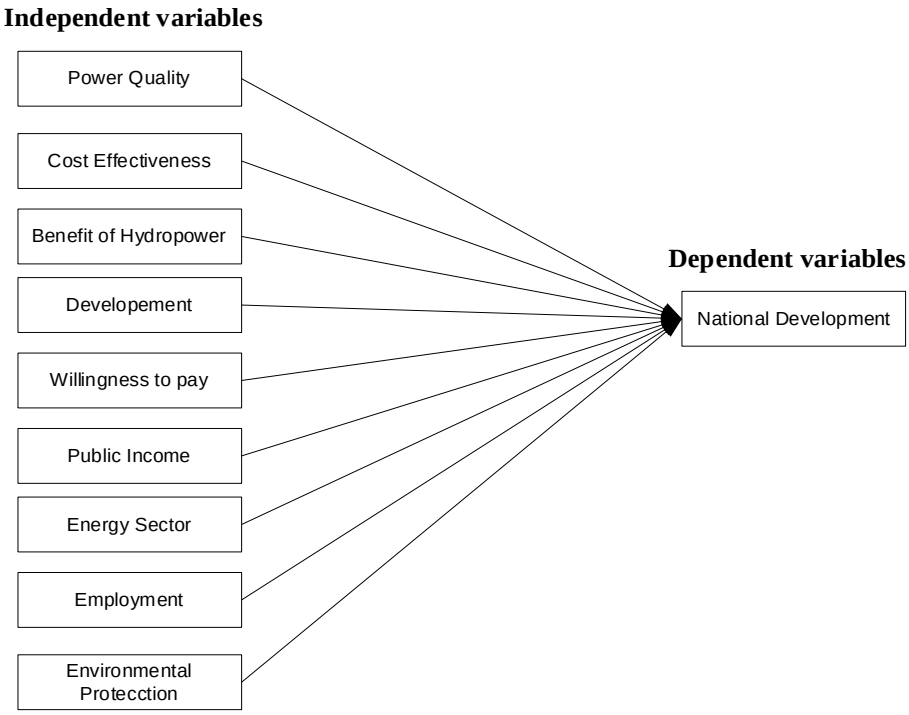

Fig (12) Conceptual framework of this study

Table (3) relationship between Influencing Factors and National Development

ID	Factor	Correlation Coefficient	P-Value
1	Power Quality	0.661	0.000
2	Cost effectiveness	0.794	0.000
3	Benefit	0.797	0.000
4	Development	0.818	0.000
5	Willingness to pay	0.500	0.000
6	Public income	0.763	0.000
7	Energy sector	0.729	0.000
8	Employment	0.669	0.000
9	Environmental Protection	0.950	0.000

Table (3) presents the correlation coefficient and p-value, which provide insights into the degree of correlation between national development and affecting factors. The correlation coefficient between environment protection and national development is 0.950, which is the strongest link seen among independent factors and national development. The remaining associations had a range between 0.500 and 0.818. The observed correlations suggested that the presence of multicollinearity in the suggested model was a significant issue. All correlations between factors were shown to be statistically significant at the 1% level, using a two-tailed test. The findings of the correlation analysis demonstrated a positive relationship between the nine influencing factors and national power sector development factors.

Table (4) Effect of Influencing Factors on national power sector development

Dependent Variable: National development	Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.	VIF
	B	Std. Error				
(Constant)	- 0.187	0.115		-1.627	0.105	
Power Quality	0.135***	0.035	0.111	3.820	0.000	2.023
Cost effectiveness	0.094**	0.046	0.092	2.032	0.044	4.960
Benefit	0.045	0.043	0.046	1.051	0.295	4.639
Development	-0.094	0.056	-0.093	-1.687	0.093	7.332
Willing to pay	0.015	0.018	0.022	0.833	0.406	1.727
Public Income	0.042	0.033	0.049	1.272	0.205	3.565
Energy Sector	-0.017	0.035	-0.019	-0.486	0.627	3.612
Employment	0.008	0.026	0.010	0.310	0.757	2.651
Environmental protection	0.811***	0.040	0.812	20.333	0.000	3.836
R Square	0.921					
Adjustd R Square	0.917					
F Value	245.862					
Statistically significant indicate *** at 1% and ** at 5% level						

The findings presented in Table (4) demonstrate that the association between many influencing factors power quality, cost effectiveness, benefits, development, willingness to pay, public income, energy sector, employment, environment protection and national development have been examined using multiple regression analysis. The coefficients of power quality and environmental protection exhibit complete significance at a 1% level, as seen by the F-statistic value (p-value=0.000). Conversely, the coefficient of cost effectiveness demonstrated significance at a 5% level, with a p-value of 0.044. The coefficient of socioeconomic developement exhibits statistical significance at the 10% level, as indicated by a p-value of 0.093. The statistical analysis revealed that the variables of benefit, willingness to pay, public income, energy sector and employment do not exhibit a significant relationship, as presented by the p-values of 0.295, 0.406, 0.205, 0.627 and .757, respectively. The R-squared score of 0.921 indicates a strong association between the influencing factors and national development which suggested that the model can be considered as effective. The numerical value of F was 788.984, which was deemed to be statistically significant. Thus, it may be inferred that 60.5% of independent variables had a significant impact on national power sector development. The multi-collinearity statistics, specifically the variant inflation factors (VIF), indicated values greater than 1. The numerical value of F is 245.862, which is deemed to be statistically significant. There exists a discernible relationship between the influencing elements and the level of national power sector development of Myanmar, as indicated by a moderate correlation.

Conclusion

In conclusion, the theory of sustainability emphasizes long-term environmental health, social well-being, and economic stability. For a long time, social well-being questionnaires of power system quality energy sector were created for respondents in this study. The questionnaires of cost effectiveness, benefit of hydropower, socioeconomics development, willingness to pay, public income, employment, national development was created for respondents in this study for the sustainability development in Myanmar. The result of the study also showed a significant and moderate correlation between many influencing factors power quality, cost effectiveness of power generation, benefits of hydropower project, socioeconomics development, willingness to pay, public income, energy sector, employment, environment protection and national development. The result found that the correlation analysis demonstrated a positive relationship between the nine influencing factors and national power sector development factors. Therefore, hydropower generation was the cost-effective power generation to get the three factors such as more electricity, cost effective and energy sustainability in Myanmar power sector.

Refrences:

1. Cunningham, W., Hollweg, C. H., Buba, J., Chea, M., Lathapipat, D., Lee, U. J., ... & Sanchez Martin, M. E. (2019). *Main Report* (No. 141416, pp. 1-48). The World Bank.
2. Edwards, K. A., Mansaray, K., Da Myint, T., Hayati, F., & Maw, A. K. M. (2023). Myanmar Economic Monitor: Challenges amid Conflict.
3. Gurbuz A. (2006). The Role of Hydropower in Sustainable Development. European Water 13/14: 63-70, 2006, IHA, White Paper.
4. Htwe M. Thar (Mandalay 2021), Global Perspectives Views on Energy and Electricity, Myanmar.
5. International Hydropower Association. (2023). World Hydropower Outlook: Opportunities to Advance Net Zero. *London: IHA*, 71.
6. Kattelus, M., Rahaman, M. M., & Varis, O. (2015). Hydropower development in Myanmar and its implications on regional energy cooperation. *International Journal of Sustainable Society*, *7*(1), 42-66.
7. Numata, M., Sugiyama, M., Swe, W., & del Barrio Alvarez, D. (2021). Willingness to pay for renewable energy in Myanmar: Energy source preference. *Energies*, *14*(5), 1505.
8. Sachs, J. D., Lafortune, G., Fuller, G., & Drumm, E. (2023). Implementing the SDG Stimulus: Sustainable Development Report 2023.
9. Saw, M. M. M., & Ji-Qing, L. (2019). Review on hydropower in Myanmar. *Applied Water Science*, *9*, 1-7.
10. Schmolke, A., Thorbek, P., DeAngelis, D. L., & Grimm, V. (2010). Ecological models supporting environmental decision making: a strategy for the future. *Trends in ecology & evolution*, *25*(8), 479-486.
11. Siciliano, G. (2023). Hydropower, climate change and sustainable energy transitions. In *Handbook on Climate Change and Technology* (pp. 82-102). Edward Elgar Publishing.

12. Tang, C. M. S. (2021). A study of sustainability in the energy sector in Myanmar between 2011 and 2020.
13. Tippetts-Abbett-McCarthy-Stratton. (1953). *Economic and Engineering Development of Burma: Introduction. Economics and administration. Agriculture and irrigation. Transportation* (Vol. 1). Knappen-Tippetts-Abbett-McCarthy.
14. Waterpower Canada (May 2023), Hydropower's Value to a Net-Zero Electricity Grid. Power Advisory, 55 University Avenue Suite 700, Po Box 32 Toronto, Ontario M5J2H7: Waterpower Canada.
15. Win, T. T. (2022). *A Study on Effect of Electrification in Rural Area (Case Study: Villages in Yaedashe Township, Bago Region) (Tun Tun Win, 2022)* (MERAL Portal).
16. Xiao, L.; Wang, J.; Wang,B.; Jiang, H. China's Hydropower Resources and Development. Sustainability 2023, 15, 3940. https://doi.org/10.3390/su15053940
17. Yarnell, S. M., Lind, A. J., & Mount, J. F. (2012). Dynamic flow modelling of riverine amphibian habitat with application to regulated flow management. *River Research and Applications*, *28*(2), 177-191.

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