# Contribution of green buildings towards achieving sustainability: A perspective of LEED-certified buildings in Sri Lanka

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***Abstract**: Recently, the focus on green buildings has fore fronted in countries. However, in the context of Sri Lanka, the number of green-certified buildings seems to be still at a minimal level and the focus is solely on the energy efficiency features. Although green buildings are meant to be sustainable, the level of incorporation of sustainable features and their contribution to sustainability is questionable. Therefore, the current study aims to examine the extent of incorporation of sustainable features in green-certified buildings in Sri Lanka. A review was conducted into the USGBC database and the profile of green-certified buildings in Sri Lanka was examined to identify the extent of green certification in Sri Lankan buildings and their level of achievement of sustainable features. The reasons for the level of achievement of those sustainable features were then identified by interviewing professionals who engaged in green buildings. Accordingly, the selected buildings have over 80% of achievement in terms of water efficiency and sustainable sites, while other design features, such as energy and atmosphere, indoor environmental quality, and material and resources are below 50% achievement. Further, energy and atmosphere, and indoor environmental quality features require alternatives with higher initial cost, early commitment, and an integrated design process. Most of the time, energy and indoor environmental quality features seem easy to achieve, but often turn out to be far more complicated, and thus less feasible, than anticipated. Knowing sustainability achievement of features would enable green building investors to select the most appropriate features for a given construction.*

***Keywords**: Green Building, LEED Certification, Sustainable Features, Sustainable Development, Sri Lanka*

## 1. Introduction

The construction industry has a significant impact on economic, environmental, and social development all over the world (Nahmens, 2009). With the growing global interest in sustainability, the concept of green building construction has come to the forefront of the construction industry in Sri Lanka (Abidin, 2010). However, as studies highlighted, there are some challenges for a developing country like Sri Lanka when leading towards sustainable construction. For example, Bombugala and Atputharajah (2010) concluded that the construction cost of green buildings is about 20 to 25% higher than that of traditional buildings. Further, Waidyasekara and Fernando (2012) indicated that green building investors primarily focus on minimising construction costs and failing to consider the economic performance throughout the life cycle. Further, Waidyasekara & Fernando (2012), stated that there is a great requirement to promote the construction of green buildings in Sri Lanka with the rapid growth of the construction industry. Green buildings incorporate various sustainable features under major focus areas such as sustainable sites, management, energy efficiency, water efficiency, materials and resources, indoor environmental quality (IEQ), health, etc. (Fowler & Rauch, 2006). Though green buildings provide sustainable features in many aspects, a visible limitation of the past studies is that the findings on the implication of sustainable features on green buildings were mostly limited to energy efficiency technologies. Therefore it is more important to identify the contribution of each sustainable feature to promote the green building concept with the green certification.

represent the next phase of buildings however, the reality is that most of the buildings in Sri Lanka are not green. LEED has been active in Sri Lanka, even before the GREENSL® rating was introduced by the GBCSL in 2010. For example, the first LEED certification in Sri Lanka was issued in 2008 (Bombugala & Atputharajah, 2010). Fowler and Rauch (2006) highlighted that LEED® is the dominant and most widely used rating system around the world. To date, LEED encompasses more than 72,500 LEED building projects in over 150 countries and territories. Moreover, GREENSL® rated building has an equivalent efficiency as a LEED-rated building (Green Building Council Sri Lanka, 2015). Table 1 provides the summary of point allocation of LEED BD+C NC (V3) and GREENSL® for the sustainable features.

Table 1: Summary of Points Allocation as per LEED NC Version 3.0 and GREENSL®

| Sustainability Feature | Points Allocated | |
|---|---|---|
| | **LEED BD+C NC v3 (2009)** | **GREENSL®** |
| **Energy and Atmosphere** | 35 | 21 |
| **Sustainable Sites** | 26 | 25 |
| **Indoor Environmental Quality** | 15 | 21 |
| **Materials and Resources** | 14 | 21 |
| **Water Efficiency** | 10 | 14 |
| **Innovation and Design** | 6 | 4 |
| **Regional Priority** | 4 | - |
| **Management** | - | 4 |
| **Social and Cultural Awareness** | - | 3 |
| **Total** | **110** | **113** |

To this end, the current study aims to examine the extent of green certification in Sri Lankan buildings and their level of achievement of sustainable features with the justifications for those achievements. It is expected that the outcome of this study would enable potential green investors to make informed decisions with sound knowledge of sustainable features. This would further enhance the sustainable performance of buildings and promote sustainable development.

## 2. Literature Review

Green Building Council Sri Lanka (GBCSL) was launched in 2009 and is a non-profit organisation that is devoted to encouraging the adoption of green building practices thereby developing a sustainable building industry in Sri Lanka and has introduced a green rating system. GBCSL came into existence because of an emerging trend toward applying greener concepts to the built environment. Thus, the green building concept is new to the Sri Lankan context and it is introduced to many industries as they are searching for more energy-efficient buildings for their usage (Green Building Council Sri Lanka, 2010). Green buildings

As shown in Table 1, energy and atmosphere are top ranked in LEED BD+C NC (v3) rating system and the sustainable sites feature is a close second, whereas, the sustainable site is identified as the most important sustainable feature in the Sri Lankan context and associated with higher points in the GREENSL® rating system. Management and social and cultural awareness are specific sustainable features of the GREENSL® rating system while regional priority feature is excluded from the GREENSL® rating system. However, the sustainability criteria in each common sustainable feature seem to be similar between the two rating systems.

## 3. Research Methodology

The main objective of the study is to examine the profile of green buildings in Sri Lanka, their sustainability level achieved through the incorporation of sustainability features, and the reasons for the level of achievement of those features. The required data were collected through documentary reviews of the USGBC directory and semi-structured interviews with professionals who engaged from the green building initiation project to operation and maintenance (O & M) activities of the selected green buildings. Initially, a search into the USGBC directory was carried out to identify the extent of green certification in Sri Lankan buildings and their level of achievement of sustainable features. In the Sri Lankan context, the LEED and the GREENSL are widely used rating systems. Amongst, the study is limited to LEED-certified buildings due to the lack of comprehensive data available in the case of GREENSL-certified buildings. As per the updated UGBC directory, altogether ninety-seven (97) buildings have been registered under LEED certification in Sri Lanka as of 2020 as per Table 2. Of them, fifty-four (54) buildings were awarded LEED certification in Sri Lanka. The majority of green-certified buildings (25 out of 54) are industrial manufacturing facilities, while office buildings were the second most certified type with 9 out of 54 buildings. Among the LEED-certified buildings, the profile of the green buildings was further reviewed based on the rating system, rating version, certified level, and certified year to ascertain the status of the green buildings. In the Sri Lankan context, green-certified buildings were registered under five (5) categories and 5 different rating versions. Amongst, the majority of buildings have been certified under LEED BD+C: NC version LEED -2009, hence, analysis was conducted for the LEED BD+C: NC (v3 - 2009) industrial and office buildings in Sri Lanka. The LEED BD+C: NC (v3 -2009) includes 08 (out of 25) industrial buildings and 07 ((out of 09) office buildings registered.

Table 2: Profile of Participants

| | Position | Profession | Experience (Years) | Involvement in the Project |
|---|---|---|---|---|
| I01 | Maintenance Engineer | Mechanical Engineer | 1-10 | Construction, O & M |
| I02 | Manager Maintenance | Mechanical Engineer | 1-10 | Construction, O & M |
| I03 | O&M Manager | Mechanical Engineer | 11-20 | O & M |
| I04 | Maintenance Engineer | Mechanical Engineer | 1-10 | O & M |

Subsequently, semi-structured interviews were used to identify the reasons for the level of achievement of sustainable features of LEED BD+C New Construction buildings. Table 3 presents the profile of the interviewees. The data collected through document analysis were subjected to descriptive statistics. Manual content analysis was used to capture the interviewees' views on the reasons for the level of achievement of sustainability.

## 4. Results and Discussion

Eight (8) industrial manufacturing buildings and six (6) office buildings certified under LEED BD+C: New Construction (v3 - LEED 2009) were considered to analyse the implication of sustainable features in the achievement of green certification.

### *A. Level of Achievement of Sustainable Features*

The points achieved to each sustainability criteria of certified industrial and office buildings were analysed and the average point achievement was considered to identify the significance of sustainable features in the Sri Lankan LEED-certified buildings. Table 4 presents the possible points allocated for each sustainable feature, average achieved points, and the percentage of achieved points from the possible points of each feature. As shown in Table 4, the average points achievement of selected green-certified office and industrial buildings indicate that regional priority, and water efficiency features have achieved over 90% of the possible points. The sustainability level of the sustainable site and innovation feature exists between 65% - 80%. Though office buildings achieve a 54% of sustainability level in energy and atmosphere features, industrial buildings account for only 44%. The remaining features: Indoor environmental quality and material and resources have achieved a sustainability level between 40% to 50%.

Table 3: Profile of LEED-certified buildings in Sri Lanka as at 2020

| Certified green spaces | Industrial manufacturing | Office | Loading | Warehouse and distribution | Multi-family residence | Retail | Higher education | Datacentre | Laboratory | Public assembly | Others | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of registered buildings | 40 | 18 | 18 | 5 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 97 |
| No. of certified buildings | 25 | 9 | 8 | 3 | 1 | 3 | 2 | 1 | 2 | - | - | 54 |
| No. of uncertified buildings | 15 | 9 | 10 | 2 | 2 | - | 1 | 1 | - | 1 | 1 | 43 |

B. *Reasons for Level of Achievement of Sustainable Features*

The interviewees were presented with the findings of a comparative analysis of points allocated and achieved and asked to comment on the reasons for the level of achievement of sustainability in terms of each sustainability feature. Reasons for the achievement level of each sustainable feature were sought and analysed separately under each feature and then a summary of all the reasons is presented.

*a. Water Efficiency*

As discussed previously in the preliminary analysis, the certified industrial buildings have achieved a 100% of sustainability level while office buildings achieved 90% in terms of water efficiency. Water efficiency consists of three criteria as water-efficient landscaping, innovative wastewater technologies, and water use reduction. All, of the interviewees (I01-I04), agreed that organisations are willing to invest in water efficiency since the building owners are required to pay for utility costs over the life cycle of the building. According to interviewees, high-efficiency irrigation using reclaimed water (water supplied to the site by the local water district) can be designed at a minimal cost. Adding to that, the interviewee (I02) stated that the native plants which are suited to the local rainwater levels reduce the additional water consumption. On a similar note, the interviewee (I01) explained that "natural drainage such as grass paving and planted stormwater retention areas were used to reduce stormwater run-off from the site at a less cost". Considering the innovative wastewater technologies, interviewees stated that sewage treatment plants (STPs) are available in many green building sites. Interviewee (I03) indicated that they used the treated water for gardening and flushing purposes, while Interviewee (I02) stated that the treated water discharged to a waterway in an environmentally friendly manner. Although implementing a STP incurs a considerable cost, both interviewees agreed that the building owners often invest in STPs due to their familiarity with the technology engaged with STP. The last criterion of water use reduction is acquired by installing water-efficient plumbing fixtures. The Interviewee (I04) stated that when achieving the points for water use reduction, feasibility in implementation is the main concern rather than the cost. I04 further noticed that "*our building has installed low flow fixtures for toilets and urinals and dual plumbing which serve the recycled water from STP for flushing purposes*". From a similar point of view the Interviewee (I01) explained that "*the waterless urinals are engaged with a technology that is unfamiliar to the technical staff; however, there is no cost impact*". Therefore, it is obvious that green industrial and office buildings achieve the highest sustainability in water efficiency through low-cost, feasible, and familiar (no modern technology) alternatives of water efficiency strategies and technologies.

*b. Sustainable Sites*

According to the preliminary analysis, on average the percentage achievement of sustainability level is 76% and 75% in terms of the sustainable site by industrial and office buildings, respectively. According to interviewees (I01-I04), more than 50% of the points can be achieved by fulfilling the requirements of development density and community connectivity, and alternative transportation since, this feature allocates more points for those criteria. The Interviewee (I04) explained that "*providing provision for bike racks and changing rooms are inexpensive to achieve with low design impact therefore we have targeted this point from the start*". Similarly, Interviewee (I01) stated that "*low emitting and fuel-efficient vehicles with electric refueling stations can be added almost any time during design and construction*". Therefore, all the interviewees (I01-I04) have agreed that over 50% of the sustainability level can easily be added to the building by making minimal design changes that require low cost and design impact. Interviewee (I03) added that they have achieved the points for site development – protecting or restoring habitat by planting native species and the heat island effect was achieved by changing the colour of concrete paving and adding shade elements at a relatively low cost. According to the interviewee (I01), other points which can be achieved with a low cost and design impact are maximising the open space and designing and constructing the building in a location near wetlands or natural ponds.

*c. Innovation in Design*

The innovation in design feature in LEED BD+C NC certification is designed to allow projects to earn points for items that may not fall into any other designated point. According to the interviewees (I01 and I04), most of the projects have achieved 60 to 70% of the points allocated for this feature by pursuing low-cost innovation points and hiring a LEED-accredited professional for green building projects.

*d. Indoor Environmental Quality*

As identified previously, the IEQ feature includes 15 single points. According to the interviewees (I01, I02, and I03), the first point: is outdoor air delivery monitoring, usually achieved by installing $CO_2$ and airflow measurement equipment and feeding the information to the heating, ventilating, and air conditioning (HVAC) system and building automation system (BAS). Knowledge of modern technologies and incorporating these strategies into the building is the key requirement to achieve this point. Further, the Interviewee (I01) stated that "*it is all about sensing, monitoring and controlling the outdoor air intake flow*". Similarly, all the interviewees (I01-I04) agreed that modern technology, as well as the strong commitment of the members of the green project, is necessary to achieve the second point: which is increased ventilation. The next two points are the construction indoor air quality (IAQ) management plan during construction and before occupancy. As the Interviewee (I03) opined, the IAQ management plan during construction is relatively difficult to achieve because this point requires significant coordination and management on the contractor's part.

Table 4: Significance of sustainable features in terms of points allocation

| | Sustainable Feature | Allocated points | Level of achievement | | | |
|---|---|---|---|---|---|---|
| | | | Industrial | | Office | |
| | | | Average points achieved | Average % | Average points achieved | Average % |
| Sustainable Site | Site selection | 1 | 0.750 | 75% | 0.800 | 80% |
| | Development density and community connectivity | 5 | 3.125 | 63% | 5.000 | 100% |
| | Brownfield redevelopment | 1 | 0.000 | 0% | 0.000 | 0% |
| | Alternative transportation - public transportation access | 6 | 5.250 | 88% | 6.000 | 100% |
| | Alternative transportation - bicycle storage and changing rooms | 1 | 1.000 | 100% | 0.500 | 50% |
| | Alternative transportation - low emitting and fuel-efficient vehicles | 3 | 3.000 | 100% | 3.000 | 100% |
| | Alternative transportation - parking capacity | 2 | 2.000 | 100% | 2.000 | 100% |
| | Site development - protect or restore habitat | 1 | 0.500 | 50% | 0.000 | 0% |
| | Site development - maximize open space | 1 | 0.750 | 75% | 0.000 | 0% |
| | Stormwater design - quantity control | 1 | 0.375 | 38% | 0.000 | 0% |
| | Stormwater design - quality control | 1 | 1.000 | 100% | 0.250 | 25% |
| | Heat island effect - non-roof | 1 | 1.000 | 100% | 1.000 | 100% |
| | Heat island effect - roof | 1 | 0.875 | 88% | 1.000 | 100% |
| | Light pollution reduction | 1 | 0.250 | 25% | 0.000 | 0% |
| | **Total Received points** | **26** | **19.875** | **76%** | **19.550** | **75%** |
| Water efficiency | Water-efficient landscaping - no potable water uses or no irrigation | 4 | 4.000 | 100% | 3.000 | 75% |
| | Innovative wastewater technologies | 2 | 2.000 | 100% | 2.000 | 100% |
| | Water use reduction | 4 | 4.000 | 100% | 4.000 | 100% |
| | **Total received points** | **10** | **10.000** | **100%** | **9.000** | **90%** |
| Energy and atmosphere | Optimize energy performance | 19 | 9.500 | 50% | 9.250 | 49% |
| | On-site renewable energy | 7 | 0.875 | 13% | 3.250 | 46% |
| | Enhanced commissioning | 2 | 1.250 | 63% | 1.500 | 75% |
| | Enhanced refrigerant management | 2 | 0.000 | 0% | 2.000 | 100% |
| | Measurement and verification | 3 | 2.625 | 88% | 2.250 | 75% |
| | Green power | 2 | 1.000 | 50% | 0.500 | 25% |
| | **Total received points** | **35** | **15.250** | **44%** | **18.750** | **54%** |
| Material and resources | Building reuse - maintain existing walls, floors, and roof | 3 | 0.750 | 25% | 0.750 | 25% |
| | Building reuse - maintain interior non-structural elements | 1 | 0.000 | 0% | 0.000 | 0% |
| | Construction waste management | 2 | 2.000 | 100% | 1.500 | 75% |
| | Materials reuse | 2 | 0.125 | 6% | 0.000 | 0% |
| | Recycled content | 2 | 1.000 | 50% | 0.750 | 38% |
| | Regional materials | 2 | 2.000 | 100% | 2.000 | 100% |
| | Rapidly renewable materials | 1 | 0.000 | 0% | 0.250 | 25% |
| | Certified wood | 1 | 0.000 | 0% | 0.000 | 0% |
| | **Total received points** | **14** | **5.875** | **42%** | **5.250** | **38%** |
| Indoor environment quality | Outdoor air delivery monitoring | 1 | 0.125 | 13% | 0.500 | 50% |
| | Increased ventilation | 1 | 0.625 | 63% | 0.250 | 25% |
| | Construction IAQ management plan - during construction | 1 | 0.750 | 75% | 0.750 | 75% |
| | Construction IAQ management plan - before occupancy | 1 | 0.375 | 38% | 0.500 | 50% |
| | Low-emitting materials - adhesives and sealants | 1 | 0.875 | 88% | 0.750 | 75% |
| | Low-emitting materials - paints and coatings | 1 | 1.000 | 100% | 1.000 | 100% |
| | Low-emitting materials - flooring systems | 1 | 0.5 | 50% | 0.750 | 75% |
| | Low-emitting materials - composite wood and agrifiber products | 1 | 0.000 | 0% | 0.750 | 75% |
| | Indoor chemical and pollutant source control | 1 | 0.000 | 0% | 0.000 | 0% |
| | Controllability of systems - lighting | 1 | 0.375 | 38% | 0.250 | 25% |
| | Controllability of systems - thermal comfort | 1 | 0.000 | 0% | 0.250 | 25% |
| | Thermal comfort - design | 1 | 0.25 | 25% | 0.500 | 50% |
| | Thermal comfort - verification | 1 | 0.25 | 25% | 0.500 | 50% |
| | Daylight and views - daylight | 1 | 0.875 | 88% | 0.000 | 0% |
| | Daylight and views - views | 1 | 0.875 | 88% | 0.000 | 0% |
| | **Total received points** | **15** | **6.875** | **46%** | **6.750** | **45%** |
| Innovation | Innovation in design | 5 | 3.125 | 63% | 3.500 | 70% |
| | LEED Accredited Professional | 1 | 1.000 | 100% | 0.750 | 75% |
| | **Total received points** | **6** | **4.125** | **69%** | **4.250** | **71%** |
| Regional priority | Regional priority | 4 | 4.000 | 100% | 4.000 | 100% |
| | **Total received points** | **4** | **4.000** | **100%** | **4.000** | **100%** |

He further stated, "*The cost to achieve this point is low, however, the contractor's bid can be very significant. Due to the reason that the construction must be planned and scheduled with well-trained members, it is ensured that all the criteria are met*". Considering the IAQ

plan before occupancy, the interviewee (I01) opined that achieving this point depends on the climate condition. In dry areas, a two-week flush-out with outdoor air is quite feasible, while in wet climates where there is high humidity, the mould could grow on the interior of the building. Both interviewees (I01 and I02) agreed that it is easy to achieve low emitting materials points where local or regional regulations already established the use of low emitting materials. Similarly, the next point: indoor chemical and pollutant source control can often be met with low cost and controllability of the system. Lighting could be achieved by integrating occupant controls for lighting and task lighting at a low cost. The controllability of the system: which is the thermal comfort often achieved by incorporating operable windows with a low direct cost premium. However, there is a significant added cost when combined with a traditional air conditioning system with extra controls, zones, and ductwork. According to the interviewee (I01), achieving this point with operable windows may also be impractical due to the concern over the security of raw materials for the garment, and the climate may not lend itself to operable windows for much of the year. Under the thermal comfort design and verification, the building envelope and systems should be designed with the capability to meet the comfort criteria under expected environmental and use conditions and should be able to permanently monitor building performance: air temperature, radiant temperature, air speed, and relative humidity levels. According to the interviewees (I03 and I04), these points are feasible to achieve with the strong commitment of the parties engaged with the green building project. Both the interviewees (I03 and I04) opined that many projects attempted to achieve daylighting and views due to the benefits of daylighting and views became more desired over time. Most of the IEQ points need to commit construction owners and teams. However, not all parties are willing to maintain the level of management needed to ensure the performance necessary to meet these points successfully. These points may seem easy to achieve, but often turn out far more complicated, and thus less feasible, than anticipated. Therefore, most of the green industrial and office buildings in Sri Lanka have achieved less than 50% points for the IEQ feature over the allocated 15 points.

e. *Energy and Atmosphere*

As discussed previously, the energy and atmosphere feature consists of optimized energy performance, enhanced commissioning, enhanced refrigerant management, measurement and verification, and on-site renewable and green power criteria. Amongst, LEED has allocated more points for optimizing energy performance and site renewable energy. The certified buildings have scored less than 50% (17 out of 35 points) in terms of energy and atmosphere, while the feature has been assigned the highest number of points in the rating system. According to the Interviewee (I02), the points for the optimized energy performance were awarded considering the percentage of energy cost savings. Therefore, to achieve more points the investor should prove that the building is responsible for the threshold points which incurs a high initial cost to achieve that level. Similarly, the Interviewee (I01) stated that "*it is difficult to reach the higher percentages because these require innovative technology. Further, reaching these higher levels added significant costs and they especially need an early design commitment*". Considering the building commissioning, measurement, and verification, both interviewees (I03 and I04) agreed that these represent a significant added cost. However, feasible to achieve with early commitment. Further, Interviewee (I03) opined that measurement and verification require a complex monitoring system that ultimately benefits the users. In terms of refrigerant management, both interviewees agreed that nowadays more energy-efficient air conditioning alternatives are available that use environmentally friendly refrigerants. Therefore, it is only a matter of selecting a system that is environmentally and economically beneficial in the long run. However, considering renewable energy and green power, these have a substantial construction cost impact and provide long-term cost savings. The Interviewee (I02) explained, "*Assume that to initiate an investment in the photovoltaic system, there should be financially backup for the investors. Currently, few organisations provide the Energy Service Contracts (ESCO) model for those kinds of investments. However, the location and climate conditions should also consider achieving uninterrupted solar energy supply*". Therefore, these green-certified industrial buildings were able to achieve a less than 55% of allocated points with an early commitment and integrated design process.

*f. Material and Resources*

The certified industrial and office green buildings in Sri Lanka have achieved a level of less than 50% in terms of material and resources. This feature is classified into two distinct categories: A) most projects pursuing the credits related to construction waste management, local content, and recycled content, and B) very few pursuing the other points like building reuse, renewable materials, material reuse, and certified wood. Therefore, the interviewees were asked to comment on the reasons for this achievement level.

Building reuse is the first point, Interviewee (I01) stated that "*it is difficult to reuse existing building structural and non-structural elements due to its impact on the cost of achieving energy and atmosphere points*". Similarly, the Interviewee (I02) added, that this point is uncommon in most projects due to the additional work and substantial material and resources that must sacrifice the energy and atmosphere of the building. However, achieving energy and atmosphere is more economical considering the long-term economic benefits. The interviewees (I03 and I04) opined that most projects are unable to incorporate rapidly renewable materials and reused materials into their design because these materials tend to be costly. Further, both interviewees

Table 5: Reasons for the Level of Achievement of Sustainability

| **Sustainable Features** | **Level of Achievement** | **Reasons** |
|---|---|---|
| Sustainable Sites | ≥ 80 | Minimal design changes which require low cost and design impact |
| Water Efficiency | | Feasible and familiar (no modern technology) alternatives |
| Innovation in Design | 50 < % ≤ 80 | Low-cost innovation strategies |
| Energy and Atmosphere | ≤ 50 | The high initial cost of implementation<br>Early commitment and integrated design process |
| Material and Resources | | Additional works and substantial cost<br>Contractor's commitment and familiarity |
| IEQ | | The commitment of the project owners and construction team |

agreed that certified wood costs more than non-certified wood. Without a clear understanding of cost fluctuations, the investors were unable to establish the cost impact. Construction waste management is the highest achieved point in almost every green project. All the interviewees (I01-I04) explained that the cost to achieve this point is highly dependent on the contractor's commitment. If the contractor is familiar with the construction waste recycling programs and practices this can be achieved with a minimum cost. However, the cost is also dependent on the project location, usually in urban projects the cost is less. The interviewees (I01 and I02) agreed that the use of recycled content and regional materials usually incurs minimal costs. Therefore, the investors go for the projects in category A since the achievement of those features requires less cost compared to projects in category B and can maintain a sustainability level of less than 50%. Table 5 summarises the reasons identified through the content analysis under each sustainable feature.

## 5. Conclusion

This study aims to examine the extent of green certification in Sri Lankan buildings and their level of achievement of sustainable features. According to the research data analyses and findings, altogether 54 out of 97 buildings are certified under USGBC LEED certification in Sri Lanka. In other words, currently, nearly 56% of registered buildings have achieved green certification in Sri Lanka. Research results further depict that the water efficiency feature has achieved 100% and 90% of sustainability levels through low cost, feasible and familiar alternatives of water efficiency technologies and strategies in industrial and office buildings, respectively, whereas over 50% of sustainability level has achieved through making minimal design changes to the building which require low cost and design impact in terms of sustainable sites feature. However, in terms of energy and atmosphere, the certified buildings have achieved only approximately 50% of the allocated points as they required alternatives with higher initial cost, early commitment, and an integrated design process. Similarly, in terms of IEQ features, the industrial buildings have earned less than 50% of the sustainability level since most of the IEQ points seem easy to achieve, but often turn out to be far more complicated, and thus less feasible, than anticipated. The certified industrial and office buildings have achieved less than 50% sustainability in terms of material and resources because most of the points are uncommon in most projects due to the additional work and the substantial cost associated with the building. Accordingly, the research findings show that in the global context, approximately 50,000 buildings have achieved the LEED certification, whereas in Sri Lanka only 54 buildings have achieved green to date. Hence, the results of this study enable to increase the in green certification in Sri Lankan buildings by achieving more sustainable features.

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