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Analyzing Sustainable Development Impacts of Large-Scale Clean Development Mechanism Projects on Host Countries

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Abstract

The objective of the Clean Development Mechanism (CDM) is to assist developed countries in achieving their emission reduction target levels and to contribute to the sustainable development of host countries. A Gold Standard (GS) rating system was developed to assess the value of emission certificates of existing CDM projects. In this paper, a framework was developed to analyze the true impact of CDM projects on host countries economically, socially, and environmentally. In addition, a comparative analysis is conducted between GS certified and non-certified projects to see which projects can be categorized as GS through Applied Statistical Inference techniques. Results show that the major impact of CDM projects was mainly related to job creation and reducing CO¬¬¬2 emissions. In addition, statistical analyses show that the sustainability filter in GS has many flaws and should be re-evaluated in order to be used as a rating system for CDM projects

Keywords: *Clean Development Mechanism, Gold Standard, sustainability, sustainable development.*

1. Introduction

1.1. Clean Development Mechanism (CDM)

The CDM was established under Article 12 of the Kyoto protocol to assist developed countries (Annex 1 Parties) in achieving their emission reduction targets whilst reducing the emissions of developing countries (non-Annex 1 Parties) [1]. Annex 1 Parties would receive emission reduction credits from the projects they are investing in, known as Certified Emission Reductions (CERs); simultaneously, developed countries would benefit by meeting their Sustainable Development (SD) goals. Benefits intended from CDM projects are numerous including: reduction of greenhouse gas emissions, increasing investment in non-Annex I countries, transfer of technology, and ensuring SD of non-Annex I countries.

CDM projects are categorized either as large scale or small scale, and are considered large scale if one of the following conditions is satisfied [2]:

- The project reduces energy consumption by more than 60 GWh/yr for energy efficiency projects.
- The project has a minimum output capacity of 15 MW for renewable energy projects.
- The project is emitting 60 ktons of CO2 per year for other type of projects.

The CDM has registered 7,589 projects up to the date 31.12.2014, almost half of which are in China and most of which are under the waste handling and energy industries (renewable/non-renewable source) [3].

1.2. Problems associated with CDM

When CDM was introduced, the Kyoto Protocol did not specify certain SD criteria that need to be met by CDM projects. Instead, this issue was left to be decided by the host country based on its national priorities. Due to the unclear definition of SD, the CDM projects faced several issues throughout their first years. It was argued that most CDM projects are not contributing to SD and the unclear definition of SD made it unfeasible to monitor and check for SD impacts [4]. Also, Buchner [5] states that there are three main problems associated with CDM projects: complexity, risks, and market uncertainties. Others claim that the two objectives of reducing emissions and ensuring SD cannot be maximized at the same time [6]. Moreover, one study

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indicated that projects that lead to sustainable development, such as renewable energy, transport, and energy efficiency projects, have low competiveness in the CDM market [7]. The financial institutions in the host countries face lack of knowledge about CDM projects, which leads to improper evaluation of their risks. Also, due to host countries' lack of market power to influence the global emission reduction market, high competition resulted between those countries to attract more projects, and this was done by lowering their SD criteria [8-11]. Furthermore, CDM literature does not provide a clear reason for the direction of CDM investment. The assumption that states that the CDM investment follows the foreign direct investment flows was criticized [12]. Also, research effort toward analyzing the CDM host country attractiveness showed that building CDM capacity was the most important factor [13-15]. Those studies demonstrated different ranking for the host countries attractiveness but did not focus on the sustainability criteria of the host country, which raise the question of the effect of the host country sustainable criteria on the distribution of CDM projects.

1.3. Gold Standard (GS) Rating

Due to the CDM contribution towards promoting SD benefits, several solutions were proposed by different Non-Government Organizations (NGOs). Research that examined SD indicators and different labels showed that creating a premium label could be one of the best available promising solutions [16-17]. In addition, it was mentioned that premium markets help in promoting SD benefits by giving a price for those benefits [11].

The World Wide Fund (WWF) initiated the Gold Standard, along with SouthSouthNorth and Helio International NGOs. Its purpose was to create a label that will ensure higher quality emission reduction CDM projects with more SD benefits. The methodology proposed by GS would assist host countries in obtaining secured environmental, social, and economical benefits for their CDM projects [18]. The GS promote SD benefits by applying sustainability matrix, Environmental Impact Assessment and stakeholder consultation in its evaluation process [19].

The types of CDM projects that are eligible for GS are: the renewable energy supply, the end-use energy efficiency, and the waste handling and disposal projects. Among the six greenhouse gases that are eligible under the CDM, the GS set only CO_2, CH_4, and N_2O to be eligible under its framework [19]. According to Sterk et al. [20], the GS is a tool that uses several screens to guide project developers to decide on their project eligibility. CDM projects must go through a SD screening, and conduct two rounds of stakeholder consultation before earning a GS label on their CERs. The sustainability assessment conducted on the CDM projects to be eligible for GS consist mainly of two components [19]:

1. 'Do No Harm' Assessment: the project developers are requested to state the risks associated with their projects and related them to the Millennium Development Goals (MDG), as well as their mitigation measures.
2. Sustainable Development Matrix (SDM): The SDM consists of three main pillars and twelve indicators as shown in Table 1. Project developer will use the SDM to score their projects with a (+) for positive impact, (-) for negative impact, and (0) for neutral impacts. Two versions of acceptance criteria were developed by the GS as seen in Table 2.

Table 1. SD indicators used in GS SD matrix [20]

Environment	Social Development	Economic and technological development
1. Air quality 2. Water quality and quantity 3. Soil condition 4. Other pollutants 5. Biodiversity	6. Quality of employment 7. Livelihood of the poor 8. Access to affordable and clean energy services 9. Human and intuitional capacity	1. Quantitative employment and income generation 2. Balance of payments and investment 3. Technology transfer and technological self-reliance

Table 2. Versions 1 and 2 of GS acceptance criteria [20]

	Version 1	Version 2
Scoring	Each indicator is given a score between (-2 to 2), -2 indicating very severe negative impact and 2 a high positive impact.	Each indicator is given a score of: • (+) for positive impacts • (0) for neutral impacts • (-) for negative impacts
Minimum scoring criteria	1. Each major category should have a non-negative sub-total 2. The total score of all indicators must be positive 3. The project is considered ineligible if one of the indicators scored -2	1. The project must score positively in at least two of the three main categories 2. The project is considered ineligible if it scored negative in one of the main categories.

1.4. Previous Studies in Analyzing impact of SD on CDM Projects

Several researchers attempted to verify the contribution of CDM projects towards SD of host countries. Research related to SD differed in the sample used, the SD indicators, and the methodology of the research. Literature review indicated that most of the researchers used Project Design Document (PDD) as the main data source of their analysis [4, 17, 21-32]. The PDD contains all important data regarding the CDM project and its activities, and is validated by an agency assigned by the CDM Executive Board, called the Designated Operational Entity (DOE), and approved by the CDM Executive Board. The PDDs are publicly available on the UNFCCC CDM website. Previous studies showed that most researchers used similar indicators as GS for SD assessment [4, 17, 22, 27]. The GS differs from other methodologies in its scoring criteria as it is qualitative, while others, used quantitative measures such as weights for their SD indicators [22] and some used a yes/no approach [32]. In general, few studies showed that CDM projects have high contribution to SD [4, 32], while others showed the contrary [21-24, 27].

There are three major studies that investigated the contribution of CDM projects towards SD. The first study [32] used the data source for the project assessment from the PDD. It used economic, social, and environmental variables. The assessment approach consisted of PDD taxonomy assessment based on a yes/no criteria. Two hundred and two projects were studied, out of which 79 are small scale and 123 are large scale projects. The sample included at least one project from the 25 UNEP Risoe sectors. Projects were mainly located in Asia (73%) and Latin America (21%). The study showed that the indicators scoring highest are: improved local quality of life (mainly in India and Brazil), employment generation and contribution to national energy security (mainly in China). The study also showed that small scale PDD state more SD benefits than the large scale ones. Also, it claims that only 5% of large scale projects had no SD benefits other than technology transfer. The study concluded that the CDM projects do have positive impacts on the SD of host countries.

The second study [22] focused on rural communities. Five hundred PDDs of small-scale registered projects (66% in Asia and 32% in Latin America) and 5 case studies on Indian CDM projects were investigated. Micro and small hydro projects dominated in terms of technology (27%) followed by biomass energy (25%) and methane recovery (22%). The research demonstrated a new framework to analyze SD benefits of CDM small-scale projects. Several indicators were identified under economic, social and environmental aspects, and based on the needs of rural communities. Each indicator was given a score between 0 to +2. One of the features of this analysis is ignoring the general statements in the PDDs, as they are considered useless without proper justification. It was concluded that small-scale CDM projects failed to contribute to the SD of host countries. On the other hand, the results of each of the five projects in India were compared to the ones obtained from PDDs. Only three out of five projects matched the PDDs analysis.

Finally, the third study [4] used PDDs as the main source for data along with the Institute for Global Environmental Strategies (IGES) data base [33]. The sample used in this study consisted of 2,250 projects, which were registered as of July 31, 2011. The study concluded that all registered projects report multiple SD benefits. It also showed that the most frequently stated indicators are employment generation (23% of projects); and reduction in noise, odors, dust or pollution (17% of projects). Furthermore, this study indicated that there was a lack of agreement between the PDD analysis and the survey conducted. The survey showed that around 19% of the responses didn't match the PDD SD indicators analysis. The technology transfer claim results showed that 21% of the projects under the UNFCCC categories didn't show any explicit statement related to technology transfer. The differences between the PDD analysis and the survey response were similar to the results from the previous analysis.

All three studies highlighted the need in creating a modular methodology and scoring system for the SD benefits of CDM projects. Also, there was a lack of focus on large scale CDM projects. The major studies focused on small scale CDM projects or CDM projects in general because of the argument that small scale projects foster more benefits [22-23].

This paper aims to assess 600 large-scale CDM projects to evaluate the level of improvement of SD in host countries. The methodology adopted and the sample chosen for analysis will be explained. The steps of creating the project database will be highlighted. In addition, the indicators and the scoring process will be discussed in details. Statistical tests and their significance in analyzing the linkages and relations between the different factors will also be presented. The process of obtaining results from the GS registry and comparing them with results from our analysis will be highlighted. Results and their discussion will then be discussed. The Journal Papers will be prepared from electronic file documents supplied by the author(s). To ensure publication quality and uniformity, the following requirements have been prepared to assist authors in preparing papers for the Journal. If these requirements are not followed, papers will be returned for revision and re-submittal. The resulting time delay could cause rejection of the paper because of publication deadlines for the Journal Publication.

2. Methodology

The research will use the GS indicators to analyze the sample, as the GS indicators showed high credibility and have been adopted by many researchers in previous studies. The scoring of the indicators will be done using Version 2 of the GS tool kit using the same criteria. The usage of a score that is (+, 0, -) was chosen because it reduces the bias of choice, and it has been used recently for GS projects.

2.1. Scope of Work

2.1.1. CDM projects sample

A sample of 600 large-scale CDM projects (14 GS and 586 non-GS projects), registered between 2009 and 2010, and lying under categories of waste handling and energy industries (renewable and non-renewable) were selected. Fourteen GS CDM projects were taken from the sample of 600 CDM projects and other 28 GS CDM projects as common projects to check whether our scoring will match those obtained from the GS registry data.

Most of the projects are located in Asia as shown in Fig. 1. For the region (others), there were only two projects, which are located in the Former Yugoslav Republic of Macedonia and Uzbekistan.

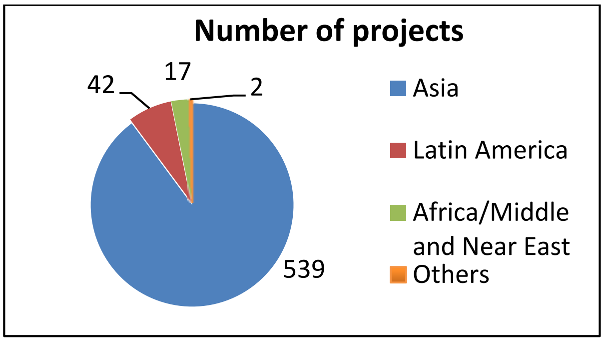

Fig. 1. Sample projects' location based on region

It is important to note that China harbors the largest number of projects with a sum of 446 projects, while India ranked second with 49 projects. Also, hydropower projects dominate the project sample.

2.1.2. The GS CDM Sample

A separate analysis of 28-registered large-scale GS CDM projects was conducted. The data for this sample was obtained from the GS registry, which includes all PDDs and PDD Annexes for the validation of the GS projects. The analysis used the scores obtained from the PDDs and PDD Annexes to score the SD contribution of the CDM projects. The scoring used was based on Version 2 of the GS tools kit. The scores of the GS projects that used Version 1 in their scoring were converted into Version 2 by changing each (+1,+2) scores to a positive contribution (+) and each (-1,-2) score to a negative contribution (-). Fig. 2 represents the sample of GS projects that was analyzed based on the host country and type of technology. It can be seen that wind projects dominated the sample.

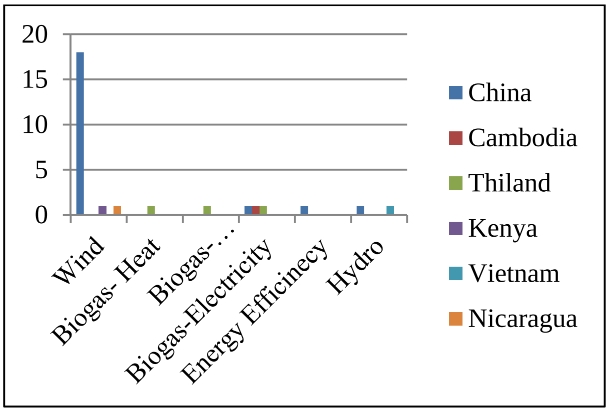

Fig. 2. GS CDM sample based on host country and technology

One of the objectives of the research is to create a database of the projects and their SD scoring. The project database from IGES [33] was adopted in order to get the basic projects' information such as CDM-EB reference number, Name of CDM Project Activity, Region, Host Party, Other Parties Involved, Type of Project, and other basic information. After that, the scoring fields are added to the database, which include 12 indicators (shown in Table 1), and a summation field of the main categories is created to get an overview of the total contribution (using version 2 from Table 2). The database will also incorporate a GS check equation, which will test if a specific project can pass the sustainability criteria of the GS.

2.3. Choosing the PDD as a Data Source

The data source that was used in this work is PDD, as this was used by many researchers and official studies conducted by the UNFCCC (Olsen and Fenhann, 2008; Sutter, 2003; Sutter and Parreño, 2007; Resnier et al., 2007; Castro and Michaelowa, 2008; TERI, 2012; UNFCCC, 2011). Table 3 shows the different sections of the PDD and the information obtained from those sections. The process of identifying those sections was based on an iterative process by examining several PDDs. The PDD contains authenticate information and each PDD is validated by the DOE, which increase the reliability of the information in those documents. The PDDs were obtained from the CDM website and downloaded accordingly.

Table 3. Information obtained from different PDD sections

PDDs section	Information obtained
Description of the project activity	• Air Quality • Water quality and quantity • Soil condition • Quality of employment • Livelihood of the poor • Access to affordable energy services • Human and institutional capacity- • Quantitative employment and income generation • Balance of payments and investment • Technology transfer and technological self-reliance
Technology to be employed by the project activity	• Quality of employment- • Technology transfer and technological self-reliance
Environmental impacts	• Air Quality • Water quality and quantity- • Soil condition-Other pollutants • Biodiversity • Access to affordable energy services • Human and institutional capacity- • Quantitative employment and income generation
Stakeholders' comments	• Water quality and quantity • Soil condition • Other pollutants • Biodiversity • Access to affordable energy services • Human and institutional capacity • Quantitative employment and income generation • Balance of payments and investment

2.4. Scoring the Sustainability Contribution of the CDM Projects

After creating the database and identifying the main sections of PDD that correspond to each indicator, the scoring was done based on the GS criteria. The GS provides a set of keywords for each SD indicator, which assists in scoring the projects. The choice of those keywords was based on an iterative process based on PDD examination. Table 4 summarizes each indicator and the keywords used to identify positive and negative contribution. Indicators that present a negative contribution but have mitigation measures will be scored as neutral.

Table 4. The keywords used to score the SD indicators

Indicator	Positive contribution	Negative contribution
Air Quality	• Decrease in (NO_x –SO_x -CO-Lead-Mercury-Ozone-Dust level- Odour levels) • The project will displace of coal fire plant • The project displacement fossil fuel fired plant • Improvement of health (respiratory problems, eye irritation)	• Increase in (NO_x –SO_x -CO -Lead-Mercury-Ozone-Dust level- Odour levels) • Negative effects on health (respiratory problems, eye irritation)
Water Quality and Quantity	• Decrease in (NO_x –SO_x -POPs-Lead-Mercury-Biological Oxygen Demand- -Chemical Oxygen Demand-Thermal Pollution) • Providing other sources of water.	• Increase in (NO_x –SO_x -POPs-Lead-Mercury-Biological Oxygen Demand- Chemical Oxygen Demand-Thermal Pollution) • Reduction in water level
Soil condition	• Reduction in (NO_x –SO_x -Lead-Mercury-Soil erosion level)	• Increase in (NO_x –SO_x -Lead-Mercury-Soil erosion level)
Other pollutants	• Decrease in Noise Levels	• Increase in Noise Levels
Biodiversity	• Increase of threatened Plants (planting new trees) /or threatened mammals, birds, reptiles, fishes (building fisheries and raising awareness between fisher men), and other species and habitats.	• Decrease of threatened Plants (planting new trees) /or threatened mammals, birds, reptiles, fishes , and other species and habitats
Quality of Employment	• Adopting high safety working conditions (providing workers with gloves and masks). • Training courses • Duration of jobs (permanent)	• Poor site safety conditions
Livelihood of The Poor	• Building hospitals • Providing medical care for the residence • Providing food for the residence • Access to waste management system • Providing safety measures (reducing the risks of explosions)	• Increasing the risk of explosions and reducing safety
Access to Affordable and Clean Energy Services	• Reduction in blackouts time • Reduction in electricity prices • Change from wood fuel to a clean energy source	• Increase in blackouts time • Increase in electricity prices
Human and Institutional Capacity	• Building schools or educational facilities • Women empowerment • Equal distribution of benefits among different ethnicity, religion, and socio-economic groups	• Unequal distribution of benefits among different ethnicity, religion, and socio-economic groups
Quantitative Employment and Income Generation	• Creating new jobs • Increase in local residence income	
Access to Investment	• Increase in currency exchange • The project is a first of its kind (which will encourage investment)	
Technology Transfer and Technological Self-Reliance	• Importing new technologies • Spending money on R&D • Seminar and workshops from foreign experts provided to the local employee	

2.5. Statistical Approach

The statistical results of this research will be an outcome of MS Excel and IBM SPSS statistics software, as these software tools have a very clear interface. The results will summarize the scores of the CDM projects indicators as descriptive statistics. Similarly, the scores of the GS CDM indicators will be summarized. In addition, a summary of the projects that passed and failed to meet the GS SD criteria will be presented in a descriptive statistics format. Furthermore, a normality test will be conducted to check if the distribution of the indicators' scores reflects a normal distribution. The Skewness of the results should be around 0 and the kurtosis should be around 3 for the distribution to be normal. After that, a test to compare CDM projects that passed and failed the GS rules with certified GS CDM projects scores is performed. If the distribution was a normal distribution, an independent t-test will be used; otherwise, a non-parametric test will be used.

3. Results and Analysis of Result

3.1. Results of SD Indicators Scoring

Fig. 3 represents the results of the SD indicators scoring. It is clear that the highest positive contribution comes from employment generation (591), followed by improvement in air quality (527). It is also noticeable that all environmental indicators, as well as livelihood of the poor indicator, incurred negative contribution with a few projects each.

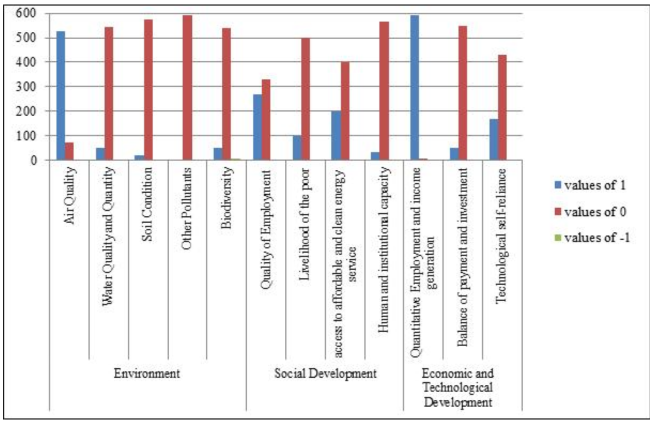

Fig. 3. SD indicators scores of the projects sample in terms of number of projects

3.2. Results of Potentiality of CDM Projects to Pass the GS Sustainability Criteria

The analysis of the results indicates that 572 projects have potential to pass the sustainability criteria proposed by the GS. Fig. 4 highlights the 28 projects that failed to meet the GS sustainability criteria based on the examination of their relative PDDs. Results show that most of these GS-failing projects were located in China (18), and most were wind power projects (12). Those results were expected because China was the major country in the sample and wind power was one of the dominating categories. In addition, all the following project types passed the GS sustainability criteria: biogas, energy efficiency, methane avoidance, other RE, and SF6 replacement.

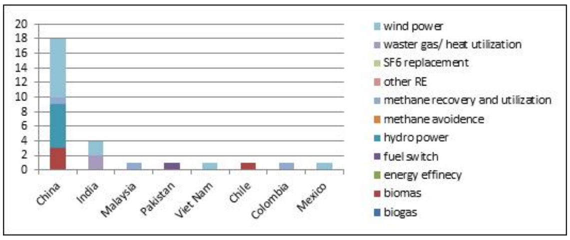

Fig. 1. Projects that failed to meet the GS SD criteria check

3.3. Results from the CDM GS Projects Analysis

A similar analysis to the one described previously was conducted on the registered large-scale CDM GS projects. The results of the analysis are summarized in Fig. 5. From the results, it is clear that quantitative employment and income generation scored 100 % positive. On the other hand, other pollutants and biodiversity are the only scores, which scored negatively and did not have any positive contribution.

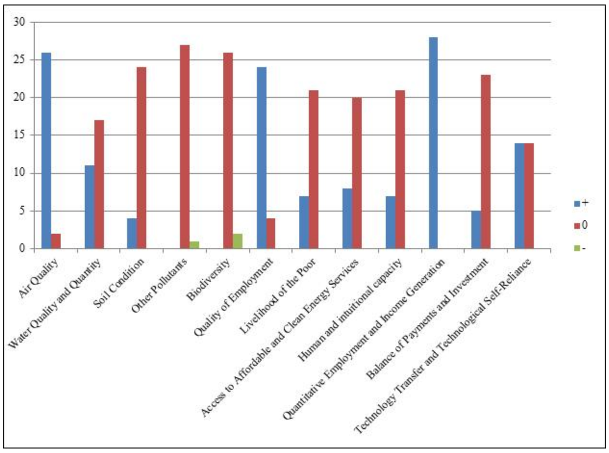

Fig. 5. SD indicators scores of the GS projects sample in terms of number of projects

3.4. Normality test

The results of the normality test are summarized in Table 5, which show that all of the indicators had non-zero skewness and a Kurtosis unequal to three, which means that our results are showing a non-normal distribution. Those results were expected for the indicators because they have discrete values (-1,0,1). This implies that an independent t-test cannot be used because it assumes that the sample is normally distributed. A Mann-Whitney test will be used to compare the scores of the CDM projects that passed and failed the GS rules with the certified GS CDM projects scores as the next section highlights.

Table 1. Normality Test Results

Indicator	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
Air Quality	-2.539	.099	5.352	.197
Water Quality and Quantity	2.247	.099	5.972	.197
Soil Condition	3.057	.099	20.886	.197
Other Pollutants	-2.169	.099	120.712	.197
Biodiversity	1.829	.099	6.408	.197
Quality of Employment	.170	.099	-1.977	.197
Livelihood of the poor	1.721	.099	1.292	.197
Access to Affordable and Clean Energy Service	.714	.099	-1.495	.197
Human and Institutional Capacity	3.533	.099	10.515	.197
Quantitative Employment and Income Generation	-8.097	.099	63.765	.197
Balance of Payment and Investment	2.917	.099	6.530	.197
Technological Self Reliance	.946	.099	-1.109	.197
Environment Total	.527	.099	3.249	.197
Social Total	.648	.099	.317	.197
Economics Total	1.355	.099	.927	.197

3.5. Mann-Whitney test

The Mann-Whitney test is a non-parametric test in which the null hypothesis assumes that the two populations are the same. This test is based on ranking the means of variables based on the Wilcoxon rank-sum test. The significance level was chosen to be 95%, which is commonly used in social and scientific studies. The hypotheses of the Mann-Whitey test are as following:

Ho= The two populations are the same;

Ha= A particular population tends to have larger values than the other

1.5.1. *Passing CDM projects scores VS certified GS projects scores*.

The scoring of the CDM projects that passed the GS rules was compared to the certified GS scores as shown in Table 6. Only six of the twelve indicators showed that the null hypothesis is true and that the two populations are the same. On the other hand, all the main categories were not similar at 95% confidence level, which implies that the GS rules logic turned out to be not that robust. The total score of all indicators also showed that the CDM projects that passed the GS rules are not the same as the certified GS projects scores.

1.5.2. *Failing CDM projects scores vs certified GS projects scores*.

Similarly, the Mann-Whitney test was applied on the CDM projects scores that failed to meet the GS rules with the certified GS projects scores. Table 7 shows that six out of the twelve indicators showed differences between the two groups of projects. Two of the three main categories are not similar between the two groups of projects. The total scores of the indicators showed that we are 95% confident that the two groups are not similar, which confirms the GS criteria in this case.

1.5.3. Discussion of the Mann Whitney test results

The results of the Mann-Whitney test indicated that we on a 95% confidence level, the passing CDM projects and the GS projects are not similar, while the failing CDM and GS projects confirmed similarity. The reasons behind this inconsistency are the following:

1. The sample of the passing CDM projects was much bigger than the sample of the certified GS projects (558 vs 28). The GS sample chosen in this research consisted of all registered large-projects, and that's why the size was limited. On the other hand, the failing CDM sample was only 28, which is the exact size of the GS projects sample.
2. The GS rules are heuristics and don't follow a logical quantitative framework to determine the certification of the projects. For example if a project scored positively in one of the indicators in two of the categories it will qualify. However, if another project scored positively in all 12 indicators it will also pass, which imply the weakness of the GS rules.

Table 6. Mann-Whitney test results of passing CDM projects and certified GS projects scores

	Ho	Ha	Test	Alpha-level	Test Value (Z)	Prob. (2 tail)	Accept Ho
Air Quality	p=0	p<>0	Two-tailed t-test	0.05	-0.59512	0.861028	Yes
Water Quality and Quantity	p=0	p<>0	Two-tailed t-test	0.05	-1.97379	6.39E-08	No
Soil Condition	p=0	p<>0	Two-tailed t-test	0.05	-1.04727	0.002324	No
Other Pollutants	p=0	p<>0	Two-tailed t-test	0.05	-0.5	0.019177	No
Biodiversity	p=0	p<>0	Two-tailed t-test	0.05	-1.74233	0.054574	Yes
Quality of Employment	p=0	p<>0	Two-tailed t-test	0.05	-2.38048	3.88E-05	No
Livelihood of The Poor	p=0	p<>0	Two-tailed t-test	0.05	-0.92195	0.24749	Yes
Access to Affordable and Clean Energy Service	p=0	p<>0	Two-tailed t-test	0.05	-1.58698	0.513205	Yes
Human and Institutional Capacity	p=0	p<>0	Two-tailed t-test	0.05	-1.45774	9.44E-05	No
Quantitative Employment and Income Generation	p=0	p<>0	Two-tailed t-test	0.05	-2	0.615234	Yes
Balance of Payment and Investment	p=0	p<>0	Two-tailed t-test	0.05	-2.76586	0.078492	Yes
Technological Self-Reliance	p=0	p<>0	Two-tailed t-test	0.05	-1.00328	0.008506	No
Environment Total	p=0	p<>0	Two-tailed t-test	0.05	-1.29921	0.005309	No
Social Total	p=0	p<>0	Two-tailed t-test	0.05	-2.08261	0.000999	No
Economical and Technological Total	p=0	p<>0	Two-tailed t-test	0.05	-1.813	0.009653	No
Total Score	p=0	p<>0	Two-tailed t-test	0.05	-4.731	0	No

4. Conclusions

The contribution of 600 CDM projects towards host countries SD was analyzed in this research, where the framework adopted is composed of 12 SD indicators. Employment generation and air quality were the two indicators that showed most of the positive contribution, while most of the negative scores were in the environmental category. The other indicators scores were mostly neutral, which reflects the lack of importance of the SD goal of the CDM. Furthermore, 572 projects passed the GS criteria, while 28 projects failed. Finally, using Mann-Whitney test, the comparison between the passing CDM projects scores and the certified GS projects scores showed no similarity between the two groups, which indicate the weakness in the GS rules. However, the results of the failing CDM projects scores and the certified GS projects scores comparison showed no similarity in two categories. These results indicate some contradictions. This is probably due to the number of projects compared between the two groups especially the GS Certified projects and the projects that met GS criteria according to GS rules.

All in all, this research highlighted the positive SD impacts of large-scale CDM projects and their potentiality to be certified as GS projects. It also showed the weakness of the current GS SD scoring framework and the need to investigate the heuristics characteristic of the GS rules.

Table 7. Mann-Whitney test results of failing CDM projects and certified GS projects scores

	Ho	Ha	Test	Alpha-level	Test Value (Z)	Prob. (2 tail)	Accept Ho
Air Quality	p=0	p<>0	Two-tailed t-test	0.05	-6.5478	5.8393E-11	No
Water Quality and Quantity	p=0	p<>0	Two-tailed t-test	0.05	-3.73786	0.0001856	No
Soil Condition	p=0	p<>0	Two-tailed t-test	0.05	-2.25418	0.02418497	No
Other Pollutants	p=0	p<>0	Two-tailed t-test	0.05	0	1	Yes
Biodiversity	p=0	p<>0	Two-tailed t-test	0.05	-1	0.31731051	Yes
Quality of Employment	p=0	p<>0	Two-tailed t-test	0.05	-6.12715	8.9469E-10	No
Livelihood of The Poor	p=0	p<>0	Two-tailed t-test	0.05	-1.80294	0.07139771	Yes
Access to Affordable and Clean Energy Service	p=0	p<>0	Two-tailed t-test	0.05	-1.66667	0.0955807	Yes
Human and institutional capacity	p=0	p<>0	Two-tailed t-test	0.05	-2.80306	0.00506203	No
Quantitative Employment and Income Generation	p=0	p<>0	Two-tailed t-test	0.05	-2.05688	0.03969745	No
Balance of Payment and Investment	p=0	p<>0	Two-tailed t-test	0.05	-0.75691	0.44910223	Yes
Technological Self-Reliance	p=0	p<>0	Two-tailed t-test	0.05	-0.79919	0.42417843	Yes
Environment Total	p=0	p<>0	Two-tailed t-test	0.05	-6.25019	4.0996E-10	No
Social Total	p=0	p<>0	Two-tailed t-test	0.05	-5.82672	5.6529E-09	No
Economical and Technological Total	p=0	p<>0	Two-tailed t-test	0.05	-1.67305	0.09431796	Yes
Total Score	p=0	p<>0	Two-tailed t-test	0.05	-6.3	0	No

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