

Impact of Solar Energy Usage on Organizations' Energy Needs: Evidence from Private Banks in Yemen

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Abstract— Republic of Yemen is a developing country. It depends on oil for the life needs. Regarding the availability of renewable energy resources, the country has huge solar resources. Due to crises and civil wars, most organizations turned to alternative energy sources, including solar energy. The research objective is to examine the impact of solar utilization and solar usage barriers on satisfying energy needs for the organizations. Self-administered structured questionnaire is utilized to conduct a survey of 250 private bank employees in Sana'a. A simple random sampling is used to distribute the questionnaires. A correlational study is applied using quantitative method and the path coefficients analysis is used to test proposed hypotheses. The main findings of the study are three-fold. Firstly, there is negative significance impact of usage barriers on the solar energy usage and satisfying organization's needs. Secondly, the effect of usage barriers on the overall solar usage satisfaction is insignificant. Finally, solar energy usage has a positive significance effect on satisfying organizational needs and overall solar usage satisfaction.

Index Terms— Organization's need, Overall Satisfaction, Renewable Energy Resources, Solar Energy, Structural equation modeling, Traditional energy sources, Usage Barriers.

1 INTRODUCTION

TODAY, the world find itself very dependent on an available and uninterrupted supply of power for all forms of life and work. There are a number of sources of energy, including traditional energy source and Renewable Energy Resources (RES), e.g., solar, wind and biomass. The high cost of traditional energy source [1], limited supply, increasing of energy demand and the global warming [2], all this make the world searching for the alternative energy resources. The development and improvement of RES has become the main focus of many researchers in the past decade, specially solar energy. The current technology of solar energy provides a reliable, economic and usage-efficient as an energy source.

A majority of the population of the Republic of Yemen has no access to electricity services due to many reasons such as civil war, high cost of oil & gas, and inefficiency of the National Electricity Grid (NAGE). This environment leads to decrease the supply of energy which has prompted many organizations to go for solar energy to satisfy their needs.

Given these challenges and high potentials of renewable energy sources in Yemen, solar energy can be used as an alternative energy source despite the barriers and constraints. The main contribution of this study is to investigate the relation between the the solar energy usage and usage barrier and organization's needs and satisfication overall satisfication. The rest of this paper is organized as follows. Section 2 provides a review of the research literature. Section 3 contains the research methodology. In Section 4, the descriptive analysis of

the studt is presented and the result an explained. The last section concludes the paper.

2 LITERATURE REVIEW

The study conducted by Sovacool, Agostino, and Bambawale [3] identifies four types of barriers with using solar home system. The barriers are technical challenges include under-standard equipment, logistical issues, Economic challenges such as lack of funding, and Social challenges such as lack of familiarity with the benefits of solar technology.

The factore influencing user satisfaction with Solar Home Systems (SHS) is examined [4]. The study assesses the factors of customer satisfaction and the expectations of households from the advantages of SHS including the efficiency of SHS devices and energy cost savings. According to the findings of study, the maintenance of SHS has a negative effect on user satisfaction and positive overall satisfaction with SHS.

Oh, Tick Hui, Pang, and Chua [5] explains issues and challenges of the new and current energy strategies in Malaysia. The study releases that the overall approach to tackle energy problems and obstacles is to concentrate on the adequacy, quality, security, sustainability of both the traditional and RE supply in the growth of the country, and the promotion and implementation of its energy efficiency programs.

The study carried out by Apergis, Nicholas, and Dan Constantin Danuletiu [6] examines the correlation between RES

and long-term economic growth in eighty countries including European Union, Western European, Asian, Latin American, and African nations. The study concludes that the interconnection between RE and economic growth promotes the continuous use of the government policies in the sector of renewable energy production.

The Reality and Prospects of Renewable Energy Challenges in Denmark are investigated by Cleveland and Morris [7]. The study identifies three aspects of RES challenges which are degree of RES contribution to the energy balance, obstacles, and RES economic consequences. The study suggests the rational use of energy sources and the need for extensive research and development in the field of renewable energy sourness.

Oh, Pang, and Chua [8] describe policies, issues, and challenges of the current and renewable energy sources and their economic advantages in achieving local and global development. The study also considers the traditional energy sources and their benefits as the basis of the research problem, the ecological impacts of traditional sources, and the motivations for the search for alternative sources. The study finds that there are three main factors that drives the market towards renewable energy usage. These factors are global energy security, fear of climate change, and lower costs due to advances in technical RES development. The study recommends that the international community to change the energy policies and work to effectively diversify the global energy sources in order to preserve the environment and the rights of future generations of energy, traditional or renewable.

3 RESEARCH METHODOLOGY

3.1 Research Theoretical Framework

In this study, a research framework is proposed to test whether solar energy usage satisfies organizations' need and to measure overall satisfaction of organization from using solar energy. Moreover, it is used to determine the influence of usage barriers of solar energy on satisfying organization's needs. The framework shows the relationships between various factors and associated hypotheses used to achieve the objectives of the study. The study Theoretical Framework is shown in Fig. 1.

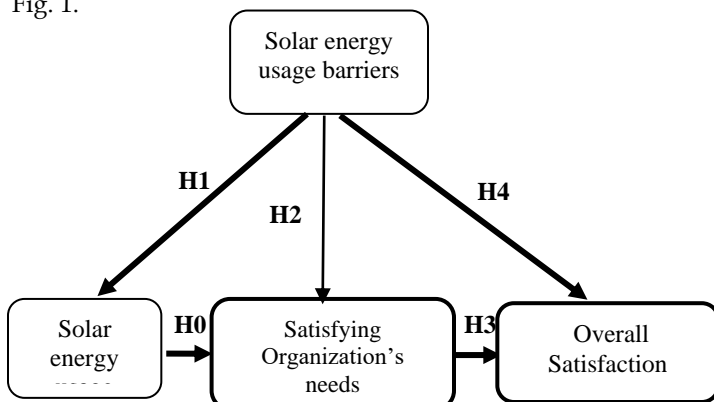


Fig. 1. Research Theoretical Framework

3.2 Research Design

This research is designed to achieve the study objectives by verifying research hypothesis to measure the impact of utilization of solar electricity on satisfying organization's need. Research is designed here based on a review of similar studies. This study is considered as an explanatory research to find specific variables used for measurements the impact of solar usage on satisfying organization's needs in Banking sector in Sana'a. It is considered as an exploratory research because there is no previous study has investigated such a problem clearly. This study is designed to examine five hypothesis using quantitative measurements tools through data-collection method.

Participants and sampling

In this study, the sample size ($n = 250$) was composed of conveniently selected employees in private banks in Sana'a. The sample size is based on Morgan and Krejcie's table [9].

Data Collection and Instrumentation

In this research, questionnaires were used to collect data related to the study objectives and questions. The proposed questionnaire survey is composed of six sections described as follows. First section provides the demographic and general data of the respondents such as gender, age, educational qualifications, and years of work experience. Second section elicits information regarding the main energy source and the size of solar energy system in the banks. Third section presents the statements regarding the measurement of first variable "Solar usage" while fourth section measures the variable "Solar energy barriers". Fifth section shows the statements related to the measurement of the dependent variable "satisfy Organization's needs from energy". Finally, the last section of the questionnaire deals with the statements measuring the overall organizations' satisfaction

The questionnaires are personally distributed to the respondents. The respondents are given a week to respond. To achieve higher response rate, 260 copies of the questionnaires were distributed instead of 256 and only 250 copies were received complete and valid.

3.4 Scale Reliability and Validity Analysis

From Table 1, it is observed that the questionnaire is reliable where the value of Cronbach's alpha for the solar energy usage dimension is 0.69 (≈ 0.7), the value of Cronbach's alpha for the Barriers dimension is 0.783 (> 0.7), the value of Cronbach's alpha for the satisfy organization's needs dimension is 0.677 (≈ 0.7), and the value of Cronbach's alpha for the overall satisfaction dimension is 0.813 (> 0.7). The questionnaire is valid where the values of Pearson correlation for all dimensions are higher than 0.6.

TABLE 1
RELIABILITY STATISTICS

Dimension	N of Items	Cronbach`s alpha
Solar Energy Usage	9	0.69
Usage Barriers	10	0.783
satisfy Organizations Needs	3	0.677
Overall Satisfaction	5	0.813

4 ANALYSIS AND DISCUSSION

In the analysis step, the collected data from respondents in the private banks in Sana'a are analyzed to determine relationships between solar energy usage, solar energy usage barriers, satisfying organization's needs from energy. Furthermore, the profile of the selected and participated respondents (sample) is explained by the frequency and descriptive statistics for the major research variables. Finally, Structural equation modeling is used to analyze structural relationships. This technique is the combination of factor analysis and multiple regression analysis, and it is used to analyze the structural relationship between measured variables and latent constructs. Also, to examine the suitability of the model.

4.1 Respondents' Profile

Table 2 shows the demographic representation of the respondents. In terms of the demographic profile of the respondents, 84.4% of the respondents are male and 15.6% are female. Approximately, 40.4% of the respondents are aged below 30 years. Social status of the respondents shows that 62.4% are married, 37.2% are single, and 0.4% are otherwise. With regard to the type career level, 81.2% employee with first career level, 14.8% with second career level and 4% with the third career level. With respect to the experience parameter, 50.8% of the respondents have more than three years.

4.2 Descriptive Analysis

Descriptive analysis includes the means and the standard deviations for variables are explained in the Table 3.

4.3 Structural Equation Modeling

Structural equation modeling is a multivariate statistical analysis technique that is used to analyze structural relationships. This technique is the combination of factor analysis and multiple regression analysis, and it is used to analyze the structural relationship between measured variables and latent constructs [10]. In order to examine the suitability of the model, Structural Equation Modeling (SEM) analysis was used as indicated in research method. Fig. 2 shows the SEM and Table (4.45) illustrated Model Fit Summary.

TABLE 2
FREQUENCY TABLE FOR COMPANY SIZE

Demographic	Frequency	Percent	Demographic	Frequency	Percent
Company Size			Work Shift		
medi-um	37	14.8	work shift 1	33	13.2
big	213	85.2	work shift 2	217	86.8
Total	250	100	Total	250	100
Career Level			Social Status		
first level	203	81.2	single	93	37.2
second level	37	14.8	married	156	62.4
third level	10	4.0	otherwise	1	0.4
Total	250	100	Total	250	100
Gender			Age		
male	211	84.4	less than 30	101	40.4
female	39	15.6	between 30 - 40	143	57.2
Total	250	100	more than 40	6	2.4
			Total	250	100
Educational Level			Experience		
high school	14	5.6	less than 2 years	74	29.6
diploma	23	9.2	between 2-3 years	49	19.6
bachelor	205	82.0	more than 3 years	127	50.8
master	8	3.2	Total	250	100
Total	250	100			

TABLE 3
DESCRIPTIVE STATISTICS

Items	Mean	Std Deviation	Verbal Appreciation
1 Solar Energy Usage dimension	4.47	0.601	strongly agree
2 Solar Energy Usage Barriers Dimension	2.7	0.576	Neutral
3 Solar Energy Satisfy Organizations' Needs dimension	4.10	.6995	Agree
4 Overall Satisfaction dimension	4.573	0.49986	strongly agree

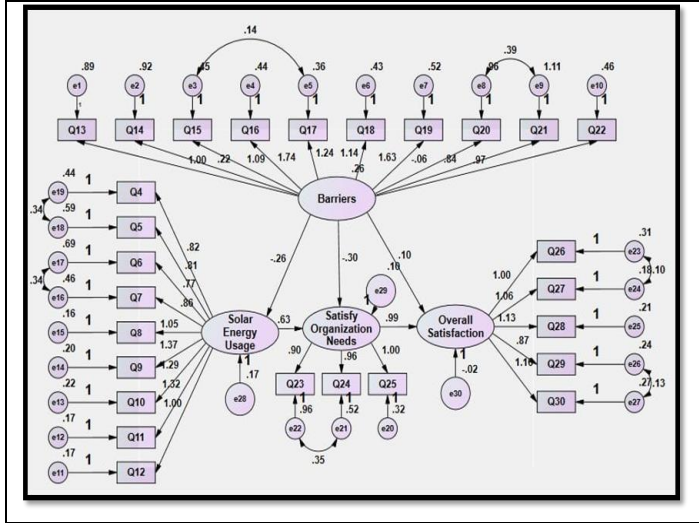


Fig. 2. Structural Equation Model

TABLE 4
MODEL FIT SUMMARY

Result (Default model)							
Chi square=788.516 DF = 312 Probability level = 0.000							
odel	CFI	NFI	GFI	RMSEA	AIC	CMIN	P
Default model	0.85	0.775	0.814	0.078	920.52	788.52	0.0
Saturated model	1.00	1.00	1.000	-	756.00	0.000	-
Independent model	0.00	0.0	0.32	0.19	3550.77	3496.8	0.0

From the Table 4, we can see that the proposed model is suitable as the comparative fit index (CFI) value is 0.849 (> 0.8), the normed fit index (NFI) value is 0.775 (≈ 0.8), the goodness-of-fit index(GFI) value is 0.814 (> 0.8), the Root Mean Square of Approximation (RMSEA) value is 0.078 (< 0.08), the AIC value is 920.516 and the CMIN value is 788.516 (small value) and significant (P< 0.05).

4.4 Path coefficient analysis

Path coefficient analysis shows the results of direct and indirect effects between the variables as shown in Table 5.

TABLE 5
PATH COEFFICIENT ANALYSIS

			Est.	S.E.	P
Solar Energy Usage	<-	Barriers	-0.257	0.068	0.0001
Satisfy Organizations' Needs	<-	Barriers	-0.301	0.092	0.001
Overall Satisfaction	<-	Barriers	0.097	0.094	0.302
Satisfy Organizations' Needs	<-	Solar Energy Usage	0.626	0.102	0.0001
Overall Satisfaction	<-	Satisfy Organizations' Needs	0.985	0.162	0.0001

AMOS software is used for calculation of path coefficients of the structural model to derive the relation between different variables. From test results, we observe the following:

- 1) There is negative significant effect for Barriers on the Solar Energy Usage.
- 2) There is negative significant effect for Barriers on satisfying organizational needs.
- 3) There is no significant effect for Barriers on the overall satisfaction
- 4) There is positive significant effect for the Solar Energy Usage on satisfying organizational needs.
- 5) There is positive significant effect for satisfy organizations' needs on overall satisfaction.

Consequently, the testing results of hypotheses are determined and summarized in Table 6.

TABLE 6
HYPOTHESES TESTING RESULTS

Hypothesis	Statement	Conclusion
H0	Solar Energy Usage has no effect Satisfy Organization needs	Reject
H1	Barriers effect solar energy usage	Accept
H2	Barriers effect Satisfy Organizations needs	Accept
H3	Satisfy Organizations needs effect overall Satisfaction	Accept
H4	Barriers effect Overall Satisfaction	Reject

4.4.1 H0: Solar Energy Usage has no impact Satisfy Organization needs

To examine the impact of solar energy usage on satisfying organization's needs from energy in the light of the first hypothesis, the study surveyed the bank employees at the private banks in Sana'a

using a research questionnaire designed properly. From Table 4.46, we can observe that the effect of solar energy usage on satisfying organization's needs is significant since the p-values = 0.0001 (< 0.05), where the value of estimate (Est) = 0.626. It implies that when solar energy usage increases the satisfying organizations' Needs increases, which does not support the first hypotheses.

4.4.2 H1: Barriers effect on solar energy usage

Table 5 shows that the p-values is 0.0001 (< 0.05), where the value of estimate = -0.257. As the result, the effect of barriers on solar energy usage is significant. Hence, from table 6, the results of the study support the second hypothesis. This is due to the fact when usage barriers increase the solar energy usage decreases.

3.3.3 H2: Barriers effect on Satisfying Organization's needs.

Based on the results of the path coefficients analysis shown in Table 5, the impact of usage barriers effect on satisfying organization's needs is significant. The reason is that the p-values is 0.001 (< 0.05), where the value of estimate = -0.301. As a result, satisfying organizations' needs decrease with an increase in usage barriers. Therefore, the hypothesis, H2, is accepted.

4.4.4 H3: Satisfying Organizations needs effect on Overall Satisfaction

According on the results of the path coefficients analysis regarding the impact of organization's needs satisfaction on overall satisfaction of solar utilization. The study found that the effect of satisfying organization's needs on overall satisfaction is significant since the p-values is 0.0001 (< 0.05), where the value of estimate = 0.985. Consequently, overall satisfaction increases when the satisfying organization's needs increases. As a result, the hypothesis, H3, is accepted.

4.4.5 H4: Solar usage barriers effect Overall Satisfaction.

Table 6 shows that the hypothesis, H4, is rejected. The reason is that the effect of usage barriers on overall satisfaction is not significant (i.e. p-values is 0.302 (> 0.05)).

5 CONCLUSION

This study provides descriptive analysis of the impact of solar energy usage and barriers on satisfying organization's needs and the overall satisfaction. Model-SEM is applied to identify the structural relationships between the variable. The path coefficient analysis shows the effect of solar energy usage on satisfying organization's needs and overall satisfaction is significant whereas the effect of usage barriers on satisfying organization's needs and overall satisfaction is significant and insignificant, respectively. There are some limitations in this study. This study was limited to examine only the impact of solar energy usage and usage barriers on satisfying organization's needs. In addition, the population size is selected and limited in Sana'a and the time given for distribution and collection of questionnaires is limited.

This study suggests that renewable energy resources could be integrated with the state grid through hybrid systems to meet the energy needs of the organization. For this purpose, Renewa-

ble Energy Authority might be initiated as a national renewable energy coordinator in collaboration with existing authorities for establishing and maintaining the central renewable energy sector in Yemen, including resource assessments, renewable energy goals, plans, policies, and regulations.

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