Green Architecture for Sustainability Development in Algeria: Limitations and Visions

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Abstract

Sustainability development aims to promote cities that can respond to different climatic, social and economic challenges. In the discipline of architecture and urban design, green architecture is one of the key aims that sustainability development aspires to achieve by bringing frameworks that support the architecture profession and architects in developing environmentally friendly buildings and cities that meet the triple bottom line of sustainability development (economic, social and environmental pillars). Algeria is a North African Mediterranean country that covers different climatic zones. There have been different attempts to develop green architecture practices. However, these attempts have not contributed yet to a holistic solution that feeds into the architecture and urban design professions in this regard, and there is no framework that can manage the development of green architecture practices in the country. Therefore, this article explores the question of why environmental assessment methods are essential to promote the green architectural practices in the country's different climatic zones. This is done through discussing the sustainability development pillars and critically analysing and evaluating previous sustainability development approaches in Algeria, reflecting by doing so on their positive and negative attributes and highlighting the limitations that push the sustainable and green architecture practices backward. In addition, these limitations are used to develop the discussion around the sufficiency of an environmental assessment method in responding to these short comes. By analysing relevant precedence (Environmental Assessment methods) which highlights critical gaps in current assessment methods and informs the construction of an opening statement to the importance of geographically, environmentally and socially routed assessment methods to develop the culture of green architecture in the country.

Keywords

Sustainability development • Environmental assessment methods • Algeria

1 Introduction

The built environment is where an individual lives, learns, explores and contributes to society (Rzin & Alhalabi, 2017). It is also considered as a base from which all things come to life and exist (Razin & Alhalabi, 2017). In addition, architecture plays a vital role to the functioning of human daily life, such as productivity, happiness and entertainment. Yet, the current situation of the world faced by global warming and climate change is considered as a real threat to the present and future generations. As a result, the environment becomes unsafe for human well-being, and uncomfortable for their day-to-day activities. The recent flooding around the world and massive wildfires in Greece, Turkey, Algeria and Austrian forests, the rise of sea level and water shortage in many countries are evidence of the disaster (Gannon & Steinberg, 2021). Therefore, the architecture has yet to consider new approaches and solutions to adapt for the present and the future.

According to many academic and research findings, global warming is mainly due to the greenhouse gases emissions (GHEs) which is considered as a major factor for climate change (Iyer-Raniga & Kashyap, 2021), such as carbon dioxide emissions which is estimated at 65%; not only from vehicle gas emissions, but also from electricity and heat production, manufacturing, transportation for building and construction industry that counts 66% of the

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GHE (Iyer-Raniga & Kashyap, 2021). Another reason is the rapid demographic growth and the expansion of major cities that hold half of the world's population (Shamseldin, 2017), which is expected to exceed 70% by 2050 (Shamseldin, 2017); cities energy consumption has escalated to a very high level in order to build, operate, maintain and manage different buildings such as office buildings and institutional and industrial structures. These cities are continuing to consume as much as 40% of the total energy consumption globally. As a result, not only the construction process but also the building industry is considered harmful to the environment on a longer term after construction (Iyer-Raniga & Kashyap, 2021).

This paper therefore will investigate sustainability and sustainable development and its triple bottom-line dimensions (environment, social and economic) within the context of architecture and built environment. It will then explore the architecture and built environment attempts to address these aspects in Algeria highlighting the gap and the need for a new bespoke environmental assessment method for the country. The current major environmental assessment methods will then be analysed in order to highlight certain shortcomes that need to be considered when designing a bespoke multi-climate environmental assessment method for the context of Algeria.

2 Sustainability, and Sustainable Development

The sustainability movement has been created to meet the present needs; and at the same time preserves the resources for future generations by implementing changes in policies, laws and regulations. It is also meant to support the human well-being, healthy environment, smart growth and to reduce the impact of each phase of the project life cycle on the environment. Therefore, it is important to highlight how the concept of sustainable development has emerged and implemented in the architecture discipline.

This definition of sustainability, as indicated above, by World Summit on Sustainable Development, Agenda 21, and Brundtland (WCED, 1987) is the most referred to, and strongly dominant in the academic literature (Moldan et al., 2012; Purvis et al., 2018). Furthermore, Purvis et al. (2018) present arguments to emphasise further and add to the definition of sustainability development by the noun from which its adjective is "sustainable" and indicates that it is something bearable and capable of conserving its condition for an extended period of time. Dempsey et al. (2011) and Hedrén (2009), additionally comment that sustainability is the different processes and actions by which human beings preserve natural resources for the purpose of a balanced society. Christie et al. (2019) further explain that the built environment is sustainable on the off chance that it doesn't harm the environment, society and the economy.

Sustainability has emerged in the work of the United Nations' World Commission on Environment and Development, and in 1987s report of Brundtland, a former prime minister of Norway first introduced the concept and the three pillars of sustainable development in his report titled "*Our Common Future*." However, Portney (2015) identifies the pillars of Sustainability as "*It has become defined by the pursuit of the three co-equal elements: economy, environment, and equity.*" (p. 56). Moreover, it can be seen that Brown et al. (1987) have tried to root the general design of the concept of sustainability by comparing six different meanings of sustainability which they have suggested into two major categories: one emphasises ecology, and other emphasises economics.

These six meanings, according to Brown et al. (1987), represent the necessary potentials that have to be sustained such as "sustainable biological resources use," which is concerned about the natural systems and what all flora and fauna cover, to keep them at a balanced state between their level of productivity and harvestability. This balance between harvesting and producing is at the same aim in "sustainable agriculture." Whereas "carrying capacity" is concerned about the whole world being at a certain balance between the number of people living on a surface area and the capacity of supportability of this area in order to avoid species collapsing. Due to the fact that there are concerns about running out of fossil fuel and natural resources, "Sustainable energy," seeks alternative sources for producing energy such as electricity and powering machinery, at the same time that do not harm the environment. "Sustainable society and sustainable economy," have a relation with "carrying capacity" where the social conditions and economic, as well as the human well-being, are the epicentre concern of these meanings. Brown et al. (1987), predict that the economy will be overwhelmed by the population growth of the planet even to an extent that the natural resources will follow this collapse too.

The last but not least meaning of sustainability according to Brown et al. (1987) is "sustainable development (SD)" which seeks a trade-off relationship or win–win situation between the economic growth and the preservation of the environment, notwithstanding that both have positive or negative impacts on the society. For instance, the world's leading developing countries such as China and India have augmented their massive productivity to grow their economy. This has led to a rise in the carbon emission in the atmosphere and contributed to climate change, and thus, many islands, nations and citizens now are in danger of being sunk due to the rise of sea level. Brown et al. (1987) consider the environment, economic and social dimensions as the triple bottom line of sustainability development (SD).

Mieg et al. (2012) reinforce this composition and recognise these aspects as the three fundamental dimensional pillars of SD; the ethos of these pillars is to improve and fulfil real needs of the current generation without imperilling the potential and capacity of people in the future to meet their requirements in accessing and utilising social, financial and natural assets. In this way, sustainability development ensures a satisfactory harmony between financial development, care for the climate and social prosperity which confirms Moldan et al. (2012) and Purvis et al. (2018) arguments.

3 Triple Bottom-Line Dimensions: Environment, Social and Economic

Loviscek (2021) states that these three bottom-line elements of sustainable development have been initiated in "*Cannibals with forks: the triple bottom line 21st century business*," in which Elkington (1997) suggests alternative components of sustainable development; they are people, planet and profit, also known as the 3 Ps. Loviscek (2021) has reviewed 575 articles based on two major databases (Web of Science and Scopus) for the last 21 year starting from 1998. However, Loviscek's research methodology has missed what has been reported by Purvis et al. (2018) from the 1960s and onwards. In addition, Portney (2015) explains that the true meaning of sustainability relies on the contexts and the disciplines where it is implemented. Indeed, Kidd (1992) further indicates that this diversity in the fundamental bases of sustainable development is rooted in different schools of thought. These schools that have acquired the notion of sustainability justifies the change in the triple bottom-line conception (Clune & Zehnder, 2020; Purvis et al., 2018). Kidd is amongst many researchers and academics who deeply historically rooted the origin of sustainable development's triple pillars of economy, society, and environment. He explains that sustainable development pillars are a natural extension of the Brundtland report by the combination and creation of the feasibility and liveability space for humankind taking into account their environmental protection and ecological objectives (Clune & Zehnder, 2020; Purvis et al., 2018). This triple bottom-line dimensions have been further developed following the Rio+20 summit in form of sustainable development goals (SDGs) and the Millennium Development Goals (MDGs), suggesting solutions for the ecological and social problems by the implementation and the development of the economy (Loviscek, 2021; Purvis et al., 2018).

The triple-dimension pillars are an applied and solutions-oriented approach to sustainable development (Clune & Zehnder, 2020). They have effectively helped its application and execution at scale and speed explicit supportability arrangements going from theories to practice. As a result, many techniques, methods and approaches have been created to make their performance better effectively in the architecture discipline at its best (Clune & Zehnder, 2020).

Iyer-Raniga and Kashyap (2021) argue that the architecture discipline has adopted these three sustainability dimension objectives since their appearance to tackle the climate change crisis through mitigating GHGs that are released in the atmosphere. Iyer-Raniga and Kashyap (2021) note that environmental dimension aims at seeking and exploring new solutions, approaches and strategies to improve buildings' efficiency in using energy and water, as well as in decreasing waste through using renewable energies and being environmentally friendly. Therefore, assessing buildings' environmental impact on the environment is a first step that indicates the level of this building's energy performance as well as its carbon footprint. It is well proved that thermal comfort, indoor air and lighting quality are amongst all indicators for a better indoor environmental improvement that has either a positive or negative impact on users' satisfaction and at the same time on the environment (Brown & Cole, 2009; Brownbill, 2019; Gowri, 2004).

Park et al. (2017) additionally comment that the environmental aspect craves at protecting and enhancing the environment conditions. They have indicated that the "Ecology, Energy and Resources" are critical success factors for reducing negative impact on the environment, such as toxic materials and urban heat island, effectively selecting energy saving materials and appliances, respectively, are amongst others to be taken into consideration.

Concerning economic dimension, Iyer-Raniga and Kashyap (2021) advocate the view that there is a potential opportunity of return investment in energy saving, maintenance and operational costs if the overall building design has been well exploited. Park et al. (2017) support studying economic factors by indicating three major opportunities: "Life cycle Cost, Durability and Adaptability," through which a good economic saving can be achieved. Due to the fact that all buildings have a life cycle similar to living creatures—development, introduction/construction, growth and maturity, and then decline and demolition—they suggest that in each stage of the project life cycle, durable and environmentally friendly materials are encouraged to be implemented amongst other products if this building would be considered sustainable.

Finally, social dimension has been getting more attention by academia, organisations and stakeholders from different fields in the last few years (Iyer-Raniga & Kashyap, 2021). This is because of sociopsychological and psychosocial well-being, comfort of the occupants and employees. Additionally, any business productivity or projects' profit

(economic) may well be affected if building-occupant interaction, behaviour and attitude are not taken into consideration (Wu et al., 2016). Mensah (2021) and Park et al. (2017) strengthen the idea and emphasise the importance of the social dimension as any project or business success' is relying on the supply chain that is in turn run by people. Therefore, the importance of the safety, health and well-being including equity, justice and diversity, as well as transparency in product consumer's ingredients/components significantly cannot be stressed more. They are vital for the growth of profitability (Arora et al., 2016).

Since the appearance of sustainable development and its triple bottom line, the architecture disciple has widely integrated and implemented this strategy. This has led to the emergence and development of many specialties and fields such as "Green Architecture," "Green Building Movement" and "Sustainable Architecture and Design," in order to contribute to sustainable development. However, building's evaluation methods are still very important to better rank those buildings according to the sustainability development requirements. Hence, there was a creation and development of (1) "Life cycle" assessment-based methods such as Athena Environmental assessment tool and (2) "Building Environment or Green Building" assessment method based such as the British Research Establishment Environmental Assessment Method (BREEAM) in the UK in the 1990s as the first assessment methods ever created, followed by the Leadership in Energy and Environmental Design (LEED) in the USA.

3.1 The Life Cycle Assessment Tools Base

As Iyer-Raniga and Kashyap (2021) explain that any building or project has a life cycle similar to living species, creation and development, maturity and then decline. Its impact on the environment is also related to these three stages. Therefore, the assessment should be taken into consideration during the construction process, during the operation and then deconstruction and recycling phase too. This cannot be well achieved only if the design process has seriously planned for the whole project life cycle. Hence, Cole (1999) defines life cycle tools with techniques that predict, estimate and calculate different environmental considerations of a project's phase. These project phases consist of the acquisition and production of building components, the exploitation and operation of these products and finally the disposal and demolition of the building. Life cycle assessment tools take into consideration the impact of each phase on the environment and assess the design performance to mitigate the impacts on natural systems (Cole, 1999).

3.2 Pure Criteria Methods Base

Unlike life cycle assessment tools, criteria-based methods classify a selected number of environmental performance criteria with certain weighting and points in order to measure the impact of the building on the environment and its users (Iyer-Raniga & Kashyap, 2021). These methods use assessment as a core function in their approach and a third party for the verification of the results before issuing their final certification (Cole, 1999).

According to Gowri (2004, p. 58) green design is "…*one that is aware of and respects nature and the natural order of things; it is a design that minimizes the negative human impacts on the natural surroundings, materials, resources, and processes that prevail in nature*." It is therefore the aim of green building rating systems to achieve these design goals through a set of performance criteria whilst assessing the entire design. Certainly, all popular green building assessment methods rank the progression of different buildings according to their environment performance in regard to current typical practice requirements (Iyer-Raniga & Kashyap, 2021).

Lee et al. (2013) and Toroghi et al. (2016) additionally comment that green buildings assessment methods whether has been developed by a construction authority, private, public, or international organisation, all assess and verifies buildings' compliance to the sustainability and green development. Mattoni et al. (2018), Wu et al. (2017), Shan and Hwang (2018) indicate that in order to recognise a building green, each of the economic, environmental and social aspects must be implemented in the building design.

Gowri (2004) indicates the five categories that green building systems take into consideration throughout the assessment process. Those categories are, site, water, energy, materials and indoor environment that weather or not consider a building green. Each category has a specific design and performance criteria assigned. These criteria are prerequisite for the achievement of the underline categories. For instance, Table 1 shows a breakdown of LEED rating system categories and their available credits. It is mandatory to meet all the existing prerequisites to be eligible for certification.

Design guidelines are organised to offer heading on the most proficient method to develop current plan rehearses and just certainly recognise its sustainability (Cole, 1999). The assumption that persistent working on the natural presentation of individual structures, the aggregate decrease in asset use and ecological loadings by the structure business will be adequate to completely address the environmental agenda. The decision of the expression "green building assessment" is viewed as a helpful term to pass on this message (Shan & Hwang, 2018). These methods educate individuals how

Table 1 Structure of the LEED rating system

No.	LEED categories	Number of prerequisites	Number of credits	Maximum number of points
1	Sustainable sites	1	8	14
2	Water efficiency	–	3	5
3	Energy and atmosphere	3	6	17
4	Materials and resources	1	7	13
5	Indoor environmental quality	2	8	15
6	Innovation and design process	–	2	5
	Total	7	34	69

From Gowri (2004, p. 58)

eco-friendly and ecological buildings can be and distinguish the economical standards and practices that have been utilised (Kubba, 2010; Pearce & Ahn, 2017).

4 Sustainable Development in Algeria

Algeria is a northern African country looking over at the Mediterranean Sea. The country covers an area over 2 million km^2. This huge area hosts three different climatic zones. From Fig. 1, only, 4% of the total area represents the coastal area with the mild Mediterranean climate of the coast. 10% of the total area represents the high plains in the country with the transactional climate of the northern hills and mountains. Finally, more than three quarters of the total area of the country represent the Sahara extended on 86% represents the desert climate.

Despite the fact that Algeria has a huge potential for the solar radiation to produce solar energy (heat or electricity), the exploitation of the renewable energies in the country is still late and undeveloped. Algeria is one of the three main contributors to CO_2 emission in Africa alongside South Africa and Egypt (Bouraiou et al., 2020). Belkacem et al. (2017) indicate that the CO_2 emission of any building is an indicator of its design and thermal quality. Thus, it could be argued that Algerian's buildings have a poor quality of design and thermal quality, based on the high amount of CO_2 gas emission indicated by Belkacem and et al. (2017). In addition, Kacher and Zermout (2016) also have compared GHGs emissions and energy performance of an ecological house to a house in Tlemcen, one of the cities in north-west Algeria. They have concluded that the emission of the house in Algeria is seven times greater than the ecologic house.

In fact, Algeria is located in the so-called Sunbelt area with a high concentration and potential of solar radiation (Abdelhamid et al., 2011). By taking into consideration the geographical location, Algeria has an important advantage for welcoming renewable energy, like the exploitation of solar energy due to the highest value of solar radiation that cover 80% of the total area of Algeria, wind turbines or wind energy conversion systems, hydro energy, biomass and geothermal energy (Blal et al., 2018; Najjar et al., 2019). From Fig. 2 and Table 2, the daily potential of energy is 16 K TWh, where 98% of it comes from the desert Sahara of Algeria. Yet, more than 99% of electricity production comes from fossil fuel (Nachmany et al., 2015). Sahnoune et al. (2016) and Nachmany et al. (2015) have indicated the significance of the rise in the electricity consumption during the last 12 years starting from 2000. Initially, the electricity consumption escalated from 25 TWh in 2000 to 40 TWh during 2008, and reaching up to 56 TWh in 2012 (Sahnoune et al., 2016). The national electricity power installation is forecasted to reach 30 GW by 2030 (Sahnoune et al., 2016). Kacher and Zermout (2016) confirm that Algeria is very late in regard to the sustainable development and the performance of the impacts of the building on the environment than in Europe in recent years.

Nachmany et al. (2015) and Sahnoune et al. (2016) estimate between 69 and 75% of the global GHG emission in Algeria are mainly from the electricity production. This electricity is primarily used for the heating and air-conditioning in general buildings in Algeria (Boudghene Stambouli, 2007). Thus, the government has put in charge the responsibility of policy advisement, the initiation and facilitation of the implementation of energy efficiency programme and promotion of renewable energy to the National Agency for the Promotion and Rationalisation of the Use of Energy (APRUE) in Algeria during 1997 (Sahnoune et al., 2016). In fact, APRUE is an Algerian public industrial and commercial firm, created in 1985, for the purpose of implementing the promotion of energy efficiency and aiming for the execution of the national energy management policy as a contribution towards the sustainable development in the

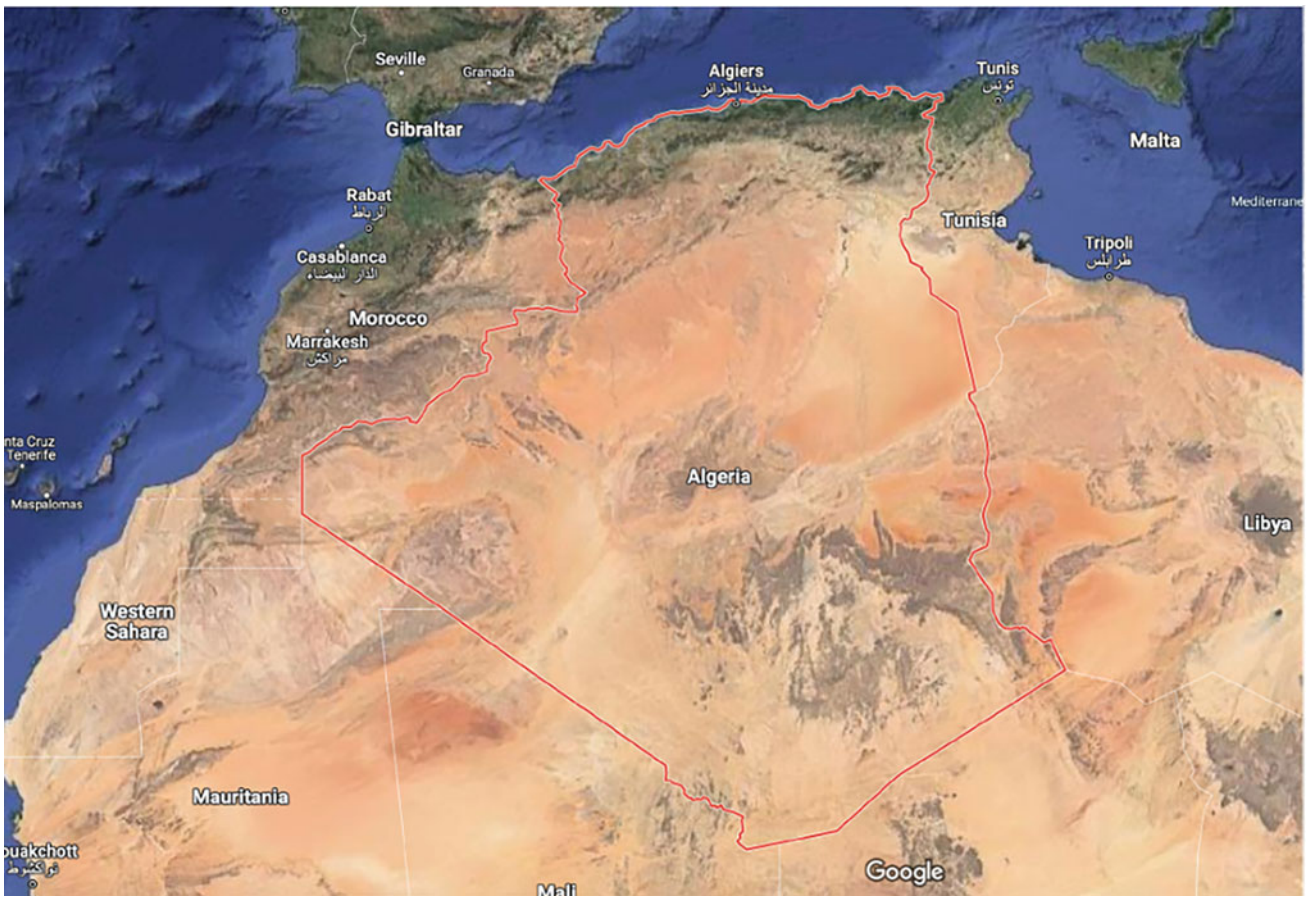

Fig. 1 Algeria satellite view. From Google Maps

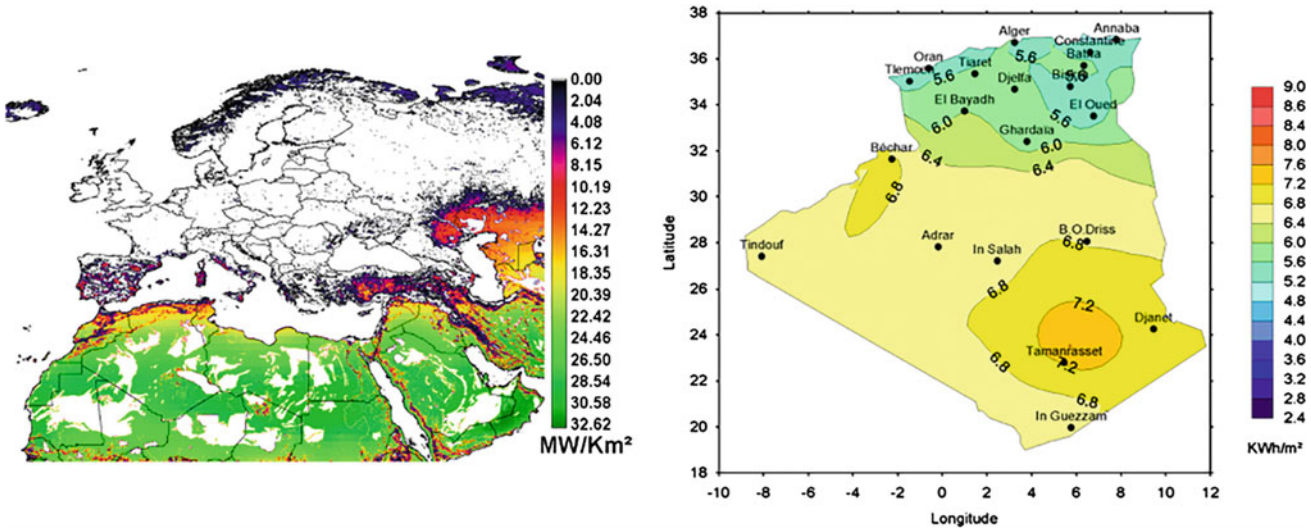

Fig. 2 Potential sites for solar electricity in Algeria. From Stambouli et al. (2012, p. 4449)

country. Its main objectives consist of advance energy reserve funds in all areas of movement, activate different entertainers around the issues and difficulties identified with energy proficiency, advance organisation in setting up energy efficiency projects, offering perceivability to likely financial backers, add to the development of a feasible energy effectiveness and improve and fortify the limits of partners in the field.

Table 2 Solar potential in Algeria

Areas	Coastal area	High Plains	Sahara	Total
Surface (%)	4	10	86	100
Area (km^2)	95,270	238,174	2,048,297	2,381,741
Mean daily sunshine duration (h)	7.26	8.22	9.59	
Average duration of sunshine (h/year)	2650	3000	3500	
Received average energy (kwh/m^2/year)	1700	1900	2650	
Solar daily energy density (kwh/m^2)	4.66	5.21	7.26	
Potential daily energy (TWh)	443.96	1240.89	14,870.63	16,55.48

From Stambouli et al. (2012, p. 4450)

Meanwhile, Algeria has joined MEDENER. The Mediterranean Association of National Agencies for Energy Management was established in Tunis in 1997 as a global non-benefit association for this reason. It unites organisations in the Mediterranean locale accountable for energy productivity and the advancement of environmentally friendly power sources, two critical success factors for the realisation of the energy progress programme. The association is enrolled in Madrid at the base camp of the organisation IDAE (Spain). The secretariat is right now dealt with by its individuals, which hold the administration on a turning premise.

Yet, it unites 11 national public organisations from the northern and southern banks of the Mediterranean:

- The French agency for ecological transition (ADEME) in France, it is a merge between AFME (French Energy Management Agency), ANRED (National Waste Agency) and AQUA (National Air Quality Agency) during 1992, is responsible for carrying out open approaches in the space of the climate, energy, economy and supportable turn of events.
- The Portuguese Energy Agency (ADENE), created in 2000 in Portugal with the mission to create and uphold exercises under open arrangements, to advance the effective utilisation of energy and water, by all and consistently, adding to a more balanced society.
- The Institute for Energy Diversification and Saving (IDAE) established in 1986 in Spain, it works in the space of energy proficiency, sustainable power sources and transport. It instructs the service on the execution with respect to energy arrangements.
- The National Agency for New Technologies, Energy and Sustainable Economy Development (ENEA), founded in Italy in 1960s for the purpose of the development of energy innovations, for which the agency is likewise the facilitator of the Energy National Technology Cluster, energy productivity, environmental change and many more. Since October 2017, ENEA (Italy) is dealing with administration for a two-year term, prevailing to ANME (Tunisia) from the year 2014 to 2016 and ADEME (France) which held the job for two years starting from 2012.
- The Centre for Renewable Energy Sources and Saving in Greece in 1987, its principal objective is to advance innovative applications in the spaces of sources of renewable energy (SRE), rational use of energy (RUE) and energy savings (ES), both at public and global level.
- The Lebanese Energy Management and Environment Association (ALMEE) founded in Lebanon in 1993, engaged with a wide scope of exercises connected to feasible practices and natural issues. This politically autonomous non-benefit affiliation works for better administration of activities and advancements connected to energy and the climate, in Lebanon as well as in the Mediterranean Basin and the remainder of the world.
- The Palestinian Energy and Environment Research Centre (PCE), created in 1993 in Palestine, aims at coordinating of all viewpoints identified with the advancement of environmentally friendly power sources, energy economies and security of the environment in Palestine.
- The National Energy and Research System (NERC) is a Jordanian non-profit organisation created in 1998 for the motivations behind research, improvement, preparation in the fields of new and environmentally friendly energy and increasing the expectations of energy use in the various areas and to advance the usage of sustainable resources in Jordan.
- The National Agency for Energy Management (ANME) created in Tunisia in 1985 aims at implementing the energy management strategies and governmental guidance by discovering alternative energy sources that may be used for a long period in order to ameliorate the energy efficiency.
- The Moroccan Agency for Energy Efficiency (AMEE) was created in 2016 in Morocco for the purpose of promoting and developing the national energy efficiency programme.
- And of course, The National Agency for the Promotion and Rationalisation of Energy Use (APRUE) in Algeria.

During the 1997, CNERIB (the National Centre for Studies and Integrated Research of Building) under Housing and Urban Planning Ministry tutelage has developed the National Regulatory Technical Documents (DTR) unfolded into three sub-documents (Djebbar et al., 2018):

- The DTR C3-2 created on 10/12/1997 that indicates the calculation of Winter Calorific Losses Rules for Housing Buildings.
- The DTR C3-4 created on 18/08/1998 that indicates the Calculations of Summer season Calorific Gain for Buildings.
- The DTR C3-31 created on 12/04/2006 indicating the Natural Ventilation of Housing Usage Areas.

After that, APRUE established a national organisation system for controlling the energy following the 28th of July 1999 law of the energy control. This National Energy Control Programme (PNME) was established on the basis of the main orientations of the government's economic and social development policy as well as energy prospective studies in medium and long term allowing the definition of the challenges and energy management potentials for each sector's economic activities. The PNME defines the orientations, objectives and the means of its implementation; it establishes the framework in which the partnerships between economic and social actors as well as public and private operators. In addition, another key player of the organisation system is the National Energy Control fund (FNME) is responsible for the continuity of the means of this policy from where the tax assigned is the main source. Hence, it is independent of the country's budget.

However, in order to maintain the success of this system, there is a need for a systematic and permanent partnership. Therefore, the Inter-sectoral Committee on Energy Control (CIME) has been created with the strategy to control and manage stakeholders involved in energy control programmes. It is therefore an advisory body placed with the Minister of Energy responsible for organising consultation and the development of public/private partnership lawful to change any policy or resources related to the energy management programme, as well as developing, implementing and monitoring it.

On the 14th of August 2004, the Algerian Government has announced law No. 04-09 relative to Renewable Energy Promotion in the Framework of Sustainable Development followed by another law on Renewable Energy and Energy Efficiency Development Plan 2011–2030 on February 2011 (Nachmany et al., 2015). Boukarta and Berezowska-Azzag (2018), Hamiche et al. (2015), Himri et al. (2009), and Sénit (2008) summarise these two laws into six main strategies that they are considered as the main pillars for the achievement towards the sustainable development according to the Algeria government.

The first strategy of intervention is a project created in 2015 in collaboration with APRUE and GIZ (The Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH, a development agency based in Bonn, Germany that provides international development cooperation and international education work services) folded into two steps:

- The first step is concerned about educating and training architects and engineers and the assessment of the building's energy demand in different education levels such as universities, institutes and schools. This guidebook presents insights of how to protect the environment by using alternative sources of energy, for instance renewable energies and making effective use of them. Algeria's main and only source of energy consumption is based on fossil fuels. Despite the fact that there is a huge opportunity for the exploitation of renewable energies in the country, Algeria has no experience in this discipline. Thus, GIZ partnership aims to support the national government project 2030 using the German experience and know-how for the installation of solar and wind energy farms with the capacity of 5.5 GW.
- The second step is the application of the Document Thermal Regulation (DTR C3-2, C3-4, C3-31). However, for the efficiency running of the use of both DTR C3-2 and C3-4, the Renewable Energy Development Centre (CDER) in Algeria has developed a software called RETA, accessible from an open platform site web (reta.cder.dz), available for the use of architects and engineering, etc., for the purpose of verifying their different building's components as well as the whole project's compliance in both climatic periods' regulations of DTR.

The second strategy is the development of solar water heaters, also known as the Alsol programme. This programme aims for the encouragement of the use of sustainable energy by citizens in order to reduce the rise of energy consumption by 40%. In parallel, it contributes to the mitigation of carbon emissions by 27%. Therefore, the Algerian authorities are supporting this project by a grant scheme of 50% in each installation.

The third strategy is another solution for the promotion of energy use through the improvement of insulation in houses; 100,000 houses per year are the target set by the government in this programme as well as keeping the awareness of consumers the wise use of their energy (cooling or heating) and diminishing energy wastage.

The fourth strategy is the improvement of energy efficiency in public lighting use; this programme aims at the replacement of the mercury lamps with high-pressure

sodium ones. This will save one million Tonnes of Oil Equivalent (TOE) projected by 2030. In addition, the government has forbidden the use of any incandescent lamps instead the government encourages the local production of energy efficient lamps as well as the partnership of foreign products.

The fifth strategy is about the promotion of liquefied petroleum gas fuel (LPG/C) and natural gas fuel (CNG); this will help the mitigation of carbon dioxide emission from vehicles as well as individual and collective transport to preserve a clean environment and reducing air pollution for the improvement of human well-being and towards sustainable development aspects.

The sixth and last strategy considers saving energy through the improvement of household appliance, for instance encouraging the consumers to buy very high energy efficient when it comes to refrigerators and freezers, washing machines, driers, ovens, dishwashers, air-conditioning appliances, boilers, etc.; by doing so, the government has required suppliers to display energy labelling on their products in order to overcome the lack of information of consumers about the performance of what they are purchasing whether it is cost benefits and environmentally friendly or not.

All these six strategies have not contributed to the development of sustainability in the country or even promoted the green buildings; this is because strategies two to six have not been very well supported by the government and have not been well podcasted through the local media amongst the citizens (Boukarta & Berezowska-Azzag, 2018; Kacher & Zermout, 2016). However, the first strategy interpreted into two steps; DTR and GIZ guidebook cannot be the main solution for the development of sustainability. The only reason is that both DTR and GIZ are physical and mathematical calculations of the thermal regulations. Whereas, the development of sustainability and green building should be considered and tailored according to climate conditions of the country as well as the consideration of the triple bottom-line dimensions equally in a bespoke assessment method (Tebbouche et al., 2017).

Although these laws and plans have been set up to contribute to the mitigation of GHG and promote the development of sustainability development and green architecture, it can be seen that the global GHG emissions in Algeria has dramatically augmented from 137.01 MT CO_2 eq in 2008 to 152.89 MT CO_2 eq in 2012 (Nachmany et al., 2015). In addition, data in Figs. 3 and 4 are showing even more augmentation of 156.22 MT of fossil CO_2 emission in 2016 and more than 200 MT CO_2 eq in 2015 (Macrotrends.net). In turn, Fig. 5 reflects CO_2 emissions by the rise of GHGs emissions (Ainouche & Malek, 2005). Remarkably, Fig. 6 justifies Algeria's GHG emission increase by the decrease in the percentage of the exploitation of energy from renewable sources which in turn reflects the lack of APRUE's and CNERIB's strategies in the contribution to the development of sustainability in the country or even promoted the green buildings. The reason why is because strategy two to six has not been very well supported by the government and has not been well podcasted through the local media amongst the citizens (Boukarta & Berezowska-Azzag, 2018; Kacher & Zermout, 2016). However, the first strategy interpreted into two steps; DTR and GIZ guidebook cannot be the main solution for the development of sustainability. The only reason is that both DTR and GIZ are physical and mathematical calculations of the thermal regulations. Whereas, the development of sustainability and green building should be considered and tailored according to climate conditions of the country as well as the consideration of the triple bottom-line dimensions equally in a bespoke assessment method (Tebbouche et al., 2017).

Whereas, a recent research study conducted by Amraoui et al. (2021) on two existing residential buildings located in El-Oued, capital of the Souf region in the desert Sahara of Algeria. Amraoui et al. (2021) indicate that one of these two buildings are considered as a typical unit in the region, and the other one represent the neo-vernacular building. Both buildings are situated in a hot climate zone which is considered the dominant climate in Algeria (Daraf et al., 2016). The research results show that such passive design strategies implemented in those kinds of buildings require no air-conditioning to maintain the thermal comfort required and operate with less energy (Amraoui et al., 2021; Alrashed et al., 2017; Leo Samuel et al., 2017; Al-Sallal & Rahmani, 2019).

Amraoui et al. (2021) indicate that the vernacular architecture has a great potential for sustainability and is considered as climate responsive design to the local contexts without any use of mechanical cooling/heating. As a result, there is no energy consumption for maintaining the indoor thermal comfort. Additionally, Amraoui et al. (2021) consider this neo-vernacular architecture as a green strategy. Such climatic responsive design is recognised as sustainable building design that reflects the local culture and environmental context (Amraoui et al., 2021). Using these proposed strategies such as the dome that replace the common flat roofs, a local material used as a brick called "Tufla," narrow opening and windows, central interior patio for passive cooling and implementations of arches and vaults in a modern mode of vernacular architecture (Amraoui et al., 2021). As a result, a reduction of 23–89% in energy consumption for cooling needs (Dubois, 2001) will be more realistic to achieve sustainable development. This can be an alternative solution, especially in a country like Algeria that is lacking standard and regulation on energy saving (Amraoui et al., 2021) regardless of the plan set by APRUE and CNERIB.

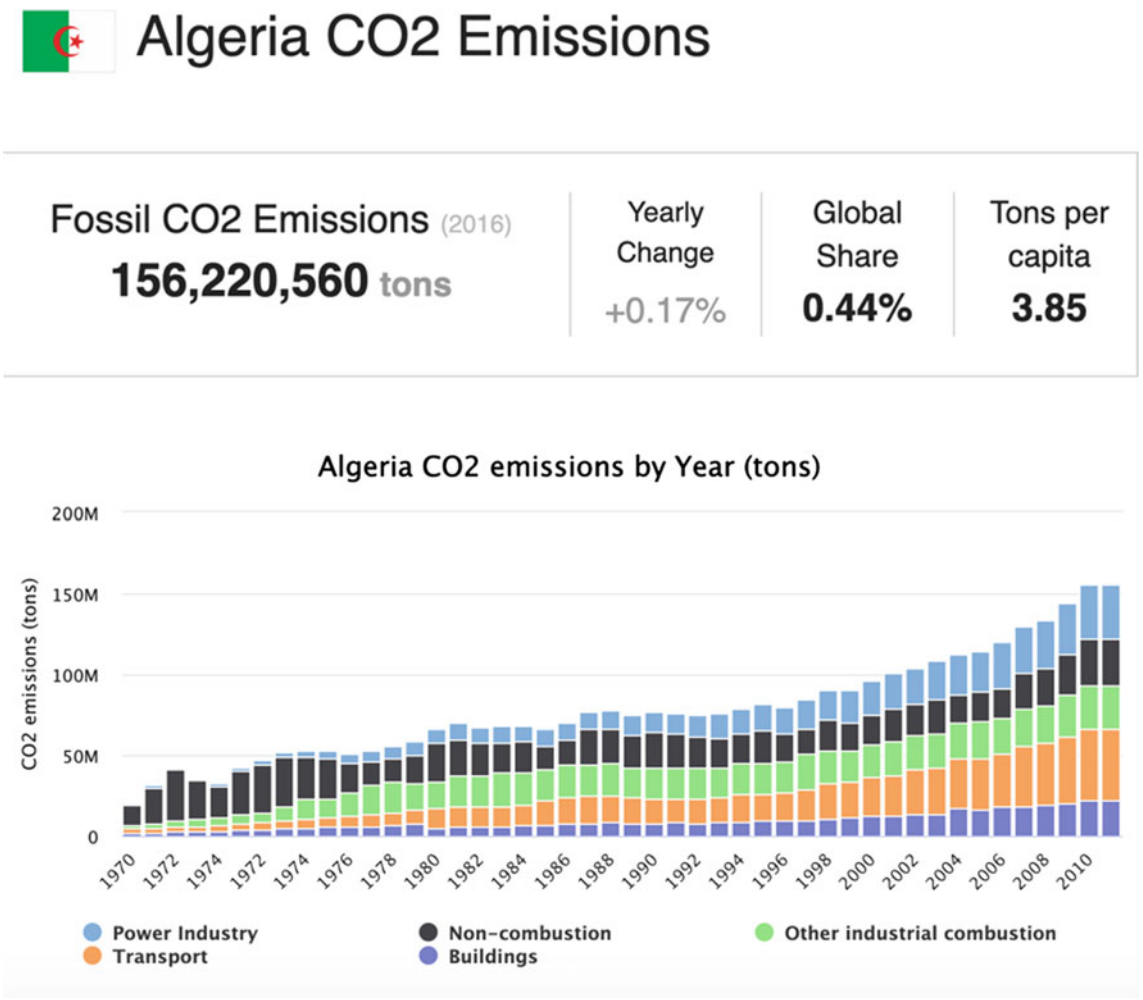

Fig. 3 Algeria CO_2 emissions 1970–2016. From worldometer.info

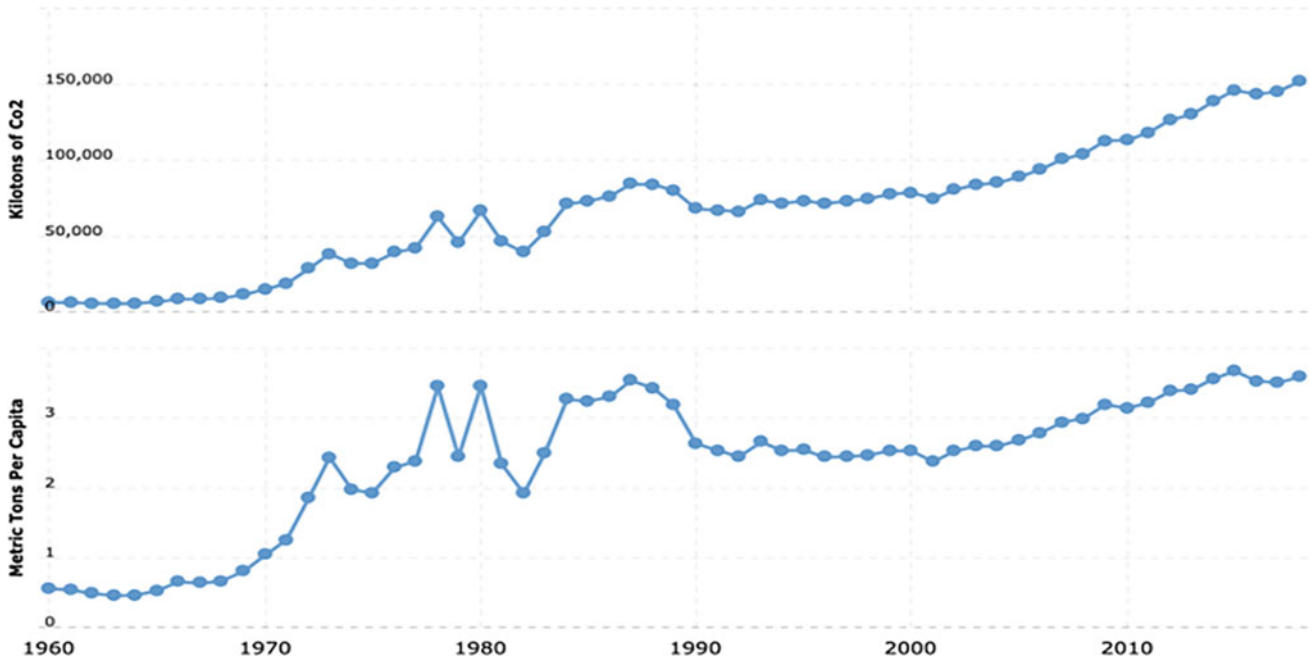

Fig. 4 Algeria carbon CO_2 emissions 1960–2022

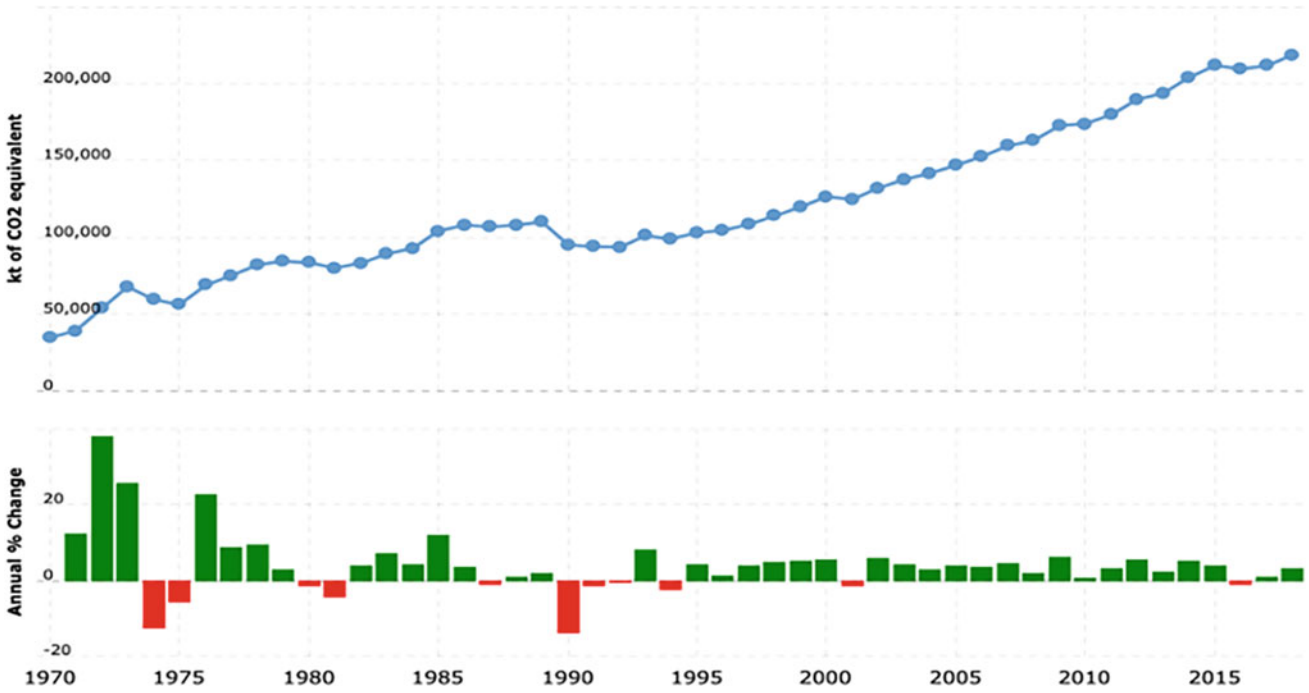

Fig. 5 Algeria greenhouse gas (GHG) emissions 1970–2022. From macrotrends.net

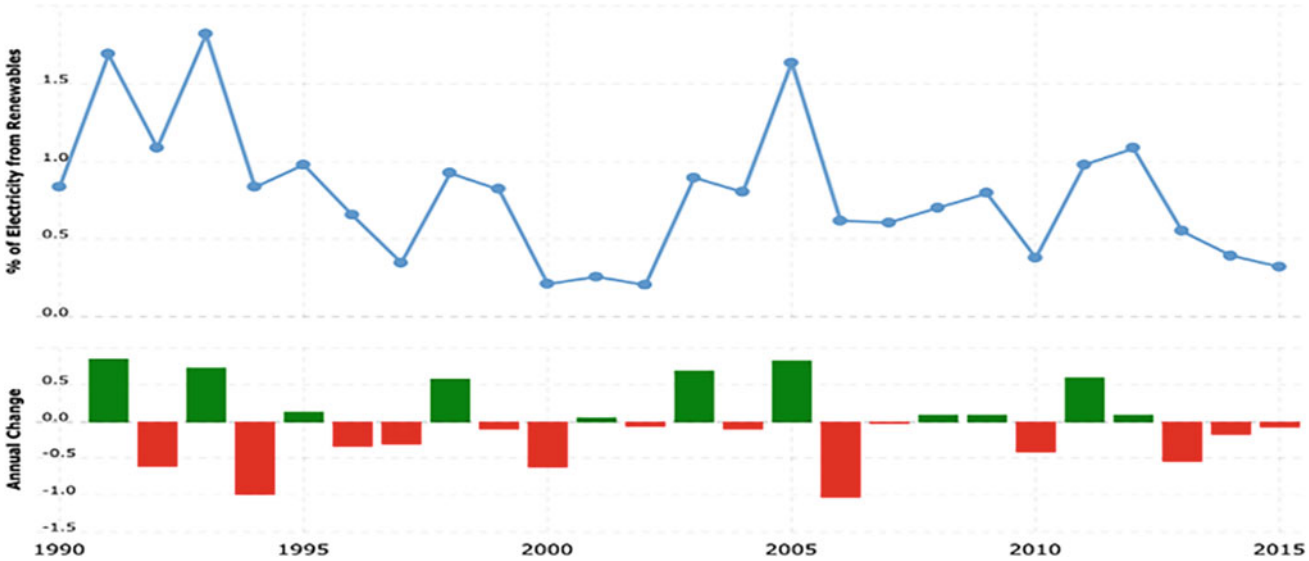

Fig. 6 Algeria renewable energy 1990–2020. From macrotrends.net

It is therefore worth mentioning that the importance and urge of the development of an environment assessment method for the Algerian context cannot be stressed more. The first critical step for mitigation of GHG and the development of green building in the country requires the identification and assessment of the existing and future built environment on how their green performance is doing. Afterwards, proper solutions and techniques will be implemented to upgrade building performance within a proper framework. This framework will then help the implementation and promotion of sustainability development in the country.

5 Lack of Environmental Assessment Method in Algeria

Even though many environmental assessment methods have been developed across the world, Algeria still does not develop its own method (Tebbouche et al., 2017). Many countries have contributed to the design and construction of environmentally friendly buildings, sustainable development and green buildings using alternative guidelines and principles for building construction (Suzer, 2015). These guidelines and principles have the potential to reduce resource consumption during construction, use and building operation as well as reducing negative impact to the environment through the emission, pollution and waste of its components (Ragheb et al., 2016). Thus, environmental assessment methods have been created to meet the required needs (Riascos et al., 2015) with the objective of providing guidelines or criteria to evaluate the green performance of buildings (Cole, 2005). Moreover, Cole (2005) confirms that the environmental assessment methods have provided a considerable theoretical and practical contribution to sustainable development, arguing by their facilitation of the communication between the stakeholders and their changing of the culture of the building industry. Suzer (2015) and Cole (2005) hold the position that environmental assessment methods have become very popular and on demand in the market in relation to the context of the green building. As a result, their positive impact on the performance of the buildings has grown remarkably. Indeed, Cole (2005) points out that building environmental assessment methods have widely contributed to the improvement of the performance of buildings because these methods aim to enhance the use of natural resources to improve indoor environment quality (Riascos et al., 2015). Consequently, these assessment methods stimulated the demand for sustainable certified buildings in developed countries.

Riascos et al. (2015) present arguments to emphasise that the development of sustainability has a positive impact not only on the growing economic but also the social improvement, which means that Algeria main economic on oil and gas will be exchanged by this development (Bouraiou et al., 2020) and the improvement of the social buildings to be environmentally friendly. That means an environmental assessment method must be developed in Algeria because it will generate a green building certificate, which will motivate the use of techniques and material of sustainable buildings in the country. This could lead to the design and building of green in Algeria as well as promote the growth of the economy to reduce the CO_2 emission and the contribution in the eco-friendly buildings.

Tebbouche et al. (2017) indicate that the real question that we need to stress in regard to the sustainable development in Algeria is, "[W]hat strategy should be developed for sustainable building in Algeria?;" they claim that the central issue of the environmental quality of the buildings in Algeria and the renewable energy remains on the development of "Sustainability" and "Green Buildings Assessment Methods," rather than imposing to the architects and engineers to implement the Document Thermal Regulation (DTR) and GIZ guidebook in every project and consider it as a solution for the development of sustainability in the country by these mathematical calculation (Boukarta & Berezowska-Azzag, 2018), nor by importing or adapting existing methods in order to avoid the challenges identified by Sev (2011) and Ding (2008) above. It is true that both DTR and GIZ guidebooks may help reduce energy consumption. But, they need to be integrate into a bespoke environmental assessment method for the country that has a set of criteria that meets all the three pillars of sustainability requirements. Whereas, DTR and GIZ guidebooks are more effective when it comes to achieving a better project's compliance to the criteria set by the environmental performance assessment methods in order to have higher rating in regards the sustainable development as an overall mark assigned to each project.

BREEAM and LEED are considered as the first worldwide assessment methods ever created and are both life cycle and green building-based methods (Shan & Hwang, 2018). These two methods have also contributed to the development and promotion to sustainability development globally (Iyer-Raniga & Kashyap, 2021). Considering the achievements of these two methods, it is necessary to develop Algerian GBRS. Having that said, it is really important to bear in mind that these methods have limitations and gaps that must be considered in order to build a successful bespoke EAM that can work within a multi-climatic country such as Algeria. The section below is critically exploring these gaps and limitations.

6 EAMs' Gaps and Limitations

It is undeniable that environmental assessment methods have widely contributed to the development and promotion of green architecture. During the last two decade, these methods they have gained more popularity, not to mention the economic improvement through creation of many jobs opportunities as well as adding to the credibility of building by initiating the green labels reflecting the environmental performance and its contribution to the mitigation of GHGs emissions (Chen, 2018; Gagnon et al., 1993; Zainine et al., 2021; Zeynalova, 2011). In fact, both studies conducted by Nwodo and Anumba (2019) and Fonseca et al. (2017) show the social, economic and environmental benefits of EAMs.

Many cities have witnessed dramatic growth in their economy when they have implemented and used EAMs by governmental organisations or non-governmental organisations projects.

For instance, take a look at the dramatic growth in the economics of Egypt, especially in the construction industry. The investments tripled during the year from 2015 and 2016 compared to the previous year and jumped from 43.2 to 198.6% in number of investments (Barakat et al., 2017). The construction and building sector witnessed an economic growth rate from 9.7% in the year between 2014 and 2015 to 11.2% in the following year (CBE, 2016). As a consequence, the construction industry contributes 5% of the total Egyptian's GDP and employs more than 11% of the total citizens in Egypt (Esam & Ehab, 2015). This is mainly due to the implementation of the Green Pyramid Rating System (GPRS) in the country. Given the fact that the construction industry is considered a wasteful sector (Daoud et al., 2018), especially during the project construction life cycle. As such, this waste will generates pollution and harm the environment on top of the high costs of construction materials (Azis et al., 2012). Thus, GPRS encourages the implementation and use of environmentally friendly and durable materials that generate less pollution and waste as well as are high cost rentability (Daoud et al., 2018). As a result, more savings from the maintenance and waste, and less overall project's cost.

On the other hand, there is evidence (Awadh, 2017; Cole, 2005; Ding, 2008; López et al., 2019; Shamseldin, 2017; Shan & Hwang, 2018; Suzer, 2015; Zainine et al., 2021) and from many research papers indicating limitations in these methods and their contribution regarding the sustainability development and its pillars from a different perspective. This is mainly due to the importability and the worldwide usage of these methods without taking in consideration the geographical, cultural, social and economic factors on their adaptability by many organisations and methodological developers (Suzer, 2015; Zainine et al., 2021). In addition, it seems like the major challenges identified in the lacks of adaptability present only in LOTUS, Vietnam environmental assessment method, by Nguyen et al. (2017) are very similar to the challenges faced by Green Start in Australia represented by social and cognitive, economic and cost, legislative and institutional, suggested by Chen et al. (2015). It can be argued that both the Lotus and Green Start have been developed based on BREEAM and LEED. Doan et al. (2017) study shows that Green Star New Zealand's, which is also based developed from BREEAM, suffer from complex administration issue related to the cost perception, client demand and benchmarks project, all of which have a relation to the economy (Zainine et al., 2021).

Moreover, many research findings (Awadh, 2017; Ding, 2008; Shamseldin, 2017; Shan & Hwang, 2018) present arguments to emphasise that several countries have not developed their own assessment methods and that there is imbalance weighting in the existing EAMs which was not adapted in the new created methods. The new methods, instead, have completely relied on other earlier methods by importing them directly or requested a modified version by simply adding or eliminating few criteria and changing their weighting and components required in the building without critical evaluation of the possible consequences (Awadh, 2017; Ding, 2008; Shamseldin, 2017; Shan & Hwang, 2018). As a result, the most significant and primary criterion in all assessment methods is the "energy" that belongs to the environmental criteria, followed by "site" and "indoor environment." It is obvious that the most well spread and used assessment methods are BREEAM and LEED: more than half million and quarter million certificates and buildings have been registered under these two methods, respectively. These two methods are also recognised as the oldest one (Shan & Hwang, 2018). Not surprisingly, each of these methods tend to focus on the energy and environment criteria in their weighting system, followed by the site and indoor environmental quality which justifies the hypothesis of Awadh (2017), Ding (2008), Shamseldin (2017), and Shan and Hwang (2018) that more than 70% of existing EAMs arise from the predominant international systems. It can be argued the lacks initiated in BREEAM and LEED have mutated in most of the other developed EAMs for many decades.

Chen et al. (2015) explain that EAMs challenges are frequently grouped under four major factors, technical and design, economic, sociocultural and institutional factors. For instance, they do not take into consideration the different climatic zoning; also, they give more importance to the environment than the economy and society dimensions. For instance, recent research conducted by Alyami (2019) on three different houses situated in different climatic zones in Saudi Arabia. These three houses in Riyadh, Jeddah and Al-Baha are located in hot arid climate, hot humid climate and mild hot mountainous climate, respectively. Through this experience, Alyami (2019) aims to confirm that BREEAM and LEED are unsuitable for the assessment of the built environment in Saudi Arabia. In contrast, he initiated the exploration of the first Saudi Environmental Assessment Method (SEAM) in 2011 at the University of Cardiff as an alternative or a bespoke assessment method for the purpose of this context.

Alyami (2019) used an IES-VE plotting tool for the simulation of the energy consumption in each house for one year. He then equipped each house with 50 m^2 of PV panels. Afterwards, he counted the energy savings for each house. The Al-Baha's house has the most saving percentage of 42.7% with a peak saving of 70.7% during February. Followed by the Riyadh's house with a 30% energy saving per annum and 65% as a highest percentage during February and

March. Finally, Jeddah's house with 25% overall saving percentage and 36.1% as a peak saving in February. For the reliability and accuracy of these results, Alyami has expanded the scale of his experiment by adding nine more houses from each region, and the results remained the same. These research findings are very critical when it comes to assessing environmental performance of these houses from the same country where there is a risk of applying the same grading system, despite the climatic difference. It is clear that the energy saving is different from one climate zone to another even though using the same PV surface of 50 m^2. Therefore, the requirements to maintain the same comfort level are not the same. This means, in order to obtain the same percentage of energy saving, PV panels area has to be extended in the case of Riyadh and Jeddah's houses, or more fossil fuel has to be burned to supply the energy needed, adding more cost in both cases. As a result, an increase in the CO_2 emissions and air pollution, affecting both the economy and the environmental dimensions of sustainability, can happen to maintain the indoor quality in this case.

Unfortunately, there are no existing EAMs that consider the supplement cost added to maintain the same comfort, not the realisation of the extra CO_2 emission. Hence, EAMs are not addressing equally sustainable development pillars which is a fundamental starting point. Alyami (2019) states that it is unfair to adapt or directly use any existing environmental assessment method without taking into consideration the external factors as important as the weather conditions such as Saudi Arabia's. Achieving a certain comfort level in Al-Baha is an easy task compared to Riyadh and Jeddah. It is therefore fair to consider this exertion when assessing any building in regard to their climatic conditions.

A similar study conducted by Shamseldin (2017) for the purpose of discovering the widespread use of LEED in her country Egypt instead of Green Pyramid Rating System (GPRS). She argues that regardless many countries; such as Canada, India, UAE and Malaysia have indeed modified LEED to adapt its use in their country (Whitehead et al., 2015). In fact, it is unreliable to exchange the use of GPRS with LEED for the assessment of building's energy efficiency weather in those countries, or in Egypt. Because the different climatic conditions and zones that LEED takes into consideration on its assessment criteria is very different and not similar to the Egyptian's climatic zones that GPRS has exploited. Whereas, Green Star is a more reasonable methodology and very similar to GPRS just in case of using an alternative assessment method (Shamseldin, 2017). In addition, Awadh (2017) analysed four well spread EAMs (BREEAM, LEED, GSAS, Estidama) in regard to their contribution to the sustainable development pillars; he concludes that all of the four EAMs tend to give more importance to the environmental pillar, whilst the social and economy are the least important. López et al. (2019) have found similar results on analysing 101 methods bundled under three groups. They have concluded that energy and indoor environmental quality which belongs to environmental criteria has a strong presence in all three groups. This can result in disbalanced SD pillars.

It can be argued that social sustainability is of equal importance as the environment and the economy that many EAMs neglect. Mhalla (2020) notes that the Novel Coronavirus appeared in late 2019 in China from a wet market in Wuhan has invaded the globe and become a real threat to the government, citizens and business. This virus has impacted the world economy, air lines, oil industry, many worldwide businesses fell to their knees due to the ill-equipped national health organisations in different countries, as well as its rapid infection that overwhelmed health services globally. There was no alternative solution except staying at home where possible and forced lockdown to the nation. Mhalla (2020) indicates that health conditions have a direct relation to social issues, and social distancing has deeply impacted the stability of economy and environment sustainability; therefore, their performance cannot be promoted unless in a safe society. Hence, the social sustainability relevance cannot be more underestimated.

Sev (2011) and Ding (2008) truly identified most of the challenges faced by Building Environmental Assessment Methods (BEAMs) when they are directly being used or imported with modification to another country or region which is the fact of many existing methods. They indicated six major issues related to the cause of this problematic:

- This building's environmental assessment methods must take into consideration the economic, social and environmental sustainability equally. Cole (2005) was the first who initially observed that the average living conditions in developing countries are much lower than the developed one. Therefore, developed countries have more intentions to reduce building's impact on the environment by keeping the same living conditions. At the same time, building environmental assessment methods are mandatory for the development and promotion of green architecture in those countries.
- For a proper use and recallability of the BEAMs, the criteria and sub-criteria must reflect national, regional and cultural diversity.
- There is a lack of consideration of the historic environment and its protection by many BEAMs. The existing EAM has no criteria that preserve the cultural or historical environment that is critical for social sustainability.
- Many of the existing EAMs are considered as a design guideline. Their assessment process is frequently implemented during the last stage of the final project design;

this will lead to the appearance of many issues in the design that have been already established. Therefore, EAMs implementation has to be as early as possible for allowing a collaboration between the design team and the assessment. Hence, more consideration for the development of appropriate design tools.

- Many EAMs such as BREEAM, LEED, BEPAC and HK-BREAM just to mention a few, they do not include the financial aspect. Therefore, the economic dimension is underestimated. Hence, the sustainability pillars are imbalanced by these EAMs, and projects are less attractive by investors which explain the lack of development of green architecture in many countries.
- Complexity is another issue faced by EAMs, GBTool is recognised as the international assessment method that can be applied in any country. Yet, its simplicity of use is far more considered compared by its 120 assessment criteria. Cole (1999), Larsson, (1999), and Ding (2008) additionally indicate that simplicity of use is a critical successful factor for the effectiveness and efficient adaptation for any development of EAMs. They argue that the number of assessment criteria must be carefully selected. Many sustainable strategies for the reduction of carbon emission include other improvements which their assessment is inevitable. For instance, physical and non-physical indicators can be grouped under the carbon emission assessment umbrella. Similarly, the effectiveness of land use can be linked to overharvesting. Jadhav et al. (2020) indicate in her comparative research of LEED and GRIHA (Indian's EAM) the complexity of using those methods in order to obtain an accurate result of buildings' performance in most of the country on top of their different overall rating of the same building that may cause a confusion in decision-making.

Furthermore, Zainine et al. (2021) explain the relevance of presenting the qualitative and qualitative data separately. This will improve the interpretation of the user to hinge each target to its required level of performance as well as better positioning of the building with respect to its performance (Cole, 1999; Haapio & Viitaniemi, 2008). Whereas, a bad results presentation may lead to a misevaluation and loss of the credibility of the building. In addition, Hossain and Ng (2020) present arguments to highlight the difficulty, if not impossible, to compare between EAMs' results that has a negative impact on decision-making due to the lack of a standardised data base, which is another issue present in EAMs.

Moreover, given the fact that many components are included during the building construction and operation phase, Whitehead et al. (2015) explain that these components such as Information Communication Technology (ICT), batteries and building services are frequently replaced every three to twenty years at least. Many EAMs neglect the assessment of these components which affect the overall environment performance of this particular building. It is therefore important to consider life cycle assessment to data centres in EAMs to improve the accuracy of the level of building's performance (Andrae, 2010).

Clune and Zehnder (2020) confirm the only way that sustainability solutions are effective, and successful is the cooperation of all three dimensions of sustainability development. They continue that through many examples it can be concluded that a sustainable project's failure is always related to a collusion between one or two pillars of the development. The shift from theory to action is inevitable without a sustainable solution and without implementing all its pillars equally. Whereas, Loviscek (2021) holds the position that this shift from theory to action is still unachievable at the present time due the need for additional conditions or characteristics that would help the transaction. Yet, Doan et al. (2017) support the idea and stress that the fourth pillar of sustainability should be the "Institutional Dimension." They argue that this suggestion on the concept dates back to 1995 when first introduced by the Commission on Sustainable Development. Ameen et al. (2015) and Doan et al. (2017) further anticipate that the next future dimension of the development is "cultural dimension" and "Epistemology dimension" based on cities and government's (2010), Redclift (1991)'s assumptions, respectively.

7 Conclusion

Environmental assessment methods are essential to promote green architecture practices in countries with different climatic zones, such as Algeria. These tools/methods should aim to inform sustainable development through seeking a win–win situation between economic growth and the preservation of the environment. The social dimension is no less important than the other two pillars and has to be taken into consideration. Thus, to preserve the natural resources for the present and future generation, it is important to achieve a rationalised balance between the three pillars of sustainable development. Although green architecture practice has witnessed a dramatic evolution around the world especially after the development of environmental assessment methods, Algeria has not created its own assessment method nor contributed to the sustainability development in a proper way. Algeria has instead followed a six-step approach for the development and promotion of sustainability in the country. The DTR document and GIZ guidebook are the most significant solutions in the programme. It is argued that thermal regulations and mathematical

calculation that were introduced in Algeria cannot be considered as a tipping point for the development and promotion of green architecture practice. Thus, it is important to critically recognise the success factors for the development of green architecture in a country like Algeria and how the development of a bespoke environmental assessment method could contribute to the country's sustainable development and green buildings. In addition, it is worth noting that the gap does not exist only within the country's capacity and experience; it is clear that existing EAMs have their limitations and adaptability problems, particularly across different cultural and environmental contexts. In summary, the development of green architecture in Algeria, as a country with a great potential as a source of solar and wind energy, requires developing a sufficient and context-routed environmental assessment method that considers the different characteristics of each climatic zone of the country and tap onto the natural and renewable resources. Therefore, a critical exploration is really needed to fulfil this gap within the country's sustainable development process.

To conclude and to address the EAMs limitations in Algeria, it is crucial to get more insightful primary data regarding the green/environmental architecture practice and its challenges in the country. This provides first-hand information that could help in informing the design of any assessment method. In addition, local and international knowledge and experience of EAMs should be investigated to understand the opportunities, shortcomes and challenges, as well as to identify key criteria that could contribute to the Algerian Environmental Assessment Method. It is important that the criteria emerging from this investigation should be tailored and aligned with the country's environmental challenges and resources and equally addressing the three pillars of sustainability development (Environmental, economic and social).

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