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Crafting Sustainable Indian Educational Institutions Through Solar Photovoltaic: A Partial Least Square-Structural Equation Model

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Abstract
The main context and aim of the research paper is to report the findings of the empirical study of the effect of government policy in implementing Grid connected Rooftop Solar Photovoltaic in Educational Institutions in the state of Karnataka, India. The Government policy has initiated the change towards sustainable development in the state of Karnataka. This research paper has used the second generation software Smart PLS3 to measure the reliability and validity. PLS-SEM highlights the effect of exogenous latent variables of Government policy, Reason for Motivation, Advantages, Opportunities and Challenges of implementing Roof top Solar Photovoltaic, as a renewable energy option for the Educational Institution with the three dimensions of sustainability, such as social, economic and environmental benefits, as the endogenous latent variables. Hypotheses are tested through bootstrapping. Effect of each construct is measured by Blindfolding method. Finally, the Importance performance matrix analysis (IPMA) has been done in order to measure the impact of constructs and the indicators on the model. Adoption of renewable energy solution, has been found to cultivate a learning environment that mirror real-world problems and encourage curriculum development in the field. It develops positive attitude of the students towards renewable energy and sustainability thereby encouraging environment conservation leading to environmentally conscious designs and technology to improve sustainability and promote conservation of natural resources.

Keywords: Sustainability, Solar Photovoltaic, Renewable Energy, Educational Institution, Government policy, Net Metering.

Introduction

India is a tropical country with 300-330 sunshine days in a year (MNRE, 2012). The availability and intensity of sunshine during the day has worked in favor of the country and solar energy has been viewed as having great potential as future energy resource. The country depends on coal for the generation of electricity. In order to reduce the dependency on Coal and conserve the natural resources, the Jawaharlal Nehru National Solar Mission was launched by the Government of India on October 9th, 2012, with an ambitious target of 175 GW of renewable energy to be implemented in India by 2022 and the contribution from Solar Rooftop is expected to be 40 GW (JNNSM, 2012). The target given to the State of Karnataka is to implement 2300 MW by 2022. In order to set the momentum, the studies in the field are a prerequisite. Government of Karnataka initiated the development through Karnataka Solar Policy. The technology was introduced to enhance energy security, sustainability and capacity addition by solar power (Solar Policy, 2014-2021). The objective of the policy was to promote and develop Solar Rooftop generation and technology, to develop R&D, skill development and innovation in the energy sector. The Government Policy has led to the wide spread installation of Solar Photovoltaic in the state.

The educational institutions have a fundamental role to play in catalyzing society's transition towards sustainable living. The United Nations (UN) had constituted the year 2005–2014 as the decade for sustainable development in education. This has bridged the gap between academia and the requirements of the community. Sustainability in higher levels of education has a positive role to play (UNESCO, 2006). As Mishra, J. K. et. al. (2008) in their working paper found, if India has to emerge as preferred location for higher education in the globalizing world it will have to develop a national policy to address the challenges of sub-standard quality, ineffective systems of monitoring and control, red-tapism in growth and development and political interference.

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The United Nations Sustainable Development Summit has introduced seventeen sustainable development goals and this gave great emphasis to ensure clean, affordable and reliable energy services (UNDS, 2015) as its seventh goal. This has generated a thrust towards the global transformation that heads towards a greener economy. Many educational institutions across the world, with a progressive bend of mind, has opted for Solar Photovoltaic as a renewable energy option for its energy requirements and subsequently branding their institution as green campuses. When compared with Green Campus and non green campus Universities, the former was found to be more contend with an enhanced quality of life in comparison to the stakeholders from the latter (Tiyarattanachai and Hollmann, 2016). These institutions are tasked with the motive to shape the minds, perception and ideology of students towards sustainability values as they are in a unique position to address the adverse impact on environment. The climate change challenge confronted by the humanity will lead to restructuring of values and reconstruction of educational system in numerous ways (Uhl and Anderson, 2001). The use of renewable energy to power the Educational Institution is being proposed as an ideal energy solution. Solar power is an effective way of power generation, resulting in cost saving for the institution and also has substantial social and environmental benefits.

Objectives of the study

The state of Karnataka, considered as one of the developed and progressive state in India and a hub for educational, industial and Information technology, is often plagued with power shortages**.** There has been a move by the state government to enhance the supply of power through renewable energy sources. Armed with the Karnataka Solar Policy 2014-2021, the state has given definite signals to accelerate the installation of grid connected Solar Photovoltaic and encourage the citizens through Net Meteing, subsidy and accelerated depreciation. This study focuses on the result of the Solar Policy in bringing about the required change by project implementation in the state and the sustainable impact of the policy on the Educational Institutions across the state. The objective of the study are the following.

1. To evaluate the total installed capacity of Solar Rooftop installation in the five Electricity Supply Companies in the state of Karnataka, India.
2. To investigate the impact of Solar Photovoltaic installation on Environment Benefits in Educational Institutions.

3. To access the impact of Solar Photovoltaic installation on Financial Benefits in Educational Institutions.
4. To investigate the role of Solar Photovoltaic installation on Social Benefit in Educational Institutions.

The Karnataka government policy in Solar Photovoltaic is the Reason for Motivation to install Rooftop Solar Photovoltaic in the Educational Institutions across Karnataka. The policy has provided an opportunity for these institutions to incorporate Solar Photovoltaic as a renewable energy source to generate power through a green energy source, reduce the energy cost and to brand the institution as Green campuses. The Advantages, Opportunities and Challenges faced by the institutions on the incorporation of the Solar Photovoltaic technology and the subsequent sustainable benefits of environment, social and financial are assessed in this paper.

Sustainable Development in Educational Institutions-Literature Review

In the Report of the World Commission on Environment and Development: Our Common Future, Sustainable development is defined as the development "that meets the needs of the present without compromising the ability of future generations to meet their needs". The modern society is anguished with environmental pollution, global warming and subsequent climate change. Solar Photovoltaic as a green technology has the potential to address health, pollution and climate change damages (Goel, 2016; Hanus, 2019) and create healthier environment and stronger local communities. Renewable energy is also directly related to sustainable development through impact on economic productivity and human development (Asumadu-Sarkodie and Owusu, 2016b).

The main three missions of universities are teaching, research, and community services (Togo, 2009). The Universities should engage themselves with students and their value systems in order to produce citizens who can progressively seek solutions to societal problems. Universities follow the environmentally friendly ways to enhance its image, attract and retain the committed staff, and reduce overall consumption of resources and save money and emphasize their commitment towards sustainable development (Jin et al., 2017). There is a need for envisioning and articulating the need for energy innovation in campuses to reduce overall environmental impacts. Students can be encouraged through research projects and training programs, which will enhance their capability and directly benefit the institution (Prasanna et al., 2016).

There is also a requirement among green campuses around the world to experiment with various green campus projects (Sharp, 2009). Sustainability lessons in education help students to learn to cope with uncertainty due to climate change and global warming and integrate mitigating measures. The potential impact and contribution of sustainable activities of the students can create great learning experiences and develop competencies and achievements that can catapult their careers, and provide them with the ability to contribute to the planet and its people (Hopkinson and James, 2010). A resilient student with problem-solving ability can be a dependable and employable and reliable graduate who will eventually be an asset to his community (Togo, 2009).

Educational institutions are vested with responsibility for knowledge transformation, science and technical talents cultivation and innovation (Tan et al., 2013). The social and environmental conscious students and faculties are leading the way as role models in the implementation and development of renewable energy projects leading to benefits including lesser power charges, dependable service reliability, and lesser carbon footprint. Use of renewable energy reduces the use of fossil fuels and helps in innovation, development of greener industries and creation of jobs (Mann and Reinstein, 2011, Goel, 2016). Universities are responsible for ensuring creative space to bring in new ideas and alternative thinking and critically explore old ones (Wals, 2010; Ahmed, Ali & Desai, 2012). A strong commitment from top management with administrative and human resource powers will build and support the interests of faculty and student and will integrate sustainability lesson plans into the curriculum. The interdisciplinary sustainability curriculum will integrate theory and practice (Bacon et al., 2010). Sustainability programs in academic institutions will develop major competencies in sustainability among students, such as investigative skills and improve the ability to successfully collude with stakeholders and experts (Brundiers, Wiek and Redman, 2010) and future leaders will be motivated and empowered to ensure sustainable development in their social set up (Reza, 2016).

Investments in green innovation generates profits and also creates large positive externalities for society and environment and will contribute to the development of a small niche market, which will have the potential to scale up and transform the entire industry and economy to new heights (Ahmed, 1999 & 2017; Farinelli et al., 2011). Hence the study of sustainable concepts has the potential to influence the decision making capacity of the students in the right direction (Kishore and Kisiel 2013).

Theoretical framework and hypothesis development

There is a large quantum of theoretical justification of government policy and intervention to develop renewable source of energy across the world. These studies advocated government intervention via public policies to transform to a more sustainable paradigm. (United Nations, 1992; IPCC, 2011b).

In the global economy, accelerated development and growth hinges on the availability of steady, reliable and quality power at competitive rates (Karnataka- Ministry of Power, 2012). Introduction of solar energy as a source of power to campuses addresses the issue of sustainability in these institutions. Integration and coordination of policies and incentives play a crucial part in the active deployment of Solar Photovoltaic (Sovacool and Drupady, 2011).The critical role of public policy as the reason for motivation has lead to the creation of a strong Solar Photovoltaic market. The technical advancement leading to the reduction in the overall cost of the system and the effectiveness of policy incentives to augment Solar PV capacity are discussed by many studies (Curtright, Morgan and Keith, 2008; Park et al., 2013; Watanabe et al., 2000; Crago and Chernyakhovskiy, 2017; Mason, 2009). Many authors discussed the different motivations and arguments for Photovoltaic deployment among major stakeholder groups (Schelly, 2014; Lewis, Sharick and Tian, 2009; Sigrin, Pless, and Drury, 2015) which addresses the environmental, socio economic, political and ethical issues. The economic feasibility and the growing environmentally friendly attitude of the community has led to the changed outlook towards Solar Photovoltaic. Thus the following hypothesis are formulated:

H1: There is a significant association between Government Policy and Reasons for Motivation to install Solar Photovoltaic.

Government policy is the Reason for motivation for incorporation of Solar PV in many countries and this has brought in multiple advantages. Motivation to adopt the technology was due to lower carbon footprint and the energy from a sustainable source has become an urgent need to mitigate the harmful effects of CO_2 emissions. Researchers are of the opinion that Solar PV could meet 30% of the world's electricity needs by 2050 (Strupeit, 2017). This will also reduce the energy cost and the longer period of time taken to implement large coal plants and nulear power plants incomparison with the easy implementation of the Solar PV projects. The Educational instititions that incorporate Solar PV will have enhanced reputation and increased education and research opportunities (Jin et al., 2017; Zhai and Williams, 2011; Goel, 2016). This also leads to creating competitive advantages (Bielak, Bonini and Oppenheim, 2007; Petrini, and Pozzebon, 2010) for these institutions by way of advanced knowledge on renewable energy and its processes, introducing sustainability into lesson plans and incorporation of new technology resulting in improved status of the institution. Based on the literature the following hypothesis is generated.

H2: There is a significant association between Reasons for Motivation and Advantage.

Broad-based policies have worked in creating project motivations leading to opportunities to innovate (Nelson, 2011; Grubb, 2004 ; Maradin et al., 2017; Uhl and Anderson, 2001) and improve the brand value of the institution. The Educational Institutions can integrate learning, technology and research and development by introducing emerging innovations and lead the institutional growth and reputation leading to enhanced competency among the students (Brundiers, Wiek and Redman, 2010). This can inspire the student community to extend the learning process into the corporations they integrate into. The institutions will also have improved the energy efficiency and better energy management, as it produces the energy for its use and the working hours coincide with the energy production and excess energy produced can be fed to the grid. Solar Photovoltaic has led to positive impact and great opportunities for Educational Institutions to develop sustainable attitude and behavioural changes among the students, leading to environmental conservation and sustainable living and good will in the community (Prasanna et al, 2014). Based on literature the following hypothesis is formulated.

H3: There is a significant association between Reasons for Motivation and Opportunities due to the installation of Solar Photovoltaic.

Reason for installations of Solar PV in Educational Institutions are multifold that include energy self sufficiency or lesser dependence on grid and environmental protection (Balcombe, 2014), but multiple barriers and challenges may prevent adoption of the solar technology, The four main barriers that the Solar PV industry faces can be categorized into economic, technical and institutional and environmental challenges, mainly due to high upfront costs, inadequate availability of financing options, lack of awareness and knowledge of available products in the market, Lack of shadow free roof space, concerns about constant system maintenance and the risk in implementing the new technology with and shorter lifespan of twenty-five years and considerably lengthy payback periods and small revenue stream. These barriers have caused much concern among the end users. (Margolis and Zuboy, 2006; Hoen *et al.,* 2011; Mason, 2009). Thus the following hypothesis generated.

H4: There is a significant association between Reasons for Motivation and Challenges due to the installation of Solar Photovoltaic.

After the publication of the Brundtland Report (WCED, 1987), socio economic and environmental implications have become predominant. Any business model innovations will enable companies to exhibit their uniqueness, enhance their value proposition, capture new markets and customers, and attain long-term sustainable and competitive advantage (Waldner, 2015; Amit and Zott 2010). Social awareness will instill people to focus on the field of sustainability and acquire adequate expertise, which would provide the country with a large number of experts in solar energy. The social acceptance of the solar technology will improve with the awareness and knowledge of renewable energy and will be a precedent in development of the technology through the development of curriculum created in academic institutions (Madvar et al., 2018). Renewable energy technologies are more labour intensive, so it has more prospect to create jobs than mechanized fossil fuel technologies, (NRDC and CEEW, 2015; Agarwal and Mishra, 2006; Ghosh, 2015). . Based on literature the following hypothesis is formulated-

H5: There is a significant association between Advantages and Social Benefits due to the installation of Solar Photovoltaic

The installation Solar PV power plant in the Educational Institution can be beneficial, as these institutions become the producers of energy and will be able to cope up with power shortages or scheduled and unscheduled power cuts. This increases the status of the institution and provides great value to the research projects and training programs resulting in enhanced capability of the students, which contributes to value addition (Prasanna et al., 2016). So Solar powered schools can improve its brand image as a sustainable institution and improve enrollment (Energy sage, 2019) and save energy leading to Financial benefits through the adoption of solar energy (Balcombe, 2014). Affordability, visual attractiveness and low maintenance reduces the overall operational and maintenance cost and simple installation process of the project (Faiers & Neame 2006) is an added financial benefit. On the basis of these literature the following hypothesis is formulated:

H6: There is a significant association between Opportunities and Financial Benefits due to the installation of Solar Photovoltaic

Climate change is an important challenge faced by mankind and fossil fuels use is considered to be the predominant cause of global warming and climate change. (Madvar et al., 2018) Solar energy is considered world wide as one of the prominent mitigation measure for developing a decarbonized energy supply (IPCC, 2007c). Solar photovoltaic contributes to mitigating environmental challenges and is an economically attractive investment option. Government policy and intervention is necessary to "internalize externalities of environmental costs" (Pigou, 1920). Educational Institutions where energy consumptions are high, will greatly benefit from the Solar PV technology as it will provide both environmental and economic benefit (Meyer, 2014). Thus the following hypothesis is formulated.

H7: There is a significant association between Challenges and Environmental Benefits due to the installation of Solar Photovoltaic

Methodology

Sample, measures and testing procedures

The first objective of this research endeavour was to find the total number of grid connected solar installations in the state of Karnataka. This information was required to check the total population and the extend of penetration of the technology. This was achieved through the direct visit to all the five distribution companies across Karnataka, namely Bangalore Electricity Supply Company LTD (BESCOM), Mangalore Electricity Supply Company LTD (MESCOM), Hubli Electricity Supply Company LTD (HESCOM), Gulberga Electricity Supply Company LTD (GESCOM) and Chamundeshwari Electricity Supply Company LTD (CESCOM) and the required information was collected from the Chief Engineers of the respective division and the result is reported in Table No 1. The main objective of this research paper is to investigate the sustainable benefits of implementation of Solar Photovoltaic as a renewable energy source for the Educational Institution. Inorder to achieve this, a questionnaire has been developed based on the literature review and guided by the opinion of the experts in the field. All the items are measured on the 5-rating Likert scale. Primary data was collected from structured questionnaire, distributed to the educational institutions with Grid connected Roof top Solar Photovoltaic. Data was personally collected and the others were mailed to the respective heads of the institutions. The Educational Institutions included Government schools and colleges, private schools and colleges such as Engineering, Medical, Pharmacy Colleges, and Management Institutions. These Educational Institutions falls under the jurisdiction of the above stated five distribution companies, in

Karnataka. Educational Institutions both government and private with grid connected Solar Photovoltaic Rooftop installations after one year of commissioning of the project has been taken as sample. Secondary data has been taken from Government publications, books, journal articles with sustainability as core ingredient with the incorporation of renewable energy in Educational Institutions.

There are broadly two ways through which sample size is determined in PLS – SEM models (Hair et al., 2014). First, the literature on PLS – SEM mentions the use of rule of thumb (Barclay et al., 1995) and second, the statistical power analysis (Cohen, 1992) for sample size determination. Sample size should be ten times the highest number of structural paths that point towards a single construct in the structural model. A Sample size of 62 educational institutions and their inputs are recorded here. The researcher has used second generation smart Partial Least Square Structural Equation Model (PLS –SEM) to measure the reliability and validity of the data and model fitness and Hypothesis are tested through Bootstrapping method. Effect of each construct is measured by Blindfolding method. Finally the Importance performance matrix analysis (IPMA) for the importance of constructs and the indicator effect is measured. The 62 respondents were selected from the five-distribution companies. Random sampling method has been used to identify the respondents.

Table 1: Details of sampling units surveyed

Sampling units	Total Installations by DISCOMs (Population)	Serviced capacity in kWp	Sample of Educational Institutions
BESCOM	1238	94000	31
CESCOM, MYSORE	241	6765.95	10
GESCOM	87	10321	1
HESCOM	402	11556.81	11
MESCOM	533	9449.86	9
Grand Total	2501	132093.62	**62**

Source: The table is constructed by the author for the purpose of this study

As per the data available with the nodel agency for renewable energy in the state, Karnataka Renewable Energy Development LTD (KREDL), on 31st April 2018, there are 2501 Grid connected Solar Photovoltaic in the state of Karnataka, amounting to 132093.62 kWp. This was cross verified by the result from the five distribution companies. The sample taken from the different distribution companies are provided in the Table.1. Maximum number of Educational Institutions are from Bangalore, as Bangalore is an educational hub and the least number of samples are from Gulberga. This is due to the lesser number of institutions with grid connected Solar PV available in this distribution company limits due to the lack of awareness of the technology which has led to the slow penetration of the technology into this region. Among the 62 educational institutions that have been surveyed, 44 institutions have a student strength of 1000 to 3000, which amount to 71% of the total sample size. This states that a large student population has been a benefited by the adoption of renewable energy. 50% of the schools, which are outside BESCOM jurisdiction experienced power outages regularly and many of these institutions used generators to run their labs and computer systems. The application of the grid connected roof top Solar PV has provided the much needed energy solution to these institutions.

PLS-SEM has been used to analyze the 62 Educational Institutions, which has installed Solar Photovoltaic in the state of Karnataka. Among the different weighting schemes that the Smart PLS provides for algorithm settings, the researcher has chosen path weighting scheme as the structural model for a weighing method for the purpose of conducting the data analysis of the study. Raw data transformation is chosen for the purpose of facilitating the incorporation of standardized data for indicators (Hair et al., 2014: 80). To facilitate algorithms convergence, the researcher has chosen the stop criterion of 1.10^{-5}, which is also the threshold value for the purpose. There is no distributional assumption. Therefore, this researcher has conducted a non-parametric test. Accordingly, non-parametric bootstrapping procedure is invoked to test the significance of coefficients.

Results

Measurement model evaluation

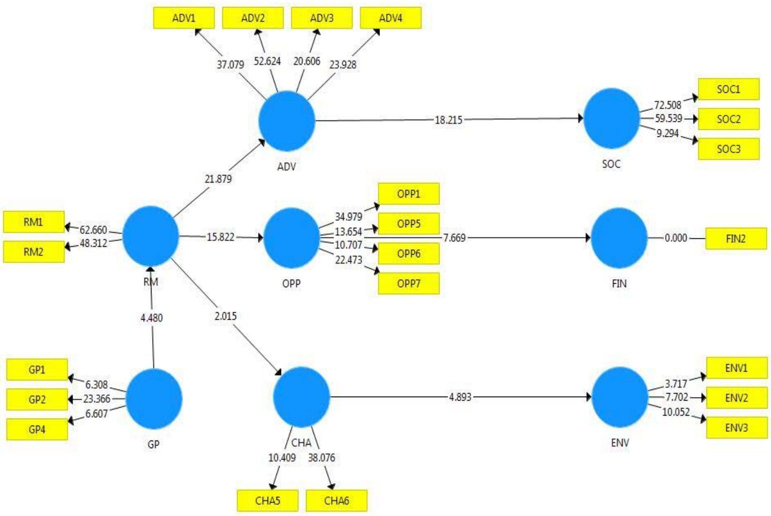
The exogenous latent variables of the measurement models, in the present study, demonstrate high levels of internal consistency reliability of 0.80.The threshold value of internal consistency reliability should be equal to or greater than 0.70 (Henseler et al., 2012). In order to obtain acceptable values of indicator reliability there should be a threshold value of 0.50 (Hair et al., 2014). This means that given indicators adequately represent the theoretical meaning embedded in a construct. All items have demonstrated indicators of reliability values that are above 0.50. Outer loadings of indicators, in reflective measurement models, indicate the absolute contributions of indicators to their respective constructs. The threshold value of outer loadings of all indicators is above 0.70. This indicates that the indicators of all constructs have acceptable levels of outer loading. It may be noted that the survey instruments has eliminated those indicators, which had weak outer loadings and indicator reliability. Among the 22 indicators that the measurement models of the present study have used, all indicators have outer loadings above the threshold value of 0.70.

To measure the convergent validity the average variance extracted (AVE) a strongly recommended test (Naylor et al., 2012). Convergent validity is measured with AVE threshold value should be more than 0.50 (McLure Wasko and Faraj, 2005; Wixom and Watson, 2001), which implies that a given construct is able to explain more than half of its indicators' variances. AVE values of all exogenous and endogenous latent variables constructs are above the threshold value of 0.50. Therefore, there exists convergent validity in all exogenous and endogenous latent variables constructs of the measurement model. PLS-SEM is a better way to assure the degree to which a given construct of the model is distinct from other constructs for measuring the discriminant validity (McLure Wasko and Faraj, 2005). To assess the discriminant validity the square of the correlations among the variables has been contrasted with the AVE (Chin, 1998). Discriminant validity is assessed using Fornell-Lacker (1981) criterion, which is a comparison between the square root of AVE and other latent variables. Therefore, discriminant validity is a measure of the uniqueness of a given construct. The model reveals the existence of discriminant validity among all constructs of the measurement model as the square root of all latent constructs is higher than their correlation with all the other latent constructs. The diagonal values are the square root value of AVE of the construct, which is higher when compared horizontally and vertically with other constructs values.

Structural Model Evaluation

By the measurement and structural model, Reason for Motivation and Advantage has the highest path coefficient and t- value. The indicator with maximum loading is RM1, being the 'popularity and prospects of the institution as a green campus', has influenced to provide advantages to the institution.

Figure 1. Structural Model



ADV2, having the maximum indicator loading, which states that the 'incorporation of sustainability into lesson plans' has the main advantage over the other indicators. The construct advantage has led to Social Benefits with the highest indicator loading as SOC1 that 'the students take a sense of pride in the institution as a green campus'. Advantage is the most significant factor that gives high impact on Social Benefit. Reason for Motivation has also led to Opportunities, and RM1, popularity and prospects of the institution as a green campus has led to Opportunities for the institution, OPP1with 'positive impact through educating students in environmental conservation and sustainable living' has high indicator loading and Opportunities have led to Financial Benefit as 'cost savings' by the institution by incorporation of Solar PV. Incorporation of solar PV has also brought in Challenges for the institution as CH6, which states that the 'lack of shadow free area' and 'availability of appropriate roof space' proved to be challenging and a limiting factor for many institution to further enhance the Solar PV capacity.

Table 2: Path coefficient and p-values after Bootstrapping

Relation	**Path coefficient**	**t-value**	**p-value**	**Bias-corrected 95% confidence interval**
Government Policy → Reasons for Motivation	0.464	4.480	0.000	(0.228, 0.642)
Reasons for Motivation → Advantage	0.849	21.879	0.000	(0.715, 0.912)
Reasons for Motivation → Opportunities	0.743	15.822	0.000	(0.620, 0.817)
Reasons for Motivation → Challenges	0.268	2.015	0.044	(0.005, 0.517)
Advantages → Social Benefits	0.793	18.215	0.000	(0.685, 0.862)
Opportunities → Financial Benefits	0.570	7.669	0.000	(0.389, 0.695)
Challenges → Environmental Benefits	0.416	4.893	0.000	(0.196, 0.535)

Results of Hypotheses Testing

The direct effect of government policy on Reasons for Motivation was investigated. The path coefficient and the empirical t value are 0.464 and 4.480 respectively (Table 2) which is above the threshold value. Accordingly, there is significance in the relationship between Government Policy and Reasons for Motivation at 5% level of significance. Thus, these values substantiate the hypotheses 1 that states the positive direct effect of Government Policy on Reasons for Motivation. Similarly the path coefficient and the empirical t value for Reasons for Motivation on Advantage has 0.849 and 21.879 at 5% level of significance substantiate the hypotheses 2 that states that there is a significant association between Reasons for Motivation and Advantage. The path coefficient and the empirical t value for Reasons for Motivation on Opportunities has 0.743 and 15.822 at 5% level of significance substantiate the hypotheses 3 that states that there is a significant association between Reasons for Motivation and Opportunities. About the Reasons for Motivation on Challenges the path coefficient and the empirical t value are 0.268 and 2.015 and with regard to Advantages on Social Benefits the path coefficient and the empirical t value are 0.793 and 18.215 respectively at 5% level of significance substantiate the hypotheses 4 that states that there is a significant association between Reasons for Motivation and Challenges and hypothesis 5 that there is a significant association between Advantages and Social Benefits stands proved. Further the constructs Opportunities on Financial Benefits and Challenges on Environmental Benefits has the path coefficient and the empirical t value 0.570 and 7.669 as well as 0.416 and 4.893 respectively at 5% level of significance substantiate the hypotheses 6 that states that there is a significant association between Opportunities and Financial Benefits and hypothesis 7 stating that there is a significant association between Challenges and Environmental Benefits stands proved here.

IPMA map for exogenous and endogenous latent variables

On the X axis, "Importance" is measured which reveals total effect. If the total effect of any construct is higher than another construct then that construct is more significant. On the Y axis, "Performance" is measured and if a construct has higher mean value then that construct has higher performance which reflects solid measurement paths (Hair et al., 2014; Rigdon et al., 2011; Höck et al. 2010; Völckner et al., 2010; Schloderer et al. 2014). The values of total effects (importance) and index values (performance), the IPMA of the exogenous constructs of this study is given in Table 3.

Table 3: Total effects and index values of latent constructs

Latent constructs	Importance (Total effects)	Performance (Index values)	Impact on endogenous constructs
ENVIRONMENTAL BENEFITS			
CHA	0.416	57.746	65.414
GP	0.052	66.299	66.050
RM	0.111	64.448	66.109
FINANCIAL BENEFITS			
GP	0.196	66.299	65.712
OPP	0.570	62.202	66.086
RM	0.423	64.448	65.939
SOCIAL BENEFITS			
ADV	0.793	56.084	49.811
GP	0.313	66.299	49.331
RM	0.674	64.448	49.692

Regarding Environmental Benefits construct, IPMA analysis (Table 3) shows that Challenges has high total effects (Importance) of 0.416 in comparison with the other exogenous latent variables. On the other hand, the index value (Performance) of Challenges is 57.746. Therefore, a one-unit increase in Challenges performance from 57.746 to 58.746 would increase the performance of Environmental Benefits by 0.416 points from 65.998 to 66.414. Similarly, in Financial Benefits construct IPMA analysis (Table 3) shows that Opportunities has high total effects (Importance) of 0.570 in comparison with the other exogenous latent variables. On the other hand, the index value (Performance) of Opportunities is 62.202. Therefore, a one-unit increase in Opportunities performance from 62.202 to 63.202 would increase the performance of Financial Benefits by 0.570 points from 64.516 to 65.086. With regard to Social benefits construct IPMA analysis (Table 3) shows that Advantage has high total effects (Importance) of 0.793 in comparison with the other exogenous latent variables. On the other hand, the index value (Performance) of Advantage is 56.084. Therefore, a one-unit increase in Advantage performance from 56.084 to 57.084 would increase the performance of Social Benefits by 0.793 points from 49.018 to 49.811.

Findings

Hence it can be observed through Importance performance matrix analysis, when the importance or the total effect is considered, the Environmental Benefit is influenced by Challenges. The Challenges are lack of appropriate roof area and availability of shadow free area. These are the primary requirements for the incorporation of the technology. If there are appropriate roof area and good usable shadow free area, it will provide Environmental Benefit as more installations can be managed, leading to more green power generation and this may lead to further reduction in carbondioxide emissions which would have been otherwise generated due to the use of power generated by fossil fuel. The environmental benefits assessed by this study are the awareness of the global green energy trends prevalent in different countries, and to develop a generation rooted in incorporating eco friendly solutions. The incorporation of green energy can solve the problem of pollution. Financial Benefits are influenced by the Opportunities. The Opportunities in incorporation of Solar Photovoltaic in Educational Institutions include handson experience for the engineering and management students in the new technology. It also helps them to enhance their engineering and math and problem solving skills. This will also have positive impact through educating students in environmental conservation and sustainable living. The peak power consumption of Educational Institutions are during day time and large amount of power generated can be fed to the grid leading to Financial Benefit of savings in energy bills throughout the year. It is observed that Social Benefits are influenced by the Advantages. Advantages include the knowledge of green energy and its processes and the practical understanding of producing solar energy, curriculum development in sustainability, teaching the students the real world situations and making them aware of the emerging crisis of environmental degradation and allowing them to have an alternate plan and idea to mitigate the problems of global warming and climate change. This can lead to social benefits of bringing in a sense of responsibility, personal involvement and a sense of pride in being able to part of the sustainable culture. This will provide the student a much needed change in attitude towards the development, which needs to be more sustainable.

In the Importance performance matrix analysis, when the Performance or the index value is considered, Government policy has the maximum index value. Government Policy is positively associated with Reason for Motivation. Reason for Motivation has direct and positive impact on Advantage, Opportunities and Challenges. Which leads to the sustainable benefits of environmental, social and financial benefits. This states that the Government Policy of ‘Net Metering’ plays an important role in bringing in the sustainable benefit to the Educational Institutions along with other Government Policies such as Higher feed in tariff, subsidy and availability of loans with less interest as priority lending. Hence it has been proved that the government policy initiates and plays a vital role in the sustainable development by way of technological innovation and policy measures. The Financial Benefit is achieved as the price of conventional power is escalating every year and the incorporation of Solar Photovoltaic will help arrest the rise in cost of energy and depend on clean green energy. The life span of Rooftop Solar Photovoltaic is twenty-five years, the amount after breakeven of the project is free for the institution for the rest of the life span of the product. The Educational institutions have their activity in the sun window and the energy developed on weekends and holidays can be exported to the grid, and due to Net Metering facility, the exported energy to the grid will be paid by the tariff approved by the government. The Social Benefits are achieved by way of enhancing social responsibility of students to the community by way of personal involvement, in the case of government schools the students cleans and maintains the panels in order to save cost and this automatically accelerates the learning process and this develops a sense of involvement in them. Environmental Benefits derived are the awareness of green energy trends among the student population where they are directly involved in mitigating pollution and this is a great opportunity to incorporate ecofriendly awareness in the future generation.

Conclusion

The Solar Rooftop installation in the five Electricity Supply Companies have seen a tremendous growth through the Government Policy. In the initial stages of the incorporation of the technology, Government Policy and intervention plays a crucial role in deeper deployment. Once the policy has achieved its target of motivating the society and after the maturity of the technology, the Reason for Motivation, as in the case of Educational Institutions, such as popularity as a green campus and incorporation of solar energy as apart of learning and the financial benefits takes over as the main criteria to catapult the whole procedure. It is observed that after a certain point, the industry dynamics will take over the instillation, as it is economically, socially and environmentally acceptable option. Government intervention is then pulled back and acceleration and adoption and deployment are through interest of consumers and end users who find sustainable value in turning towards renewable energy. The sustainable benefits of the Solar Photovoltaic intervention are encouraging. Along with the financial benefits, environmental and social benefits are found to be favorable to the students and society at large. The grid connected solar photovoltaic in educational institutions enhances the quality of education by encouraging curriculum development in renewable energy and sustainability. Solar Photovoltaic in universities may motivate students to explore a new career field which they otherwise wouldn't have considered. The problems that the society is facing due to mindless developments without considering the ecological impact has reached a point in which crucial solution are to be implemented to reverse the damages caused. New technologies and solutions have to be created and engrafted into the minds of the new generation. Educational institutions can bring in these attitudinal changes by instilling responsible stewardship and resource use. Adoption of renewable energy solution will cultivate a learning environment that mirrors real-world problems. This will provide advantages to the society and environment by developing positive attitude of the students towards renewable energy by promoting efficiency and responsible development practices. This ultimately will develop environmentally conscious designs and technology to improve sustainability and promote conservation of our planet's finite natural resources and enhance quality of life. However the study is not with out limitations. This research endeavor is confined to Mangalore, Bangalore, Gulbarga, Hubli and Mysore distribution divisions in the state of Karnataka, India. Generalizing the findings to the Indian context may not be appropriate as the state of Karnataka is one of the relatively developed states in India, and there could be regional disparities and difference in the tariff rates. However, generalization could be drawn to the state of Karnataka.

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