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Guidelines Green Building Standards for Lao People's Democratic Republic

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Abstract. This research presents importance and possibility concerning the eco-building through analysis strength, weakness, opportunity, and threats to bring the guidelines for drafting green building Standards for Lao People's Democratic Republic. The regulation in this research referred under the context of TREES-NC. V.2013 standard of Thailand, LEED-NC. V.2009 standard of USA, CASBEE-NC. V.2014 standard of Japan, and additional literature reviews, therefrom using these regulation derived from a collection of the three standards to create a questionnaire to interviewing by 40 well-selected experts from relevant divisions. Use statistical methods to analyze, classification and rank importance and possibility. The result shows that each regulation includes both importance and possibility are arranged in high to moderate levels. It shows that there are no regulation that are not important to green building standards. So all regulation can be possible for Green Building standard if it is used in Laos and when analyzed regulation with SWOT analysis of first and last 3 regulation, it found that most of the regulation are still some problem such as: some technologies must be imported from abroad, some devices have not sold, some device is expensive and Infrastructure of the country is not favorable, such as no lane for bicycle.

1. Introduction

Nowadays, Lao People's Democratic Republic (Lao PDR) is currently developing in many ways including a building construction which tends to be increasing every year, especially in the capital since it is a center of government buildings, offices, and shops with its high population density. Therefore, the demand for natural resources and energy has increased. In order to comply with the policy of the Government [1] and the global trend which wants to promote buildings that are environmentally friendly and help reduce energy consumption in buildings, the concept of Green Building is an important key which helps control and monitor energy-efficiency in the buildings, reduce environmental impacts, improve quality of occupants, build a positive image of the organization, promote long-term cost reduction and results in sustainable development.

Green Building refers to a building that focuses on a minimal impact on the environment, efficiently using energy, water, and eco-friendly building materials, reducing waste and toxins [2, 3] as well as using resources effectively and efficiently. It is a combination of nature with the use of modern technology, relying on nature and making the most out of it [4] by covering the entire lifecycle of a



building be its site selection, design, construction, operation, maintenance and demolition [5]. Nowadays, the Green Building concept has been paid more attention all over the world. Each country has developed its own Green Building standards to be used as its building rating system.

Aforementioned issues and policy, this research has compiled all regulation relevant the Green Building as well as arranging the importance and possibility to analyses strength, weakness, opportunity and when these are used for the standard of Laos Green Building in this coming future. Above standard is under the saving and sustainability which conform the social context, cultures, and people life with applying reference in terms of 3 Green Building standards such as 1) Thai's Rating for Energy and Environmental Sustainability (TREES-NC.2013), Thailand [6], 2) Leadership in Energy and Environment Design for Building Design and Construction (LEED-NC.2009), the USA [7], and 3) Comprehensive Assessment System for Building Environmental Efficiency (CASBEE-NC. 2014), Japan [8]. Bring all regulation from these standards to asking the opinions of the experts by relevant divisions in Laos - total 40 persons from government, academic from national university of Laos and private sectors (engineer and architecture). Besides, this has used the Analytic Statistic to get the result and take the priority and possibility with SWOT Analysis to analyses both strengths, weaknesses, opportunity and threats if these are used in Lao PDR, This is a guideline for the green building of Lao in the future.

2. Literature Review

Laos provides the promotion policy concerning the design and construction that at least affect resource and environment usages. [1] These policies get emphasized the green sustainable development [9] maintaining originally uniqueness and culture. Hence, to build the standard of Green Building relevant country policy and content are needed.

According to each Green Building regulation standard, the Thai Green Building (TREES) is a proper ideal to build the Green Building in Laos since the weather, geography, and culture in Thai are more similarly to Laos. For the literature reviews, the TREES standard acquires an influence and development from the Green Building standard concept (LEED). Thus the LEED standard is the main resource conforming to Adegbile [10], regulation analysis to find the proper Green Building standard relevant the Nigerian environment to be as references for Green Building. One of the standards is LEED standard through questioning relevant divisions of the country. The result shows that every standard similarly provides the basic principle, for instance, the building planning, designs, energy, water, materials, environment quality within buildings, increasingly the efficient operation, as well as preservation and waste reduction. In addition, LEED regulation standard is appropriate likely with Nigeria which contains 80 per 100 of opinion total scores from concerned people. This is because of the favorite standard and its providing the obvious regulation can follow up and completely check the building efficiency. These also consist the same direction as Ali and Al Nsairat [11] that have chosen LEED standard as the standard reference in the case study to do making the Green Building standard for Jordan.

Therefore, if it considers the unique regulation that appropriates with the clear context, so the Green Building standard in Japan (CASBEE) would not be missed on previously mentioned. Green Building in Japan has designed from the good concept that is proper with their country conditions. For instance, defining the concept of planning to support vibration after the earthquake for more efficiency. (Since in Japan often occurs the earthquake). So that the concept of TREES, LEED, and CASBEE standards are truly appropriate as the reference to study importance and possibility if they are used for Green Building in Laos.

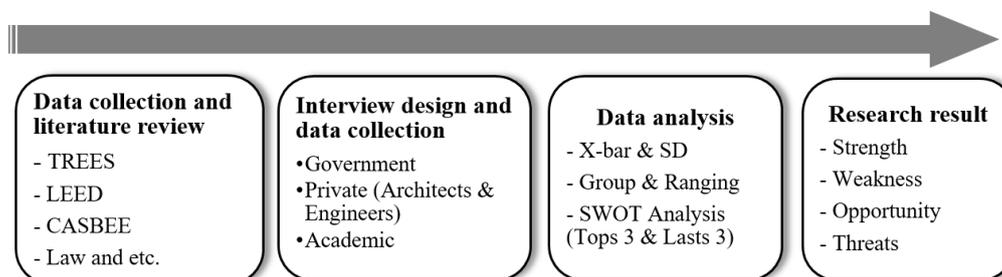
The details and specifications of these three standards (TREES, LEED, and CASBEE), are shown in Table 1.

Table 1. Description of TREES LEED and CASBEE

	TREES	LEED	CASBEE
Country	Thailand	USA	Japan
Version	New Construction - 2013	New Construction - 2009	New Construction - 2014
Development	(TGBI – Thai Green Building Institute)	1993 by the United States of America Green Building Council (USGBC)	2001 by Japan Sustainable Building Consortium (JSBC)
Criteria used in measuring	<ul style="list-style-type: none"> - Building Management - Site and Landscape - Water - Energy & Atmosphere - Materials &Resources - Indoor Environmental - Environmental Protection - Innovation 	<ul style="list-style-type: none"> - Sustainable Site - Energy & Atmosphere - Water - Materials &Resources - Indoor Environmental Quality - Innovation - Region Priority 	<ul style="list-style-type: none"> - Indoor Environment - Outdoor Environment on Site - Quality of Service - Energy - Resources and Materials - Off-site Environment
Level	The Rating is divided into four level : 30 to 37 - Certified 38 to 45 - Silver 46 to 60 - Gold 61 to 85 - Platinum	The Rating is divided into four level : 40 to 49 - Certified 50 to 59 - Silver 60 to 79 - Gold 80 to 110 - Platinum	The Rating is divided into five level: Poor = C Rather Poor = B Good = B+ Very Good = A Excellent = S

3. Methodology

The research method is summarized in Figure 1 as follows:

**Figure 1.** Methodology

3.1 Data collection and literature review

This research applies the regulation of three standards - LEED, TREES, and CASBEE as the major concepts which collectors gradually collect information detail, evaluation criterion, certification criterion, and analysis the differences in each regulation standard in order to make the structured interview. If there is any identical regulation, it will be chosen only one matter. Moreover, there are the literature review and relevant laws to add more regulation for the proper country condition besides the regulation of three standards above.

3.2. Interview Designing and data collection

The research interview form is divided into two groups including 1) Questions about the basic information of answerers – divisions, age and working experiences and 2) Questions about the opinion of each regulation and collected inquiring – divided as 3 Rating Scales (high, moderate, and low) which questioning about both issues: importance levels and possibility levels of each regulation . The second question provides the suggestions to collect data through asking opinions one by one from the expert target as the mentioned format interview about 40 persons of government, academic from national university of Laos and private sectors (architects and engineers) but scholars from Laos are collected data by note and record.

3.3. Interpretation of interview, Ranking and SWOT Analysis

3.3.1 Data Interpretation, Ranking. An interpretation and analysis of the collected data are divided into two sections: 1) Analyses the basic information of answerers such as divisions, age and working experiences by descriptive statistics and 2) Interpret the opinion data of each regulation or the collected inquiring which this research uses 3 rating scales for opinion evaluation – high-level (3 points), moderate-level (2 points), and low-level (1 point) respectively by evaluating two qualities: importance and possibility with using the mean of Class Interval (3 classes and 3 decimal numbers) as following:

3.000 –2.334 means the importance and possible group at the highest level;

2.333 –1.667 means the importance and possible group at the moderate level;

1.666 –1.000 means the importance and possible group at the lowest level.

Then this continually uses the mean and Standard Deviation (SD) arranging the importance and possibility to present the results as charts.

For the importance and possibility arrangements will basically use the average score from the expert opinions by arranging regulation score from highest to lowest. If there is any regulation with the same score, there will consider the Standard Deviation or SD from the lowest SD to the highest one. Besides, the analysis will be separately analyses of importance and possibility.

3.3.2 SWOT Analysis. The SWOT Analysis has brought the first and last 3 regulation (both importance and possibility) from the mentioned arrangement to analyses both strengths, weaknesses, opportunity, and threats of each regulation if these are used or consisted into Laos Green Building that may be built in this coming future.

4. Result

4.1. The Collected Regulation Results

All information are the regulation gathering by three standards: LEED, TREES, and CASBEE, additional literature reviews have 73 regulation which divide into 10 groups following the content of each regulation (As the table 2).

Table 2. Assessment categories and indicators

Assessment categories and indicators	
Sustainable Site (SS)	
SS (1)-construction Activity Pollution Prevention	SS (9)-Site Development, Protect or Restore Habitat
SS (2)-Site Selection	SS (10)-Maximize Open Space
SS (3)- Development Density and Community Connectivity	SS (11)-Storm water Design, Quantity Control
SS (4)-Brownfield Redevelopment	SS (12)-Storm water Design, Quality Control
SS (5)-Public Transportation Access	SS (13)-Heat Island Effect ,Non-Roof
SS (6)-Bicycle Storage and Changing Rooms	SS (14)-Heat Island Effect ,Roof
SS (7)-Low-Emitting and Fuel-Efficient Vehicles	SS (15)-Light Pollution Reduction
SS (8)- Parking Capacity	
Water Efficiency (WE)	
WE (1)-Water Use Reduction,20% Reduction	WE (3)-Innovative Wastewater Technologies
WE (2)-Water Efficient Landscaping	WE (4)-Water Reduction
Energy and Atmosphere (EA)	
EA (1)-Minimum energy efficiency	EA (5)-Enhanced Refrigerant Management
EA (2)-Optimize Energy Performance	EA (6)-Measurement and Verification
EA (3)-On-Site Renewable Energy	EA (7)- Green Energy
EA (4)-Enhanced Commissioning	
Material and Resource (MR)	
MR (1)-Storage and Collection of Recyclables	MR (6)-Recycled Content
MR (2)-Building Reuse	MR (7)-Regional Materials
MR (3)- Maintain of Interior Non-Structural Element	MR (8)-Rapidly Renewable Material
MR (4)-Construction Waste Manage , Divert from Disposal	MR (9)-Certified Wood
MR (5)-Material Reuse	

Table 2. (Continue)

Assessment categories and indicators	
Indoor Environment Quality (IEQ)	
IEQ (1)-Minimum IAQ Performance	IEQ (10)-Low-Emitting Material, Composite Wood and Agrifiber products
IEQ (2)-Tobacco Smoke Control	IEQ (11)-Pollutant Source Control
IEQ (3)-Outdoor Air Delivery Monitoring	IEQ (12)-Comfort- Indoor lighting
IEQ (4)-Increased Ventilation	IEQ (13)-Thermal Comfort , Design
IEQ (5)-Construction IAQ Management Plan ,During Construction	IEQ (14)-Thermal Comfort , Verification
IEQ (6)-Construction IAQ Management Plan ,Before Occupancy	IEQ (15)--Daylight
IEQ (7)-Low-Emitting Material, Adhesives, and sealants	IEQ (16)- view
IEQ (8)-Low-Emitting Material, Paint and Coating	IEQ (17)-Thermal Comfort , Control of Systems
IEQ (9)-Low-Emitting Material, Carpet Systems	IEQ (18)-Control of Systems, Lighting
Innovation Design (ID)	
ID (1)- Innovation Design	
Regional Priority (RP)	
RP (1)-Regional Priority	RP (2)-Local characteristics and appearance
Building Management (BM)	
BM (1)-Public relations	BM (3)-Monitoring and Evaluation
BM (2)-Manuals and Training	
Environment Protection (EP)	
EP (1)-less environmentally-friendly chemicals in the fire system	EP (3)-glass outside the building
EP (2)-Placing position air cooling	EP (4)-.Install electric gauges for wastewater treatment
Quality Service (QS)	
QS (1)-Allocation	QS (6)-Decoration
QS (2)-Information and Systems	QS (7)-Design Considerations Maintenance
QS (3)-Barrier-free Design	QS (8)-Maintenance
QS (4)-Width and good view	QS (9)-Earthquake resistance
QS (5)-Comfortable corner and refreshing space	QS (10)-Earthquake Relief and Vibration

4.2. The Analytic Statistic Results and Arrangement

The results by interviewing the 40 experts from three divisions in Laos: 14 persons of the government sector, 17 persons of the private sector (architects and engineers), and 19 persons of academics. Most of them are in the span of age between ages 30 to 39 years old as in picture 2 and mostly have working experiences in 10 years average (29 years for highest experienced and 2 years for lowest experienced), as shown in Figure 2.

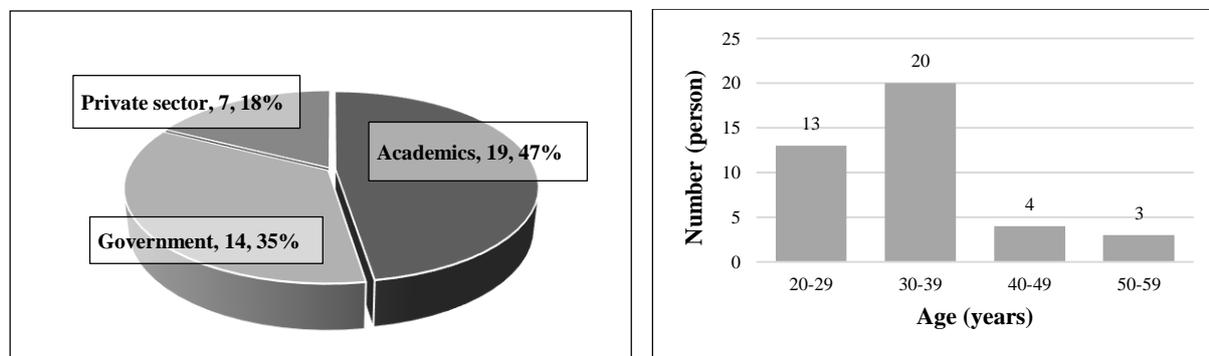


Figure 2. The chart shows the proportion of experts from various agencies (left) and age group of experts (right)

For the opinion, analysis results from each regulation and collected inquiring with the interview format and the results of both importance and possibility arrangement through the statistic process as

the table 3 show particularly the first and last 3 regulation by arranging both importance and possibility.

Table 3. Assessment categories and indicators

Level of Importance						Level of Possibility					
Category (No.)	Mean	S.D	Priority	Remark	Degree	Category (No.)	Mean	S.D	Priority	Remark	Degree
WE (3)	2.975	0.1561	1	T	High	BM (3)	2.875	0.3307	1	T	High
EA (7)	2.975	0.1561	1	T	High	EP (2)	2.825	0.4409	2	T	High
IEQ (1)	2.975	0.1561	1	T	High	EA (7)	2.775	0.4737	3	T	High
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.
SS (8)	2.375	0.5856	71	L	High	MR(4)	1.975	0.5695	71	L	Moderate
EP (4)	2.350	0.4769	72	L	High	IEQ(3)	1.950	0.3841	72	L	Moderate
QS (5)	2.250	0.5361	73	L	Moderate	SS(7)	1.925	0.5190	73	L	Moderate

* Remark: T=Top means the first three regulation. L=Last is means the last three regulation, ascending order

From the Analytic Statistic results and regulation arrangement as the table 3 reveal that the first 3 regulation of importance are in the same ranking which consists equal X-bar and SD. These are wholly from the expert opinions. The regulation of this group firstly has the equal importance, while others are usually arranged from low to high. In addition, when it brings to divide by Class Interval, it shows that every regulation owns the importance and possibility ranking of highest to moderate (without the lowest). So this reveals that there is none any regulation which is unimportant for the Green Building as well as there is none any impossible or a bit possible to build Green Building for Laos in the next future.

4.3 The result of SWOT analysis

The result of the strengths, weaknesses, opportunities, and threats of the various ranked regulation shows the first 3 and the last 3 regulation that have importance and possibility shown as follows:

The importance of the first 3 regulation

WE (3) – Innovative Wastewater Technologies: It is a process of wastewater treatment, which makes the wastewater clean again. The usages of equipment and sanitary ware that are water-saving help reducing the level of wastewater. Strengths: It helps reducing level of using water, the burden of water supply from a related department, expense, water pollution and also level of applying chemicals in a water supply. Weakness: It requires a lot of resources such as area, chemicals, and microbe, which are likely to negatively affect the environment. Opportunities: It increases business opportunities for entrepreneurs such as granted an opportunity to have a private company to import equipment or sanitary ware that are water-saving and also an opportunity to build an efficient system of wastewater treatment. Threats: Much water-saving equipment and creating the system of wastewater treatment are costly and some of the materials must be imported from overseas.

EA (7) - Green Power: At least 35% of using electricity in the project must be from the powerhouse that is renewable energy. Strengths: It is clean and environment-friendly energy. It does not cause pollution either (some types of pollution). Weakness: Due to the renewable energy powerhouse requires the huge amount of money in investment for building, it might result in having high electricity charge. Opportunity: There is the high possibility to create green power due to The Lao PDR has built the dam for electricity generation come from water energy, which helps to promote environment and ecology. Threat: If it was energy from the renewable energy powerhouse such as wind power and solar energy, it has its own limitation due to the country cannot produce much and it is not enough for a demand of users.

IEQ (1) – Minimum IAQ Performance: There is enough ventilation for good quality air in the building. Strengths: For the sake of good quality air and health of people in the building, it helps to restrict the level of contaminants in the building such as germ, dust, vapor, chemicals, and smoke. It also helps reducing heat accumulation, as well as, controlling temperature and humidity on a comfortable level. Weakness: In a case of ventilation positioned on a wrong spot, it might cause pollution and bad air get into the building. Opportunity: Equipment or ventilators are available

everywhere at various prices that are quite convenient to the level of need and budget. Threats: It leads to a high cost of the building. And in a case of the automatic ventilator, it will be needed to import from overseas.

The importance of the last 3 regulation:

BM (1) – Public Relations: 1) Putting a label of public relations in front of the area of construction by representing information about the building, promote with the giving away brochures and propagate information on website. Strengths: It promotes the image and intention of creating a green building. It also helps to generate interest for people on the green building more than the regular building. Weaknesses: The increasing cost of public relation expense and if the public relation were not good, there would not be people interested. Opportunity: Public relations can be done accordingly to what the project's owner's objective. Threat: Complication of public relations will come with cost afterwards.

SS (6) – Bicycle Storage and Changing Rooms: Designing an area for parking bicycles of the building that can support 5% of the people in the building and also changing rooms with a distance of 200 meters from the entrance of the building. Strengths: It is a campaign encouraging people to use less their personal cars for the sake of the environment. It also promotes health and exercise. Weakness: The parking area would be a total waste if there were very few numbers of people who ride bicycles. Opportunity: There are some ASEAN countries that have started building an area for parking bicycles and changing rooms due to they see the importance of riding bicycles as a way to reduce pollution from driving personal cars. This would be a good example for The Lao PDR to start developing this in the future. Threats: Most people still prefer driving cars due to it is more convenient. The roads in the country also have fewer areas for parking bicycles, which makes fewer people ride bicycles, as well as, many organizations have no policy on this.

QS (5) – Comfortable Corner and Refreshing Space: Designing a relaxing and comfortable space to reduce work stress at least 1% of the working area by providing facilities such as vending machine and coffee equipment. Strength: it helps relaxing people in the building from their work stress. Weakness: The facilities could distract the people from their work. Opportunity: It can be done accordingly to each organization's objective. Threat: Cost for building the facilities.

The possibility of the first 3 regulation:

BM (3) – Monitoring and Evaluation: Keeping up with the result of evaluation while designing, building and until construction done. Strengths: It is an important part of ensuring the efficiency of the project that helps in to acknowledge problems and to find immediate solutions. It also helps in to acknowledge whether the project's objectives are met or not, which will be a way to make a decision on whether to carry on the project or not. Weakness: In a case of people who are in charge of evaluating the performance have no expertise; this will result in the inefficient project. Opportunity: It can be done due to it is a principle of construction the building, as well as, activities of construction that include engineer and architect to direct. Threat: If each department incorrectly cooperates, it would make the evaluation harder to do, which will cause a high possibility of mistake.

EP (2) – Placing Position Air-Cooling: The position for air-cooling for the small building is 4 meters away from the nearby building. And the position for air-cooling for a big building is 8 meters away from a nearby building. Strength: It helps air-cooling to work conveniently, which reduces an effect of air-cooling to nearby building and ecology outside of the building. Weakness: In a case of limited space with distance not reached its regulation, the placing position air-cooling would be farther from the air conditioner. This will cause higher cost due to more usage of electric wire, which is complicated for installation. Opportunity: It can determine an appropriate position for air-cooling before installation. Threat: In a case of limited space in the building or positioned at a nearby building, it would be an obstacle for operation, as well as, enforcing a regulation such as the distance of the building is not as good as it should be.

EA (7) - Green Power: At least 35% of using electricity in the project must be from the powerhouse that is renewable energy. Strengths: It is clean and environment-friendly energy. It does not cause pollution either (some types of pollution). Weakness: Due to the renewable energy powerhouse requires a huge amount of money in investment for building, it might result in having high electricity charge.

Opportunity: There is a high possibility to create green power due to The Lao PDR has built the dam for electricity generation come from water energy, which helps to promote environment and ecology. **Threat:** If it was energy from the renewable energy powerhouse such as wind power and solar energy, it has its own limitation due to the country cannot produce much and it is not enough for the demand of users.

The possibility of the last 3 regulation:

MR (6) – Recycled Content: Choosing recyclable materials. Strengths: It helps reducing waste that is a cause of pollution and problem to the environment, which can also reduce the likelihood of global warming. Besides that, it also helps reducing energy usage in the process of production and to supply new materials. Weaknesses: It may not be as beautiful as it should be. Efficiency and shelf life are less than original materials. **Opportunity:** There are many ASEAN countries with technology that can produce recyclable materials, which is a good example for people in The Lao PDR to develop, research and seize it as an economic opportunity. **Threats:** There is no factory for recyclable material production; hence it cannot produce recyclable materials. Besides that, technology and equipment have the high cost of production, which needs to import from overseas. As a result, recyclable materials are costly.

IEQ (4) Increased Ventilation: There is a system of adding air to the building for adding fresh air. It has ratios of ventilation in the areas of air-conditioned and non-air-conditioned accordingly to the standard of ASHARE 62. 1-2007. it was calculated from the quantity of air from people and the areas of the building. **Strength:** It increases good quality of air for people in the building. **Weaknesses:** it still lacks experts to be in charge of this matter. Equipment for assessment is not enough to have efficient performance, which cannot meet the required standard. **Opportunity:** It can be done due to neighboring countries like Thailand, Vietnam and China has the equipment and the experts that The Lao PDR can utilize, as well as, send related people of the country to learn and train for the future use. **Threats:** The equipment is costly and needs to import from overseas. It also lacks experts in this field.

SS (7) – Low-Emitting and Fuel-Efficient Vehicles: Designing an area for car parking that is specifically for cars that have a low level of pollution, eco cars and other types of cars that use fuel less than 5% of the total number of cars parked in the building. **Strength:** It creates motivation for people to use cars that reduce pollution. This is due to there is a car parking space for this type of vehicle. **Weakness:** The car parking space could be a total waste with no use. This is due to the majority of people still prefer to use regular cars, as well as, there is no this type of vehicle in the country, yet. **Opportunity:** it is an attempt at reducing greenhouse gas, which would be a good opportunity for entrepreneurs in the country to import this type of vehicle in the future. **Threat:** Due to the country does not have this type of vehicle, hence, there is no policy from any organization.

5. Conclusion

This research represents the importance and possibility of the various regulation that are related to the green building by applying SWOT analysis in a case of The Lao People's Democratic Republic as a guideline for further creating a standard of the green building. This study referenced to the required standard of TREES-NC. V. 2013, LEED-NC. V. 2009, CASBEE-NC. V.2014 and revision of additional literature with the total of 73 regulation divided into 10 categories. The research was done by interviewing a group of 40 experts in various public, private and academic departments that are related along with a rating scale of 3 levels for giving points. The analysis was done by applying the statistical method using x-bar, SD and for finding a result. It was found that the average of every regulation had importance and possibility at high to moderate level (no low level). This shows that there was not a single regulation that was not importance to the green building and not a single regulation that has no possibility or least possibility not to create the standard for the green building in the future.

From the SWOT analysis, per the first 3 and the last 3 regulation, it was found that the most importance and possibility regulation to apply in The Lao PDR was EA (7) – Green Power, which is using electricity in the project at least 35% of using electricity in the project must be from powerhouse that is renewable energy such as water energy, which is concordant with factors in the country building a dam for producing electricity generation from various water energy.

Per other regulation, most of them are stuck with some problems such as lacking experts with specialized knowledge to maintain the system and transfer the knowledge; some technological materials need to import from overseas such as recyclable equipment, renewable energy like wind energy and solar energy; some materials are hard to find in the country, which makes them expensive; lifestyle of the people that prefer to use their own cars for traveling, as well as, no public utility to support the possibility of the green building such as road for bicycles and public transportation; as well as, requirement and policy issues on waste management from construction, distance of the buildings and so on.

Hence, applying these various regulation for the green building in the future needs to have a plan and solution in some aspects. For instance, there should be a green building organization to be in charge, transfer the knowledge and support of various materials. There should also be as research about creating innovation for supporting the green building in order to reduce the likelihood of importing technology. Besides that, there should be a promotion of supporting business to distribute environmental-friendly materials, campaigning for using more bicycles or public transportation, as well as, creating value for people, especially amongst young people in the country to cherish their environment for sustainability in the future.

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