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COMPARISON OF THE CONSTRUCTION COSTS OF LEED AND NON-LEED COFFEE SHOPS IN BANGKOK, THAILAND

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ABSTRACT

This study scrutinizes the construction costs difference between LEED and non-LEED of coffee shops in Bangkok, Thailand. This study provides an understanding of criteria that influence the construction cost of coffee shops those attached inside the buildings, such as shopping malls and department stores. This study is a quantitative research approach by collecting data from 24 coffee shops in several locations in Bangkok, Thailand. The results show that the overall project cost of projects with LEED certification is 5.20% higher than the non-LEED projects. Moreover, the cost per square meter of the air conditioning system of the LEED projects is significantly higher than non-LEED projects for 1.6 times, but other costs are not significantly different between those LEED and non-LEED projects. This can conclude that there are numbers of design items supporting LEED-certified achieving without extra cost. Such criteria are water efficiency, material and resources of interior decoration, and the quality and sanitary conditions in buildings. These criteria support the projects to satisfy the LEED requirement within competitive project cost.

Disciplinary: Civil and Architectural Engineering.

1. INTRODUCTION

The food and beverage business is a business with a very high market value. Currently, this business keeps expanding continuously and results in higher competition, especially in Bangkok, the capital, and the center of the business sector in Thailand. This causes the entrepreneur, especially coffee shop owners, must make a difference for themselves in order to compete for market share

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(Ariyabuddhiphongs & Kahn, 2017; Gulasirimaa et al., 2019). Also, the current awareness about global warming and green business are issues that have made the business model of the coffee shop begin changing since urban consumers are more likely to use products and services that are environmentally friendly nowadays (Chou et al., 2012). Global warming is a trending topic that every society around the world is interested in due to the industries in the world that were developed in the past without awareness of the environment causing global warming by greenhouse gases (GHG). This causes the world to become more interested in global warming as can be seen from the emergence of many green businesses because the young generation is going with the flow of green, environment, and quality of life. Therefore, the development of the current project construction is also matched up with the green trend. Green project proposals tend to be well received. Some projects even need to be awarded energy conservation buildings or green buildings to be a part of showing their corporate social responsibility (CSR). Restaurant operators are increasingly focusing on global warming (Lee & Heo, 2009; Santitham & Horayangkura, 2017).

According to the international definition, it can be said that green building is an environmentally friendly building, and it is a building that helps to reduce energy use in the building and provides better health and quality of life when living in. Currently, project owners, building owners, and various departments, both the public and private sectors, are very interested in dealing with the environment and energy use in buildings to help to solve global warming by conserving natural resources and reducing energy consumption to contribute to the sustainable development of the country. Therefore, engineers and architects need to adapt to meet the needs of customers in the green building, must follow various technologies that can be applied in the building, must increase and seek new knowledge in the design and construction of green buildings all the time. Although the green building does not always have to use high technology, there might be the use of technology such as automatic shut-off systems, project water re-use systems (Santitham & Horayangkura, 2017; Shen et al., 2017). However, among various green building measurement systems, the internationally popular system is the green building criteria developed by the United States Green Building Council (USGBC) and is used as a basis for modifying green building criteria to suit each country (Rinchumpoo et al., 2010; Zhang et al., 2017).

Nevertheless, the development of projects to satisfy the green building criteria mostly requires a higher cost than the original project development due to a large number of relevant regulations. For example, in terms of energy consumption, it is necessary to use the higher-grade materials that save electricity and energy, sanitary ware that controls water consumption such as automatic tap, water-saving systems for the toilet. These materials or systems are more expensive than general materials or systems. Consequently, these reasons cause an increase in project costs (Thirakomen, 2013; Wu & Lo, 2018). Due to the inconsistency of costs and the LEED criteria, many project operators have neglected to develop their programs to satisfy the criteria because of the problem of bearing the higher cost making it not worth the investment. However, the LEED criteria consist of many components that cover from the design phase to the construction phase. some criteria can be applied without additional cost or a very small cost. The project owner can use these criteria in the project to develop their projects to satisfy the green building criteria at an appropriate cost (Chegut et al., 2015; Dwaikat & Ali, 2016). This is also including the development of food and beverage projects as well.

From the above explanation, this research aims to study the construction costs of LEED and non-LEED coffee shops in Bangkok, Thailand. The various LEED criteria have been studied on

how much they will affect the cost of coffee shop construction and decoration projects. As a result, coffee shop business operators can choose to apply regulations that have a low-cost impact on their projects to help protect the environment and can demonstrate social responsibility in another way.

2. LITERATURE REVIEW

To gain an overall understanding of the theories and principles used in the study, the literature review, therefore, consists of contents related to coffee shop businesses, the idea of green buildings of U.S. Green Building Council (USGBC) and the cost of the coffee shops construction projects and interior decoration as following.

2.1 FOOD AND BEVERAGE BUSINESS

Food and beverage business means the business operation of providing food and beverage services for travelers, tourists, or general people by preparing seats to customers in the service place or packing food for customers to take out (Ball & Roberts, 2003). However, Thai food markets are limited by intense competitive conditions. Fast food markets have been competing with each other by the price all the time. Thus, branding is an important strategy. Larger restaurants will have more advantages. There is a competition by creating an advantage with more investment and reducing the total operating cost as much as possible. Therefore, branch distribution is an element that needs to be considered more in business expansion. Besides, food businesses must create strengths, attract family-like customers, focus on more modern lifestyles, create more convenience, and improve the development of various organization management (Hnuchek et al., 2013). However, the type and size of the market can be divided into 4 categories:

1. Fast food restaurant :The market size is approximately 12,000 million Baht .Some marketeers have more than 300 branches of KFC and are the market owners who have annual sales of about 4,000 million Baht .Meanwhile, McDonald's has sales of 2,000 million Baht per year, and the pizza markets have earned over 2,000 million Baht annually .The remaining market share belongs to various small and medium-sized businesses.

2. Takeout restaurants or delivery :The market size is increasing rapidly and consists of a variety type of food. There is a market size forecast based on business estimates in this field .It is found that the market size of the takeout restaurant or delivery business was forecasted about 1,300 million Baht. Such markets must be more competitive .Self-service food markets are food courts .

3. Restaurants :This is considered a general restaurant with market size of up to $500,000$ million Baht per year. If the focus on the possibility, it can be observed from the types of restaurants .For example, Sukiyaki restaurants can build markets more than $2,000$million Baht annually, or Thai restaurants with high standards could be operated well in the branch system and could generate more than $1,000$million Baht per year .If many distributed restaurants are included, it is showing the potential of the Thai food business that is still growing and widely open for investment.

4. Coffee shops : The coffee shops, which are consumed through other sale systems such as wholesale markets, department stores, and supermarket, has a market size of about $900,000$million Baht per year.

From the analysis of the outside consumption market of the population in the big city based on the consumption of food compared with the income per household, it is found that there is the amount of outside consumption about 1,800 million Baht per month, only the population of

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Bangkok, which is considered only about 5% of the total household income, with a tendency to increase by more than 20% per year according to the changing of social behavior in the more popularity of eating out (Hnuchek et al., 2013).

However, this has shown the market size and the expansion of coffee shops of the largest market, which is Bangkok areas, so this leads to the creation of coffee shops located in other business areas such as shopping malls and department stores more. It is a style that is consistent with Thai consumer behavior who commonly use services from the areas of the shopping mall and department store for a variety of activities but centralized in action (Unapamnak, 2016). As there is more competition, entrepreneurs are trying to make a difference by creating an image of being an environmentally responsible person. The development of coffee shops in green buildings is one of them, but they still have concerns about the increase in construction costs. In the next part, the content describes the green building and the green building assessment form. Also, the principles of construction costs are in the next section.

2.2 CONCEPT OF GREEN BUILDING

Green building is a term known as a building that has been designed and constructed to effectively reduce the use of resources such as energy, water, materials, or chemicals more than general buildings. The definition of a green building is the building that has the least environmental impact, saves energy, uses environmentally friendly materials, and applies technologies to the building for environment condition usage as much as possible (Chou et al., 2012; Santitham & Horayangkura, 2017). Meanwhile, the green building is a reflection of the movement of contemporary architecture which aims to create a building that is environmentally friendly, energy-saving, using resources most efficiently, and the use of solar energy and materials that do not damage the environment throughout the production process. The use and the degradation are the application of appropriate technology to help the building be able to usefully benefit from the natural environment with passive methods, which are ways for the development of buildings that are environmentally friendly, energy-saving and using resources most efficiently for sustainable development (Wu & Lo, 2018; Zhang et al., 2017).

The Pollution Control Department (2013) reported that alertness in green buildings emerged during the first energy crisis, causing many organizations in America to agree that there should be specific organizations to evaluate "green" for buildings. Therefore, the American Architects established the Committee for Environmental Quality in 1980 as a source of knowledge and finding ways to design buildings that would reduce the impact on the environment, and the organizations are gradually occurring widely in many countries around the world. This also results in green building criteria of the U.S. Green Building Council (USGBC) which is the standardization of green building called green building rating system (USGBC, 2019b). At present, the types of green building by USGBC are categorized as follows:

1. Building Design and Construction (BD+C) is the criterion for new buildings or full renovations

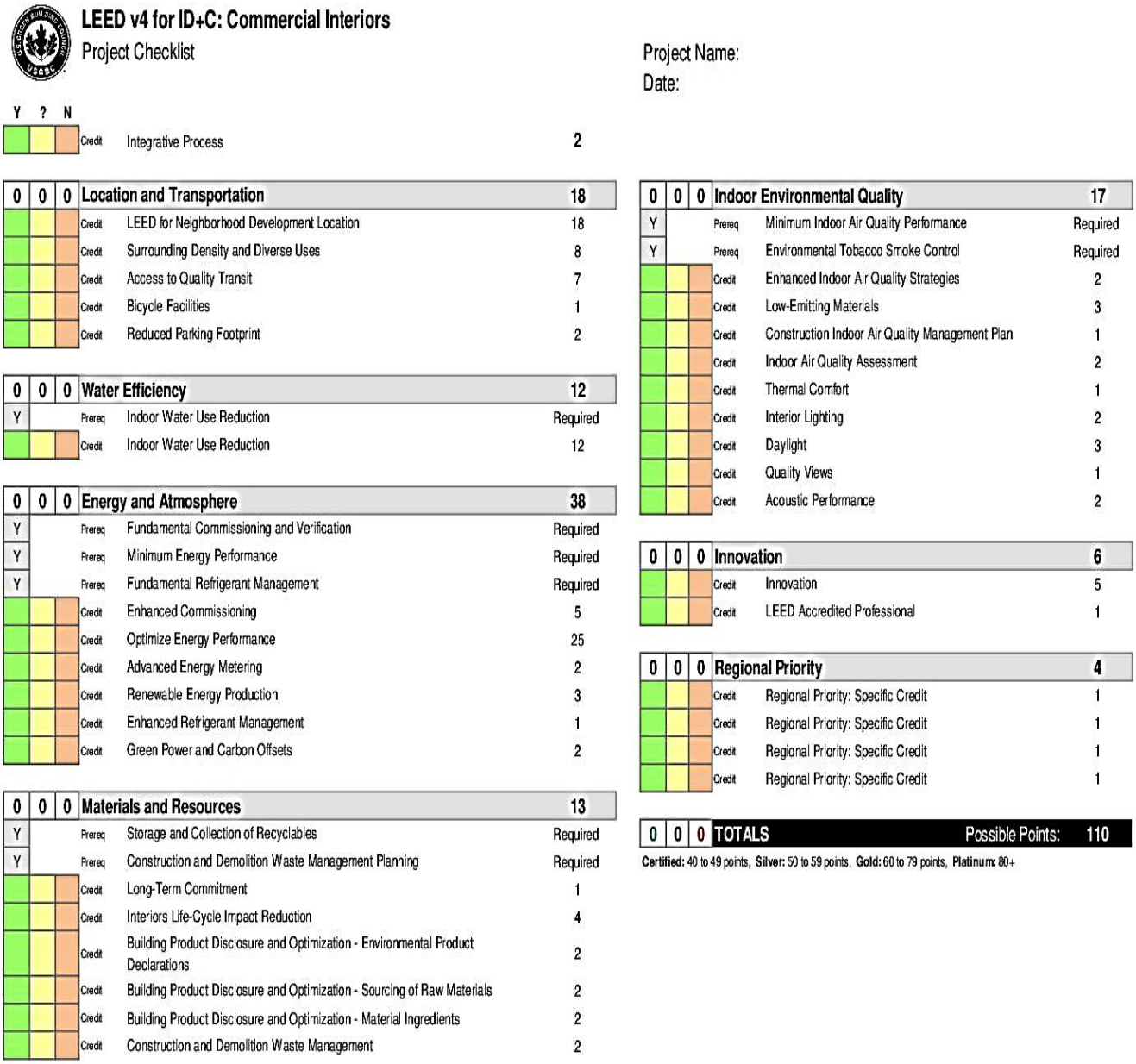
2. Building Operations and Maintenance (O+M) is the criterion for old buildings that are under management. The building must be practically and fully used.

3. Interior Design and Construction (ID+C) is the criteria used for buildings that need changes for the interior decoration or used for interior design and decoration.

4. Neighborhood Development (ND) is a criterion used for community development in the same area to be harmonized, revival and development plan for the community

5. Homes are criteria for single-family homes, low-rise multi-family or mid-rise multi-family; includes homes and multifamily low-rise and mid-rise.

6. Cities and Communities are criteria for entire cities and sub-sections of a city. Using the performance platform, LEED for Cities projects can measure and manage their city's water consumption, energy use, waste, transportation, and human experience.



LEED v4 for ID+C: Commercial Interiors
Project Checklist

Project Name:
Date:

Y	?	N			
			Credit	Integrative Process	2

0	0	0	**Location and Transportation**		18
			Credit	LEED for Neighborhood Development Location	18
			Credit	Surrounding Density and Diverse Uses	8
			Credit	Access to Quality Transit	7
			Credit	Bicycle Facilities	1
			Credit	Reduced Parking Footprint	2

0	0	0	**Water Efficiency**		12
Y			Prereq	Indoor Water Use Reduction	Required
			Credit	Indoor Water Use Reduction	12

0	0	0	**Energy and Atmosphere**		38
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Fundamental Refrigerant Management	Required
			Credit	Enhanced Commissioning	5
			Credit	Optimize Energy Performance	25
			Credit	Advanced Energy Metering	2
			Credit	Renewable Energy Production	3
			Credit	Enhanced Refrigerant Management	1
			Credit	Green Power and Carbon Offsets	2

0	0	0	**Materials and Resources**		13
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
			Credit	Long-Term Commitment	1
			Credit	Interiors Life-Cycle Impact Reduction	4
			Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
			Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
			Credit	Building Product Disclosure and Optimization - Material Ingredients	2
			Credit	Construction and Demolition Waste Management	2

0	0	0	**Indoor Environmental Quality**		17
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
			Credit	Enhanced Indoor Air Quality Strategies	2
			Credit	Low-Emitting Materials	3
			Credit	Construction Indoor Air Quality Management Plan	1
			Credit	Indoor Air Quality Assessment	2
			Credit	Thermal Comfort	1
			Credit	Interior Lighting	2
			Credit	Daylight	3
			Credit	Quality Views	1
			Credit	Acoustic Performance	2

0	0	0	**Innovation**		6
			Credit	Innovation	5
			Credit	LEED Accredited Professional	1

0	0	0	**Regional Priority**		4
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1

0	0	0	**TOTALS**	Possible Points: 110

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80+

Figure 1: Project checklist for LEED for Interior Design and Construction (USGBC, 2019a)

Furthermore, there is also a LEED Recertification for special cases of existing buildings prior to the use of the LEED for evaluation and LEED Zero, which is for projects with the net-zero goal in carbon and/or resource, LEED standards in all systems will be the same contents in seven main categories: 1) Sustainable Site 2) Water Efficiency 3) Energy and Atmosphere 4) Material and Resources 5) Indoor Environmental Quality 6) Innovation in Design and 7) Regional priority Thailand has also developed the criteria from LEED by modifying or adding some criteria to suit the environment, topography, and the weather in the country including in Thailand, especially business

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owners that are foreign networks. Aside from focusing on the environment, they also conduct business for a global image. the evaluation is divided into 4 levels which are Certified, Silver, Gold, and Platinum (Santitham & Horayangkura, 2017; Shen et al., 2017).

However, coffee shop businesses located inside other buildings that want to assess for the green building are within the scope of the Interior Design and Construction (ID + C) or LEED-ID + C, which were developed specifically for interior decoration. The criteria will focus on the quality of life and the performance of the building users. The criteria will reduce sustainable importance, location, and energy use. These are choices for building users and designers who cannot design and construct the whole building to be a whole green building. The samples of the project checklist table are shown in Figure 1.

Since construction cost is another important factor in choosing the project development model; also, coffee shop projects which mainly focus on interior design are the main issues in this study, principles of fundraising for construction and interior decoration projects are shown in the next section.

2.3 CONSTRUCTION COST

According to a literature review about the construction cost of the project and the interior decoration, there are unique characteristics such as construction work, construction cost estimation, and estimation of interior decoration cost. This can be described that the cost of construction can be calculated by calculating the cost of materials and equipment in the construction plan (drawing) and specification and cost for installation. Normally, it is called a bill of quantity (BOQ) according to the category of each item to submit to the auction or for the project owner to prepare construction costs at the specified value. It is like the reference number that the project owner actually invested when they agreed to the construction contract, but in practice, the cost of the project tends to increase or decrease as the project owner changes (Tas & Yaman, 2005; Xu et al., 2013). Figure 2 shows a sample of coffee shops in the scope of this study.

Figure 2: Sample of a coffee shop (Courtesy of PTT Oil and Retail Business (PLC), 2017).

Figure 2 shows that most coffee shops consist of construction work that is not the same as

general building construction. According to the study of Wattanakamnerd & Tochaiwat (2014), it is found that most coffee shop constructions are located in shopping areas in Bangkok. Construction costs can be classified into 4 work categories. They are 1) Building and interior decoration costs such as floor work, walls, doors-windows, and ceiling-curtains 2) Electrical system costs such as electrical wiring, lighting, and heating. 3) Sanitation system costs such as plumbing, toilets and sanitary wares. and 4) Air conditioning system costs such as air conditioner and ventilation. This study is based on the guidelines of the construction cost classification of coffee shops according to the categories shown in Figure 1.

3. METHOD

This study was mainly conducted with the quantitative method by collecting data from BOQ of coffee shops that are under construction during 2016, totaling 24 projects in the Bangkok area. These projects were evaluated by 11 LEED-ID+C in Certified projects and 13 general projects. After that, construction cost data were separated into 4 groups, which are 1) Building and interior decoration costs 2) Electrical system costs 3) Sanitation system costs and 4) Air conditioning system costs.

Then, the data were analyzed by descriptive statistic technique. They were frequency, mean, and standard deviation separated by each construction cost and total cost of the 2 project groups, and the differences of mean values between groups were tested by inferential statistic technique with an Independent *t-test* at 95% confidence interval. The results showed the influence of LEED-ID+C green building per project cost of coffee shops in Bangkok as detailed in the next section.

4. RESULT AND DISCUSSION

Regarding the data collected from BOQ of coffee shops in Bangkok of both the LEED-ID+C and general projects, totaling 24 projects, the results could be divided into 3 issues following:

4.1 DATA DESCRIPTIVE

Preliminary data from a survey of 24 coffee shops in Bangkok to consider the overall data as information shown in Table 1.

Table 1: General data descriptive of samples

List	Minimum	Maximum	Average	SD
Interior space (m^2)	106	426	194	74
External space (m^2)	0	172	29	38
Total areas (m^2)	106	426	223	79
Number of inside chairs per interior space	27	126	68	25
Number of outside chairs per external space	0	70	12	15
Total number of chairs	38	160	80	29
Total number of tables	16	75	35	14

Regarding Table 1, it is found that the average area of food and beverage restaurants is 194 m^2, the standard deviation (SD) is 74 m^2. The average of external space is 29 m^2 with an SD of 38 m^2. The average number of chairs inside the shop is 68 with an SD of 25. The average number of chairs outside the shop is 12, which its SD is 15, and the average number of total tables is 35 with the SD of 14. All the information indicated that the size of coffee shops in Bangkok is equivalent to a single family-sized family home in Bangkok However since it is a semi-public area which uses more energy

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and resources than residence which is a private building, the design must be more prioritized in reducing energy and resources used in both during construction and throughout the long-term use.

4.2 PROJECT CONSTRUCTION COST

The data on the construction cost, interior decoration, and system work of the sample units of coffee shops in Bangkok, totaling 24 projects, to consider an overview of all the data are shown in Table 2.

Table 2: Construction and interior decoration cost per square meter of sample units

Average Cost (Baht/m^2)	13 General Buildings				11 LEED-ID+C Buildings			
	Min	Max	Average	SD	Min	Max	Average	SD
Building and interior decoration	7,861	18,128	10,262	2,827	4,697	13,696	8,997	2,584
Electric System	2,122	9,707	4,087	2,149	1,807	3,762	2,615	491
Sanitary System	771	2,563	1,430	700	329	1,729	971	428
Air Conditioning System	584	6,581	2,586	1,884	2,451	10,978	6,738	2,567
Total Cost	11,696	33,226	18,365	5,413	13,404	28,310	19,321	4,840

Table 2 indicated the construction, interior decoration, and work system costs of each 2 groups. This showed that the group certified by LEED-ID+C had an overall average cost higher than the group without certification for 5.20%. Each category can be divided into the cost of building construction and interior decoration average per square meter, electric system costs per square meter, and sanitary costs per square meter. For the project groups certified by LEED-ID+C, the costs are lower than those groups that are not certified for 12.33%, 36.02%, and 32.05%, respectively. In addition, the air conditioning costs of the groups certified by LEED-ID+C are higher than those uncertified groups for 160.58%. Therefore, it is found that the most different cost is the air conditioning system group. When considering the details of the design conditions for the building to be LEED-ID+C certified, it is of the utmost importance. In the end, certified buildings will be energy-efficient and can reduce costs in the long run.

4.3 STATISTICAL TESTING

The test of the influence of LEED-ID + C certification on the construction costs of coffee shops in Bangkok, which uses the Independent t-test statistic at a 95% significance level, shows test results as in Table 3.

Table 3: Statistical testing of differences, mean and construction costs

Cost Average (Baht/m^2)	General Group	LEED-ID+C Group	t	2-tailed significant	Hypothesis Testing Summary
Building and interior decoration	10,262	8,997	0.351	0.268	Not different
Electric System	4,087	2,615	2.902	0.037	different
Sanitary System	1,430	971	2.491	0.013	different
Air Conditioning System	2,586	6,738	-5.052	<0.001	different
Total cost	18,365	19,321	0.452	0.655	Not different

According to Table 3, it presented that group of LEED-ID+C certified projects has cost differences (costs per square meters) compared to non-LEED certified projects in electric system, sanitary system, and air conditioning system by a statistically significant difference at the 95% confidence level. The construction cost of electrical system and sanitary system of LEED ID+C certified projects are lower than those costs of non-LEED certified projects, while the construction

cost of air conditioning system of LEED ID+C certified projects are higher than those of non-LEED certified projects. On the other hand, the construction cost of building and interior decoration has a statistical test showing that the mentioned difference is not statistically significant at the 95% confidence level .According to the construction costs differences, the total construction cost of the projects between LEED ID+C and non-LEED certified projects are not statistically different at the 95% confidence level as well. The results of this study show that to achieve LEED-ID+C certified projects, there is a little or non-impact to total construction cost, which conforms to previous researches about the study of the construction cost for LEED-certified projects (Mapp et al., 2011).

The electrical system, sanitary system, and air conditioning system have a significantly different average cost with the consistency of LEED-ID+C requirements, which give importance to all 3parts of the system work significantly to the design and construction of the project.

5. CONCLUSION

Regarding the results of the construction costs of coffee shops in Bangkok, it is found that projects certified by LEED-ID+C have overall costs higher than general ones only 5.20% and there is no statistically significant difference. Only costs per square meter of air conditioning system certified by LEED-ID+C are statistically significantly higher than general projects, with an average of 160.58% while the green building criteria LEED-ID+C will not increase the cost of other parts. However, due to the LEED-ID+C green building criteria consisting of 7 main categories as mentioned above, in some categories, they are long-term useful investments such as the investment in water-saving toilets. Regardless of whether the project needs to be assessed for LEED-certified or not, project owners have needs in this area. At the same time, increasing costs in other parts is not very high while the investment in air conditioning systems is LEED in Category 3, which deals with energy and atmosphere. It is a criterion that requires investing in air conditioning systems that have a very high cost. Therefore, certified projects have significantly higher air conditioning costs than non-certified projects.

From the analysis of the influence of green building criteria LEED-ID+C on the cost of coffee shops construction projects, when considering the mean, it is found that the LEED-ID+C certified projects have the cost per square meter of electrical system work and sanitation system cost lower than uncertified projects. According to the study, it can be concluded that green building LEED-ID+C criteria will result in the low cost of electrical and sanitation systems while the cost of air conditioning systems gets higher. Nevertheless, the test results indicate that green building LEED-ID+C criteria do not result in the increase of costs in other parts. Therefore, the project development to satisfy green building criteria, project owners can choose the LEED-ID+C criteria in other categories that do not result in the increase of costs, which are the use of water efficiency reflecting the cost of working systems, materials and resources which are reflected by the cost of interior decoration and the cost of sanitary work of indoor environmental quality. These criteria will help project owners develop their own projects into green buildings while still having appropriate costs and being able to compete.

As a result, the results of the study can be used as a suggestion that the design to satisfy LEED-ID+C criteria can be used to select other issues in order not to incur higher costs such as sustainable site, water efficiency, material and resources, indoor environmental quality and innovation in design; these criteria will not result in the higher costs of the projects. Therefore,

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entrepreneurs or project owners should apply those criteria to their own projects for the benefit of the environment and can save energy in the long run as well.

6. DATA AND MATERIAL AVAILABILITY

Information can be made available by contacting the corresponding author.

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