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Review of the LEED Category in Materials and Resources for Developing Countries

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Abstract

Material selection in sustainable projects affects the environment a great deal. Selected materials gain importance as they can contaminate the environment and can produce waste during construction. Use of limited resources has also environmental impacts. Thus, considering sustainable materials in the projects and appropriate consumption of available resources are important for sustainability considerations. The danger of running out of resources and the consequences of contamination of the habitat point out to the importance of green building certification systems. Issues such as storage and collection of recyclables, waste management planning, PBT source reduction, sourcing of raw materials, material ingredients, and design for flexibility that are treated in this category are difficult to implement in developing countries, mainly because they are based on local practices. The use of materials and resources accounts approximately for 11% of the points a building can receive for LEED v4 certification. However, the use of LEED in countries other than the U.S. can be controversial as local conditions are effective in earning credentials required for certification. This study aims to review the "materials and resources" category of LEED. Comparison of local practices in selected developing countries is made based on credits in this category to provide guidelines for green projects in those countries. It is expected that practitioners in developing countries will benefit from the outcome of this study.

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1. Introduction

Selection of suitable materials is essential in achieving sustainability goals when a construction project seeks accreditation through a certification system. These systems encourage the consumption of recycled and renewable materials [1]. It is also preferred to supply those materials from local manufacturers to earn credits needed for certification. Sustainability principles require that in addition to minimizing the consumption of water and energy, considering appropriate sustainable materials be used whenever possible.

According to a UNEP report [2], three billion tons of raw materials, which correspond to 40-50% of the total flow in the global economy, are used in the manufacturing of building products and components worldwide each year. The production processes of building materials have environmental impacts. These impacts can vary depending on the location of the facility. Energy consumption and the environmental impacts of producing the same material can differ from industrialized countries to low-income countries where less efficient processes are used [3]. Also, energy may be produced by hydropower, nuclear, fossil, or thermal plants resulting in different impacts. The transportation distances and local conditions can also significantly influence energy consumption [4].

The benefits of using sustainable materials not only helps the achievement of sustainability goals for construction projects, but also contributes to obtaining higher scores during the application processes for green building certification. Although many certification systems are developed in different countries for rating buildings, LEED has established strong credibility among experts [5]. The "materials and resources" category in LEED v4 accounts approximately for 11% of the contribution of all categories.

LEED is normally applicable in the U.S. construction industry because it complies with U.S. rules, codes and regulations. Professionals in other countries who want to use a credible and established certification system sometimes use LEED in order to rate their buildings. Regional adaptations are researched and in progress in several countries which would reflect the local conditions more realistically as in India, Canada, Mexico and Brazil. As a country located in a hot region, the Abu Dhabi Urban Planning Council in U.A.E. prepared its own rating system by considering local conditions. India spent significant efforts to develop its own certification system. The aim of this study is to focus on the review of the "materials and resources" category in selected developing countries in comparison with LEED v4 NC. It is expected that practitioners in developing countries will benefit from the outcome of this study.

2. Applicability of Materials and Resources Category in Different Countries

The use of sustainable materials and resources is an important requirement in popular green building certification systems such as those developed in industrialized countries like the U.S. and the U.K. Some developing countries prefer direct application of LEED or BREEAM, while others attempt to adapt the established systems to local conditions.

2.1. India

India has introduced LEED India, its own green building certification system after a preparation period. Indian construction needs are quite well represented in LEED India [6], which brings India among the first adapters of the LEED certification system to local requirements and conditions. Introduced in January 2007, the LEED India Green Building Rating System has considerable similarities with LEED 2009 NC [7].

A comparison of "materials and resources" credits in the two systems is shown in Table 1. LEED-India has one prerequisite and seven credits; four of the seven credits are structured into sub-credits. This category in LEED India refers to LEED 2009 NC and delivers a maximum of 13 points out of a maximum of 69, amounting to approximately 19% of the total points for new construction. On the other hand, in LEED v4 NC, the

"materials and resources" category amounts to approximately 11% of the total points. In LEED v4 NC, the "materials and resources" category focuses on minimizing the embodied energy and other impacts associated with the extraction, processing, transport, maintenance, and disposal of building materials. It is organized with three prerequisites and five credits that are listed in Table 1. Here, the requirements are designed to support a life-cycle approach that improves performance and promotes resource efficiency.

2.2. Abu Dhabi

The green building certification system in Abu Dhabi was introduced in 2010 as a mandatory requirement for all buildings linked to the Abu Dhabi Municipality building permitting process [8]. The system is titled The Pearl Rating System for Estidama, in which the word "estidama" means "sustainability" in Arabic. The category corresponding to "materials and resources" in Estidama is named "stewarding materials". It is structured with three requirements and fifteen credits, which delivers a maximum of 28 points out of a maximum of 177 points, amounting to approximately 16% of the total points.

This section encourages design and development teams to consider 'whole-of-life' when selecting and specifying materials [9]. The overall objective is to improve the social and environmental outcomes related to manufacture, transport, installation and disposal of materials. Requirements in Estidama emphasize the elimination of hazardous materials, and the basic management of construction and operational waste. The rating system was developed based on U.S. standards such as ASHRAE, IESNA, and ASTM as well as CIBSE (U.K.) and ISO standards, and EU directives [10]. Referring to a variety of standards shown in Table 1, prerequisites in LEED v4 NC focus on storage and collection of recyclables, construction and demolition waste management planning, and building life cycle impact reduction. With the introduction of LEED v4 NC, this category adopts the life-cycle approach.

Table 1. Comparison of LEED 2009 NC, LEED India NC, and Abu Dhabi ESTIDAMA PBRS on the basis of Materials and Resources categories

LEED v4 NC			**LEED India NC**			**ESTIDAMA PBRS: Design & Cons., V. 1.0**		
Materials and Resources category			**Materials and Resources category**			**Stewarding Materials**		
Prerequisites - Credit No.	**Po.**	**Referenced Standards**	**Prerequisites - Credit No.**	**Po.**	**Referenced Standards**	**Requisites - Credit No.**	**Po.**	**Referenced Standards**
MR Prerequisite. Storage and Collection of Recyclables	-	N/A	**Pre.1** Storage & Collection of Recyclables	-	Same as LEED 2009 NC	**SM-R1.** Hazardous Materials Elimination	-	Cabinet Resolution No. 39 of 2006 Concerning Prohibiting Import, Production and Utilization of Asbestos Boards, ASTM E 2356-04 - Comprehensive Building Asbestos Surveys
MR Prerequisite. Construction and Demolition Waste Management Planning	-	European Commission Waste Framework Directive 2008/98/EC; European Commission Waste Incineration Directive 2000/76/EC; EN 303-1—1999/A1—2003, Heating boilers with forced draught burners, Terminology, general requirements, testing and marking; EN 303-2—1998/A1—2003, Heating boilers with forced draught burners, Special requirements for boilers with atomizing oil burners; EN 303-3—1998/AC—2006, Gas-fired central heating boilers, Assembly comprising a boiler body and a forced draught burner; EN 303-4—1999, Heating boilers with forced draught burners, Special requirements for boilers with forced draught oil burners with outputs up to 70 kW and a maximum operating pressure of 3 bar, Terminology, special requirements, testing and marking; EN 303-5—2012, Heating boilers for solid fuels, manually and automatically stoked, nominal heat output of up to 500 kW; EN 303-6—2000, Heating boilers with forced draught burners, Specific requirements for the domestic hot water operation of combination boilers with atomizing oil burners of nominal heat input not exceeding 70 kW; EN 303-7—2006, Gas-fired central heating boilers equipped with a forced draught burner of nominal heat output not exceeding 1000 kW	N/A	-	N/A	**SM-R2.** Basic Construction Waste Management	-	Centre of Waste Management, Abu Dhabi

LEED v4 NC			LEED India NC			ESTIDAMA PBRS: Design & Cons., V. 1.0		
Materials and Resources category			Materials and Resources category			Stewarding Materials		
Prerequisites - Credit No.	**Po.**	**Referenced Standards**	**Prerequisites - Credit No.**	**Po.**	**Referenced Standards**	**Requisites - Credit No.**	**Po.**	**Referenced Standards**
MR Credit 1. Building Life-Cycle Impact Reduction	5	ISO 14044; National Register of Historic Places; Secretary of Interior's Standards for the Treatment of Historic Properties	**MR Credit 1.1** Building Reuse, Maintain 75% of Existing Walls, Floors and Roof	1	Same as LEED 2009 NC	SM-R3. Basic Operational Waste Management	-	Centre of Waste Management, Abu Dhabi
MR Credit 2. Building Product Disclosure and Optimization-Environmental Product Declarations	2	ISO 14021–1999, Environmental labels and declarations—Self Declared Claims (Type II Environmental Labeling); ISO 14025–2006, Environmental labels and declarations (Type III Environmental Declarations—Principles and Procedures); ISO 14040–2006, Environmental management, Life cycle assessment principles, and frameworks	**MR Credit 1.2.** Building Reuse, Maintain 100% of Existing Walls, Floors and Roof	1	Same as LEED 2009 NC	**SM-1**. Non-Polluting Materials	3	EU Directive on Dangerous Substances 67/548/EEC, EU Directive 67/548/EEC Annex III
MR Credit 3. Building Product Disclosure and Optimization-Sourcing of Raw Materials	2	Global Reporting Initiative (GRI) Sustainability Report; Organisation for Economic Co-operation and Development (OECD) Guidelines for Multinational Enterprises; U.N. Global Compact, Communication of Progress; ISO 26000—2010 Guidance on Social Responsibility; Forest Stewardship Council; Sustainable Agriculture Network; The Rainforest Alliance; ASTM Test Method D6866; International Standards ISO 14021–1999, Environmental Labels and Declarations—Self Declared Environmental Claims (Type II Environmental Labeling)	**MR Credit 1.3.** Building Reuse, Maintain 100% shell + 50% Non shell	1	Same as LEED 2009 NC	**SM-2**. Design for Materials Reduction	1	N/A
MR Credit 4. Building Product Disclosure and Optimization-Material Ingredients	2	Chemical Abstracts Service; Health Product Declaration; Cradle-to-Cradle CertifiedCM Product Standard:; Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH); GreenScreen	**MR Credit 2.1.** Construction Waste Management, Divert 50% from Disposal	1	Same as LEED 2009 NC	**SM-3**. Design for Flexibility & Adaptability	1	N/A

LEED v4 NC			LEED India NC			ESTIDAMA PBRS: Design & Cons., V. 1.0		
Materials and Resources category			Materials and Resources category			Stewarding Materials		
Prerequisites - Credit	**Po.**	**Referenced Standards**	**Prerequisites - Credit**	**Po.**	**Referenced St.**	**Requisites - Credit**	**Po.**	**Referenced Standards**
MR Credit 5. Construction Demolition Waste Management	2	Certification of Sustainable Recyclers; European Commission Waste Framework Directive 2008/98/EC; European Commission Waste Incineration Directive 2000/76/EC; EN 303-1—1999/A1—2003, Heating boilers with forced draught burners, Terminology, general requirements, testing and marking; EN 303-2—1998/A1—2003, Heating boilers with forced draught burners, Special requirements for boilers with atomizing oil burners; EN 303-3—1998/AC—2006, Gas-fired central heating boilers, Assembly comprising a boiler body and a forced draught burner; EN 303-4—1999, Heating boilers with forced draught burners, Special requirements for boilers with forced draught oil burners with outputs up to 70 kW and a maximum operating pressure of 3 bar, Terminology, special requirements, testing and marking; EN 303-5—2012, Heating boilers for solid fuels, manually and automatically stoked, nominal heat output of up to 500 kW; EN 303-6—2000, Heating boilers with forced draught burners, Specific requirements for the domestic hot water operation of combination boilers with atomizing oil burners of nominal heat input not exceeding 70 kW; EN 303-7—2006, Gas-fired central heating boilers equipped with a forced draught burner of nominal heat output not exceeding 1000 kW	**MR Credit 2.1.** Construction Waste Management, Divert 50% from Disposal	1	Same as LEED 2009 NC	**SM-4**. Design for Disassembly	1	N/A
			MR Credit 2.2. Construction Waste Management, Divert 75% from Disposal	1	Same as LEED 2009 NC	**SM-5**. Modular Flooring Systems	1	N/A
			MR Credit 3.1. Resource Reuse, 5%	1		**SM-6.** Design for Durability	1	N/A
			MR Credit 3.2. Resource Reuse, 10%	1		**SM-7.** Building Reuse	1	N/A
			MR Credit 4.1. Recycled Content, 5%	1	Same as LEED 2009 NC	**SM-8.** Material Reuse	1	N/A
			MR Credit 4.2. Recycled Content, 10%	1	Same as LEED 2009 NC	**SM-9.** Regional Materials	2	N/A
			MR Credit 5.1. Regional Materials, 20%	1		**SM-10.** Recycled Materials	6	Estidama Concrete Embodied GHG Calculator
			MR Credit 5.2. Regional Materials, 50%	1		**SM-11**. Rapidly Renewable Materials	1	BRE Environmental Profile, Cradle to Cradle Certification
			MR Credit 6. Rapidly Renewable Materials, 5% of Building Materials	1	Same as LEED 2009 NC	**SM-12.** Reused or Certified Timber	2	Forest Stewardship Council, Program for the Endorsement of Forest Certification scheme (PEFC), Canadian Standards Association (CSA), Sustainable Forestry Initiative (SFI), Malaysian Timber Certification Scheme (MTCS), Convention on International Trade in Endangered Species (CITES) list of endangered species, Appendix I, II and III
			MR Credit 7. Certified Wood, 50% of Wood based Materials	1	N/A	**SM-13.** Improved Const. Waste Man.	2	Centre of Waste Management, Abu Dhabi
						SM-14. Improved Operational Waste Man.	2	Centre of Waste Management, Abu Dhabi
						SM-15. Organic Waste Man.	2	Centre of Waste Management, Abu Dhabi

3. Conclusion

Material selection in sustainable projects affects the environment a great deal. Therefore, green building certification systems include a section related to materials to minimize and control environmental contamination and construction waste due to the use of building materials. Because sustainability considers appropriate use of available resources, certification systems encourage the selection of sustainable materials, waste management planning, storage of recyclables, and reuse of materials.

Industrialized countries started developing such systems earlier than counties in other parts of the world. LEED was developed in the U.S. and is the mostly recognized system in the world. It is sometimes used in less industrialized countries. However, the use of LEED in countries other than the U.S. can be controversial as local conditions are not reflected in the implementation, hence making it difficult to earn credits required for certification. In time, some countries managed to develop their own certification systems that reflect local conditions and construction practices.

India is one of the first countries that developed its own certification system. LEED India NC was based on LEED 2009 NC and regional properties. Indeed, LEED India NC has strong similarities to LEED 2009 NC. In the U.S., with the introduction of LEED v4 NC, a life-cycle approach was adopted and the number of prerequisites increased in the "materials and resources" category. LEED v4 references standards such as European Commission Directives, ISO Standards and many others as illustrated in the previous section. It also addresses strategies recommended by the Environmental Protection Agency (EPA), including source reduction, reuse, recycling and reducing waste.

For Abu Dhabi, the local conditions are different, as the United Arab Emirates is located in a hot climate zone. In Estidama, introduced in 2010, the materials section named "stewarding materials" considers the influence of materials on the region's carbon footprint in addition to the use of recycle of materials, recycling of waste, the the use of local materials. The system refers to several standards such as European Commission Directives, Centre of Waste Management in Abu Dhabi, ASTM etc. as seen in Table 1.

This study aims to review the "materials and resources" category of LEED in the U.S. and two developing countries, namely India and Abu Dhabi. A comparison of local practices in LEED India NC and Estidama is made based on the prescribed credits and the standards used in this category. It is expected that practitioners in developing countries will benefit from the outcome of this study.

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