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APPLICATION OF SUSTAINABLE CONSTRUCTION TO EXISTING EDUCATIONAL BUILDINGS USING AGILE MODEL AND LEED BD+C IN EGYPT

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ملخص البحث:

تمتلك مصر ثروة كبيرة من المباني والمنشآت التعليمة القائمة والتي يمكن الاستفادة منها لتصبح منشآت مستدامة وذلك بتقليل الاثار البيئية الناتجة عن استخدام تلك المنشآت و خفض كمية المياة و الطاقة المستخدمة ويتم ذلك بإعادة تأهيل وصيانة المنشأت التعليمة الحالية وذلك بتطبيق متطلبات LEED BD+C حيث يهدف هذا البحث الي اعداد نموذج بإستخدام تقنية agile development و ذلك بتحقيق الحد الأدنى من متطلبات الاستدامة كخطوة اولي تتبعها عدد من الخطوات حتي يتم تطبيق أعلي درجات الاستدامة للمنشآت التعليمية القائمة وذلك عن طريق الثمانية محاور الرئيسية لمتطلبات LEED BD+C وهي الوصول الي الموقع و الموقع المستدام ووكفاءة استخدام المياة والطاقة والمحافظة علي الغلاف الجوي وطريقة استخدام مواد وموارد التشييد والمحافظة علي جودة البيئة الداخلية والابتكار في التصميم والاولوية الاقليمية للموقع. حيث تم تطوير نموذج تم تسميته Agile Model and Integrated Sustainable for Operations and Maintenance of Existing Educational Buildings (ASOME-EB) يتم من خلال سبعة دورات كالتالي: الدورة الاولي تحقق 40 نقطة بمستوي مصنف كمنشاء مستدام والدورة الثانية تحقق 47 نقطة لدرجة اعلي من المستوي مصنف كمنشاء مستدام والدورة الثالثة تحققق 57 نقطة بمستوي فضي والدورة الرابعة تحقق 63 نقطة بمستوي ذهبي والدورة الخامسة تحقق 87 نقطة بمستوي ذهبي والمستوي السادس يحقق 100 نقطة بمستوي بلاتني والمستوي السابع والأخير يحقق اقصي درجات الاستدامة بعدد 110 نقطة بمستوي بلاتيني وذلك لمساعدة متخذ القرار من القدرة علي تطبيق وتحقيق متطلبات الأستدامة للمنشآت التعليمة القائمة .

ABSTRACT

Egypt has a large wealth of existing educational buildings that can be utilized to be sustainable buildings by reducing the environmental effects resulting from the use of these buildings and reducing the used amount of water and energy. This goal can be applied by the rehabilitating and maintaining of the existing educational buildings by achieving the requirements of the reference guide Leadership in Energy and Environmental Design version 4 for Building Design and Construction ($LEED_{V4}$ BD+C) requirements using an agile model for achieving the minimum sustainability requirements as a first cycle followed by a number of cycles in order to achieve the highest requirements of sustainability to existing educational buildings based on the eight main goals required for existing sustainable educational buildings, location and transportation, sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation in design and regional priority. The name of the proposed model is Agile Model and Integrated Sustainable for Operations and Maintenance of Existing Educational Buildings (ASOME-EB) through seven sessions as follows: The first cycle achieved 40 points with a level classified as sustainable and the second cycle achieved 47 points to a higher level classified as sustainable and the third cycle achieved 57 points in silver level and the fourth cycle achieved 63 points with a golden level and the fifth cycle achieved 87 points at a gold level, the sixth level achieves 100 points in the platinum level and the seventh and final level achieves the highest grade of sustainability with 110 points in Platinum level.

***Keywords*:** LEED BD+C; Sustainability; Educational Buildings; Agile Model.

1. Introduction

Egypt has 59,000 existing school according to the ministry of education statistics while, the number of universities in Egypt is 27 public universities, 24 private universities, and 12 academic institutions. With a total of 63 universities and academies in Egypt. This research presents an approach for the application of sustainable design and construction for the rehabilitation and maintenance of existing educational buildings using an agile model, to reduce and contribute to the environmental effects to the construction industry. Agile model is not restricted to a special industry, process or application, the models are used as a road map with flexibility for changing internal and external variables [1]. LEED BD+C for the rehabilitation and maintenance of existing buildings is an ongoing process, and its prescriptive and performance strategies are intended to provide operational benefits throughout the life of the building. If the strategies are sustained, the building can maintain and even improve its performance over time. The LEED BD+C for Existing Buildings: operations, rehabilitation and maintenance recertification Guidance is focused on providing clear direction for existing buildings projects that are ready to recertify [2].

2. Factors Required For Each Aim of Sustainable Design and Construction the Rehabilitation and Maintenance of Existing Constructions

Building Preview sets the planning and strategy to sustainability through a direction for the facility. The public can be included as participants, as appropriate. This early planning meeting is critical to setting the stage for attaining the sustainable strategy [3].

Sustainability and $LEED_{V4}$ BD+C Design this stage apply the requirements that highlight on increasing energy efficiency and several other requirements for the sustainable design for which performance criteria is the common sustainable building certification standard within the United States. The $LEED_{V4}$ BD+C was developed by the US High performance building Council. The certification standards give a checklist and possible points scale to determine the certification levels for sustainable design and construction of rehabilitation and maintenance for existing educational buildings [2].

Bidding stage the documents are complete with all aspects needed to meet $LEED_{V4}$ BD+C requirements. For design and construction, the documents (drawings and specifications) are taken to a stage with the requisite prescriptiveness to let the design build contractor complete the design and construct the facility in a manner that meets the client requirements [4].

Construction the sustainable building includes site work and location. Additional sustainable aspects of construction include waste management, emissions, material transportation and waste management [5]. Proper training and oversight are required to ensure that all aspects of the sustainable educational building are incorporated during construction.

Acceptance / rejection decision maker will check all specifications, drawings, and all presented data then review it with LEEDV4 BD+C requirements of educational buildings design and construction, if this data approved it will be accepted, if not it will be rejected with notes or fully rejected, and then starts a new cycle of design.

3. Sustainable Construction Requirements for Existing Educational Buildings

According to the center for sustainable educational buildings at the U.S. Green Building Council, a "sustainable educational buildings" is an educational buildings or facility that creates a healthy environment conducive to learning as well as saving energy, resources, and money [6]. Green Building Design and Construction: LEED V4 BD+C reference guide for green building design and construction version four 2016 indicated sustainable construction requirements for educational buildings in a very clear format of six environmental categories by which buildings are evaluated are: location and transportation, sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality Innovation, and Regional Priority. The pie chart in Figure 1 shows system goals required for operations and maintenance of existing educational buildings based on LEED V4 BD+C reference guide for green building design and construction in general, there are eight main goals required for new sustainable educational buildings. Location and Transportation (LT) 14%, Sustainable Sites (SS) 9%, Water Efficiency (WE) 11%, Energy and Atmosphere (EA) 35%, Materials and Resources (MR) 7%, Indoor Environmental Quality (IEQ) 15%, Innovation in Design (ID) 5% and Regional Priority (RP) 4%.

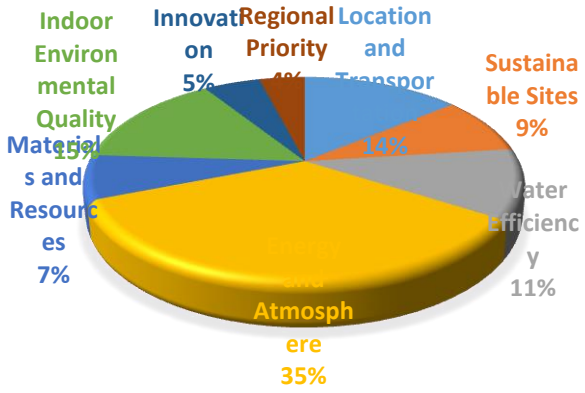

Figure 1: LEED V4 (BD+C) System Goals for Maintenance of Existing Educational Buildings [2].

Location and Transportation (LT)

The LT category is an outgrowth of the Sustainable Sites category, which formerly covered location-related topics. Whereas the SS category now specifically addresses on-site ecosystem services, the LT category provides requirements for the developments of educational buildings considers the existing features of the surrounding community and how this infrastructure affects occupants' behavior and environmental performance [2]. Table 1 shows all possible credits listed that may be obtained for certification that may be obtained for LEED V4 BD+C certification.

Table 1: Location and Transportation Sections and Credits for Maintenance of Existing Educational Buildings [2].

Location and Transportation	Possible Points (15)
Alternative Transportation	15

Sustainable sites (SS)

SS credits deal with issues outside of the building, including some of the building exterior, the land that is being developed, and the surrounding community [7]. The sustainable sites category emphasizes on limiting the impact of buildings on local ecosystems by integrating the building location and sustainable features. Table 2 shows all possible credits for existing educational buildings listed that may be obtained for LEED V4 BD+C certification.

Table 2: Sustainable sites Sections and Credits for Maintenance of Existing Educational Buildings [2].

Sustainable Sites	Possible Points (10)
Site Development-Protect or Restore Habitat	2
Rainwater Management	2
Heat Island Reduction	2
Light Pollution Reduction	1
Site Management	1
Site Improvement Plan	1
Joint Use of Facilities	1

Water Efficiency (WE)

The Water Efficiency (WE) section addresses water holistically, looking at indoor use, outdoor use, specialized uses, and metering. The section is based on an "efficiency first" approach to water conservation. As a result, each prerequisite looks at water efficiency and reductions in potable water use alone. Table 3 shows all possible credits for existing educational buildings listed that may be obtained for LEED V4 BD+C certification.

Table 3: Water Efficiency Sections and Credits for Maintenance of Existing Educational Buildings [2].

Water Efficiency	Possible Points (12)
Outdoor Water Use Reduction	2
Indoor Water Use Reduction	5
Cooling Tower Water Use	3
Water Metering	2

Energy and Atmosphere (EA)

The EA category recognizes that the reduction of fossil fuel use extends far beyond the walls of the building. Projects can contribute to increasing the electricity grid's efficiency by enrolling in a demand response program. Demand response allows utilities to call on buildings to decrease their electricity use during peak times, reducing the strain on the grid and the need to operate more power plants, thus potentially avoiding the costs of constructing new plants. Similarly, on-site renewable energy not only moves the market away from dependence on fossil fuels but may also be a dependable local electricity source that avoids transmission losses and strain on the grid. Table 4 shows all possible credits for existing educational buildings listed that may be obtained for LEED V4 BD+C certification.

Table 4: Energy and Atmosphere Sections and Credits for Maintenance of Existing Educational Buildings [2].

Energy and Atmosphere	Possible Points (38)
Existing Building Commissioning- Analysis	2
Existing Building Commissioning-Implementation	2
Ongoing Commissioning	3
Optimize Energy Performance	20
Advanced Energy Metering	2
Demand Response	3
Renewable Energy and Carbon Offsets	5
Enhanced Refrigerant Management	1

Materials and Resources (MR)

(MR) credits deal with issues that reduce the use of new materials and resources, encourage the use of materials and resources that have a smaller impact on the environment, and promote the reuse or recycling of materials so that more virgin materials and resources are not used on LEED V4 BD+C certified projects [7]. The efficiency of energy in sustainable building beginning with a highlight on a design that decreases total energy requirements, for example, building orientation and glazing selection, and the choice of environment -appropriate building materials [2]. Table 5 shows all possible credits for existing educational buildings listed that may be obtained for LEED V4 BD+C certification.

Table 5: Materials and Resources Sections and Credits for Maintenance of Existing Educational Buildings [2].

Materials and Resources	Possible Points (8)
Purchasing- Ongoing	1
Purchasing- Lamps	1
Purchasing- Facility Management and Renovation	2
Solid Waste Management- Ongoing	2
Solid Waste Management- Management and Renovation	2

Indoor Environmental Quality (IEQ)

The EQ category combines traditional approaches, such as ventilation and thermal control, with emerging design strategies, including a holistic, emissions- based approach (Low-Emitting Materials credit), source control and monitoring for user-determined contaminants (Enhanced Indoor Air Quality Strategies credit), requirements for lighting quality (Interior Lighting credit), and advanced lighting metrics (Daylight credit). Table 6 shows all possible credits for existing educational buildings listed that may be obtained for LEED V4 BD+C certification.

Table 6: Indoor Environmental Quality Sections and Credits for Maintenance of Existing Educational Buildings [2].

Indoor Environmental Quality	Possible Points (17)
Indoor Air Quality Management Program	2
Enhanced Indoor Air Quality Strategies	2
Thermal Comfort	1
Interior Lighting	2
Daylight and Quality Views	4
Green Cleaning- Custodial Effectiveness Assessment	1
Green Cleaning- Products and Materials	1
Green Cleaning- Equipment	1
Integrated Pest Management	2
Occupant Comfort Survey	1

Innovation in Design (ID)

Sustainable design strategies and measures are constantly evolving and improving. New technologies are continually introduced to the marketplace, and up- to-date scientific research influences building design strategies. The purpose of this LEED V4 BD+C category is to recognize projects for innovative building features and sustainable building practices and strategies. Occasionally, a strategy results in building a performance that greatly exceeds what is required in an existing LEED V4 BD+C credit. Table 7 shows all possible credits for existing educational buildings listed that may be obtained for LEED V4 BD+C certification.

Table 7: Innovation in Design Sections and Credits for Maintenance of Existing Educational Buildings [2].

Innovation in Design	Possible Points (6)
Innovation	5
LEED Accredited Professional	1

Regional Priority

Because some environmental issues are particular to a locale, volunteers from USGBC chapters and the LEED V4 BD+C International Round Table have identified distinct environmental priorities within their areas and the credits that address those issues. These Regional Priority credits encourage project teams to focus on their local environmental priorities. Table 8 shows all possible credits for existing educational buildings listed that may be obtained for LEED V4 BD+C certification.

Table 8: Regional Priority Sections and Credits for Maintenance of Existing Educational Buildings [2].

Regional Priority	Possible Points (4)
Regional Priority: Specific Credit	4

4. $LEED_{V4}$ BD+C Certification

LEEDV4 BD+C certification for sustainable construction requirements for sustainable buildings is awarded to four levels as shown in Figure 2. Which, Certified projects achieve 40-49 points; Silver projects achieve 50-59 points; Gold projects achieve 60-79 points, and Platinum projects receive over 80 points, LEEDV4 BD+C certification involves four main steps as the flowing:

- **Main steps to LEED certification**
  - Register your project by selecting your team, completing key forms and submitting payment.
  - Verify your project milestones and achievements through the on-site verification process.
  - Review. Submit the necessary information, calculations, and documentation to your Green Rater. Your LEEDV4 BD+C application is then reviewed.
  - Certify. Receive the certification decision. If you've earned LEEDV4 BD+C certification.

Figure 2: Certification of (LEEDV4 BD+C) [2].

5. Agile Development Model

Agile is an iterative approach to project management that helps teams deliver value to their customers faster and with fewer headaches. Instead of betting everything on a "big bang" launch, an agile team delivers work in small, but consumable, increments. Requirements, plans, and results are evaluated continuously so teams have a natural mechanism for responding to change quickly [8].

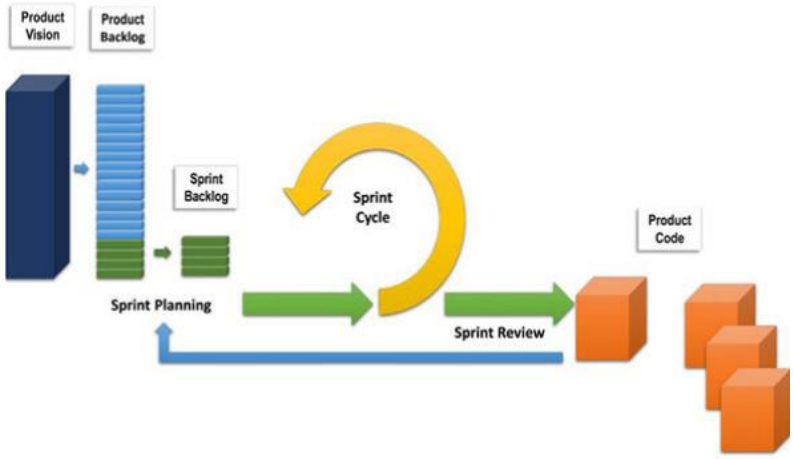

Figure 3: Agile Model [8].

This methodology gives users to take up changes more easily and make path corrections if needed. Traditional methodology considered each act task does its act and hands over to the next act task. The previous act tasks have to sign off before it is handed during the coming act task notarized that the act is full and complete in all aspects. For example, requirement collecting is completed and delivered to design stage and it is thereafter delivered to improvement and later to testing and rework. Each act task is a stage by itself. In the Agile method of working, each trait is finished in terms of design, development, code, testing and rework, before the trait is called done. There aren't isolated stage and all the work is done in one stage only, Figure 3 shows the agile methodology. The agile model has a lot of benefits and defects that can summarize in the flowing pontes [8].

The general principles of the Agile Method

- Changing requirements are embraced for the competitive advantage.
- Concentrate on delivering working software frequently. Delivery preference will be placed in the shortest possible time span.
- Developers and business people must work together throughout the entire project.
- Projects must be based on people who are motivated. Give them the proper environment and the support that they need. They should be trusted to get their jobs done.

6. Agile Model and Integrated Mapping to Sustainable Design and Construction of Maintenance for Existing Educational Buildings

Extensive documentation is completed by the end of each cycle of the agile development model. After the requirements are set to include the sustainable strategy with performance criteria to design and construction of sustainable educational buildings, the next phase occurs for the integration of the systems with the cycle life cycle that leads to being delivered to the decision making.

The name of the proposed module for the maintenance of existing constructions is Agile Development Module and Integrated Sustainable for Operations and Maintenance of Existing Educational Buildings (ASOME-EB). The first cycle with a minimum requirement for applying sustainable design and construction of educational buildings in maintenance to existing constructions as shown in Figure 4. The second cycle updates the first cycle based on stakeholders' feedback and adds a new feature to improve the sustainability certification of the educational buildings. The third cycle is similar to the second cycle till the building achieves the highest certification of sustainability as shown in Table 9.

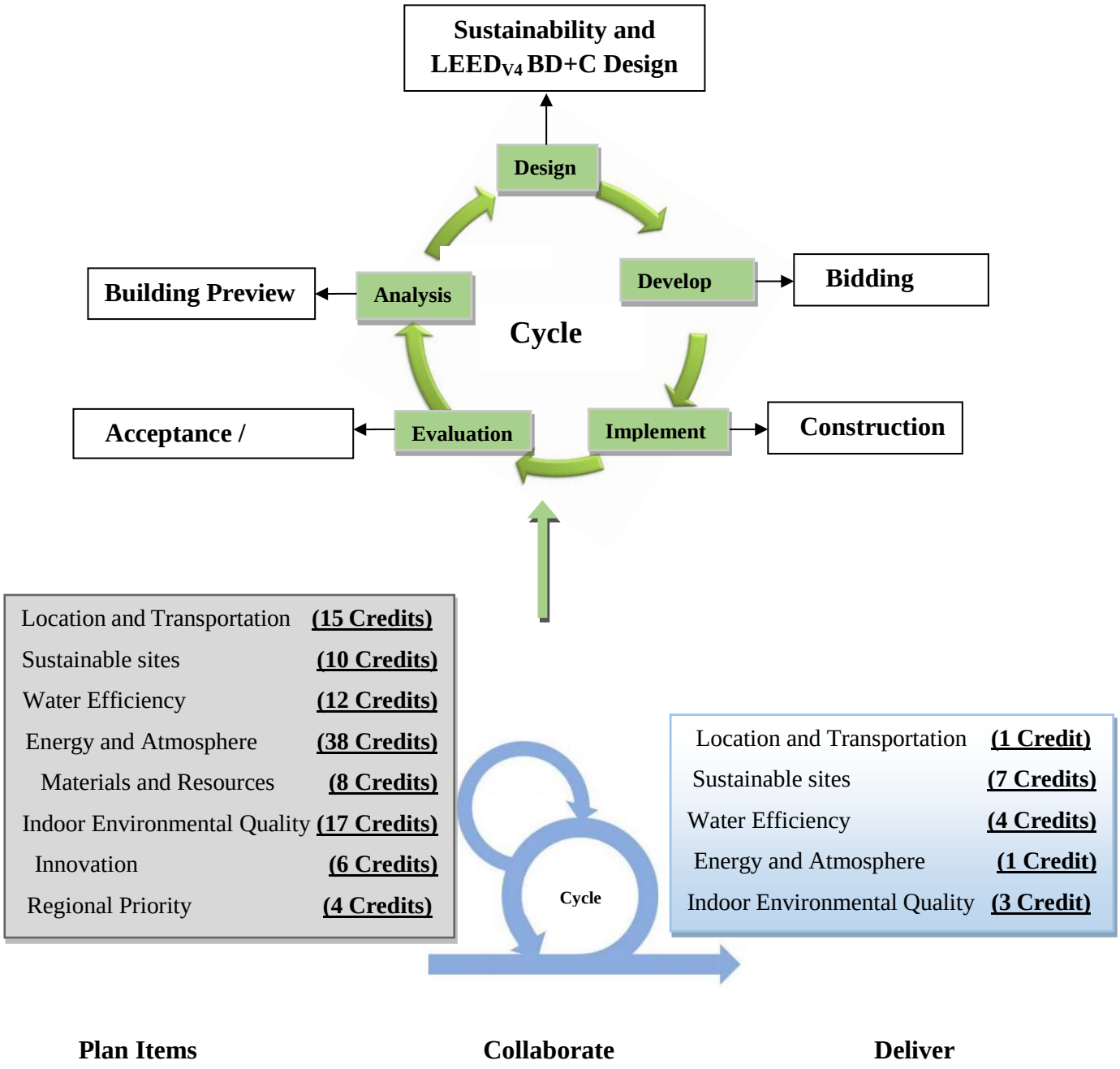

Figure 4: (ASOME-EB) Mapping - Cycle (1)

The summarized cycles and certify level for operations and maintenance of existing constructions (ASOME-EB), which indicates the LEEDV4 BD+C requirements and its credits required for educational buildings to each goal, the number of agile cycles applied and delivered one by one to stakeholders. The total points give certify based on LEEDV4 BD+C certification as shown in Figure 4, this certifies devolved after each cycle of the agile development model.

Table 9: (ASOME-EB) Model Cycles

LEEDV4 BD+C Requirements	Credits	Agile Cycles	Delivered	Credits No. applied	Points	Total Points	Certify
Location and Transportation	1	1	Location and Transportation	1	15	40	 Certified
Sustainable sites	7		Sustainable sites	1,2,3,4,5, 6,7	10		
Water Efficiency	4		Water Efficiency	1,2,3,4	12		
Energy and Atmosphere	8		Energy and Atmosphere	1	2		
Materials and Resources	5		Indoor Environmental Quality	3	1		
Indoor Environmental Quality	10	2	Energy and Atmosphere	2,3	5	47	 Certified
Innovation	2		Materials and Resources	1,2	2		
Regional Priority	4	3	Indoor Environmental Quality	1,2,4,5	10	57	 Silver
		4	Indoor Environmental Quality	6,7,8,9,10	6	63	 Gold
		5	Energy and Atmosphere	5,6,7,8	11	78	 Gold
			Materials and Resources	3,4	4		
		6	Energy and Atmosphere	4	20	100	 Platinum
			Materials and Resources	5	2		
		7	Innovation	1,2	6	110	 Platinum
			Regional Priority	1,2,3,4	4		

7. Conclusion

ASOME-EB model aims that the stakeholders that have educational buildings projects can apply the sustainability requirements to achieve the Leadership in Energy and Environmental Building Design and Construction (LEEDv4 BD+C) certification using agile development for the maintenance to existing constructions. The agile model to design and construction proses of existing educational buildings to make it applied in a simple model format, to apply in Egypt, due to the lack of financial resources and a shortage of skilled labors for this type of constructions. The criteria presented in this research based on $LEED_{V4}$ BD+C requirements for existing educational buildings design and construction. Agile applied the sustainable existing educational buildings through several cycles as it indicated in the research.

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