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Status and Prospects of Green Building in the Middle East and North Africa (MENA) Region with a Focus on the Moroccan Context

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Abstract: To promote the development of the Green Building (GB) concept in developing countries, this paper treated the combination of the scientometric analysis of green building research in the Middle East and North Africa (MENA) region, with investigation into the current state of deployment of GB and barriers to sustainable construction practices in the Moroccan construction industry. A scientometric method was used to analyze 159 articles published from 2000 to 2021, and a survey of 167 Moroccan professionals with green building experience was conducted to understand the stakeholders' position. The examination of the dataset reveals the significant contribution in GB research from Gulf countries (Saudi Arabia with 27 articles). The adoption of GB in the Moroccan construction industry is not apparent. Four clusters for the twelve barriers have been identified by the clustering analysis. They were attributed to government, social and awareness barriers, design phase barriers, high initial costs, and technology barriers. This paper provides stakeholders with the necessary knowledge and understanding of the current research, its gaps, inter-regional and international cooperation, and future direction in the MENA region. This could aid practitioners and policymakers in taking the proper actions to mitigate obstacles for GB adoption.

Keywords: scientometric analysis; green building movement; sustainable development; MENA; Morocco

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1. Introduction

The building industry is one of the most important economic sectors, directly or indirectly providing employment opportunities and contributing between 5% and 15% to GDP [1], but also with irreversible effects on the environment [2]. In 2020, the energy consumption of this sector was in the order of 41.40 PWh, representing 36% of global demand, and CO_2 emissions had reduced by 10% to 11.7 gigatons, a level that has not been achieved since 2007 [3]. These decreases are due to COVID-19 lockdowns, the decarbonization of the electricity industry and the energy-efficient buildings (new constructions and renovated existing buildings).

The construction industry, which includes the entire life cycle of a building from conception to demolition, has a significant impact on the environment, economy, and society. Indeed, it is considered to exert an intensive demand for natural resources, consuming 40% of the world's raw materials (sand, gravel, and stone), 25% of wood and 12 to 16% of freshwater [4]. In addition, the activities of construction and operation generate large quantities of solid waste, noise, dust, fumes, and wastewater, which can be harmful to the environment and human health. Therefore, significant changes are needed on the local and global scales to achieve the 17 sustainable development goals and the Global Alliance for Buildings and Construction targets [5].

The Middle East and North Africa (MENA) region is characterized by modernization and rapid urbanization of over 60%, compared to a world average of 52%, which creates a growing demand for new housing [6]. This represents an opportunity to make renovation and new construction more sustainable [7]. However, many MENA countries are currently dominated by conventional construction industries. The majority of the 19 countries in the MENA are classified as arid climates (max 49 °C, min −12 °C), which results in uncomfortable living conditions with high energy consumption for air conditioning and heating. On the other hand, this region is well adapted to use renewable energy sources to reduce the energy loads. However, the economic inequality between the countries in the region may affect the funding of sustainable solutions.

In order, green building (GB) is a strategy to establish sustainability in the construction sector. The recent adoption of the GB concept is a tripartite concern: academic, professional, and governmental. The GB movement has emerged with the creation of green building councils in some parts of the world. These councils were initiated by governments, non-profit organizations, and academic institutions. At present, the number of countries in the World Green Building Council network does not exceed 73 members. In the MENA region, only two has established in Jordan and the United Arab Emirates (UAE), two are prospective in Palestine and Bahrain, and four others are considered emerging in Qatar, Lebanon, Kuwait, and Egypt [8].

Recently, in developed and developing countries, there has been an increase in research publications on GB [9]. Between 2000 and 2016, Zhao et al. (2019) [9], in their scientometric study, analyzed 2980 articles published on the Web of Science using Citespace software. This study was expanded by Darko et al. [10] using other scientific databases, such as Scopus and Google Scholar. The scientometric analysis using VOSviewer V1.6.8 software (CWTS, Leiden University, Netherlands), by Ibrahim et al. (2019) [11] focused only on articles published in construction journals during the period 2000–2018. Oguntona et al. (2021) [12] concentrated on the scientometric analysis and they concluded that green building is still in the embryonic research area with 156 articles in only ten African countries, but did not visualize the network collaboration. However, many countries in the MENA region, such as the UAE, Qatar, Saudi Arabia, and Egypt, have made considerable progress in developing their green strategies in the construction industry. To help stakeholders and relevant practitioners develop a deeper understanding of the knowledge basis, research hotspots of GB research, conduct a visual analyses network of collaboration (2000–2021) to develop inter-regional collaboration (North Afrique with Gulf countries), and highlight future research trends, it is necessary to make a scientometric analysis of the existing research results in the MENA region.

Recent literature reviews reveal that the situation of green building in developing countries is not very mature [12,13], which is a result of the stakeholders' lack of information and awareness. The review also revealed that the main factors hindering the implementation of sustainability in the construction industry are the lack of policies, regulations and finance [14]. Ecological wisdom is that there is still a long way to go to achieve a sustainable construction industry, and this process requires input from all industry stakeholders [15]. Moreover, the barriers that prevent the spread of green building vary from country to country. Factors that are more important in one place can be less critical in a different place due to country-specific characteristics, such as economy, socio-political factors, and environment [16]. This discrepancy arises from reconsidering and readjusting existing green building practices to the needs and capabilities of the country. However, few have attempted to analyze obstacles to GB adoption in developing countries. As identified by a recent critical analysis of green building research by Y. hang et al. (2019) [17]. Therefore, it is crucial to identify the status and barriers of green building in Morocco to develop a proper approach to overcome the barriers.

The first part of this research is based on the scientometric analysis of research publications between the years 2000 and 2021 on the GB theme, in the MENA region. It introduces important information to academics, practitioners, and government agencies in the field of construction sustainability. Therefore, it is the starting point of this paper to grasp and sort out existing research on GBs in the MENA region, especially to explore new research topics and fields from the perspective of time series, identify key literature and the collaborative network, and summarize the evolution trend of related research to form a panoramic knowledge network structure. In a second part, a questionnaire survey was carried out among 169 industry professionals in Morocco to accomplish study objectives. Multiple data analysis methods were used to address the industry's perception of sustainability in the construction sector. Based on these findings, we identify the cluster groups of the barriers to practice sustainable construction.

2. Materials and Methods

Two main approaches were considered for this paper, a scientometric analysis for one and ranking of barriers to the adoption of GB in a local context (Morocco) for the other. The following sections details the research methods.

2.1. Scientometric Analysis

A scientometric review is defined as a bibliometric tool for analyzing and measuring the productivity and quality of academic research [18]. The scientometric analysis can complement the systematic review by finding links between different papers and visualizing datasets (co-authors, co-citations, and clusters) [19]. The data in this study were analyzed using the VOSviewer software (version 1.6.17, CWTS, Leiden University, Netherlands) to visualize the existing interconnections between the bibliometric data. In the bibliographic data collection stage, we used the interchangeable keywords for GB "sustainable/green/ecology", "building/construction", and the name of each MENA country (e.g., "green building" AND "Morocco") and the language section unlimited to "English", for the period 2000–2021. We used the article contents and conference proceedings from the web of science, Scopus, and the MDPI publisher.

In total, 586 papers were found, including 332 conference papers, and 76 reviews. As most attention was focused on the paradigms (barriers, drivers, critical success factors) of GB development and green building rating system in the countries of the MENA region to filter the database. To keep neutral analysis, non-peer-reviewed papers were removed from the list.

As a result, 159 papers were selected for scientometric analysis where published articles represent 85% of the total number of databases.

Figure 1 graphically shows the research framework used in this party. The approach adopted is consistent to achieve the study objectives of (a) identifying the countries and authors who have published the most on GB research in the MENA region, (b) identifying the most cited published articles and (c) mapping future GB research and identify trends.

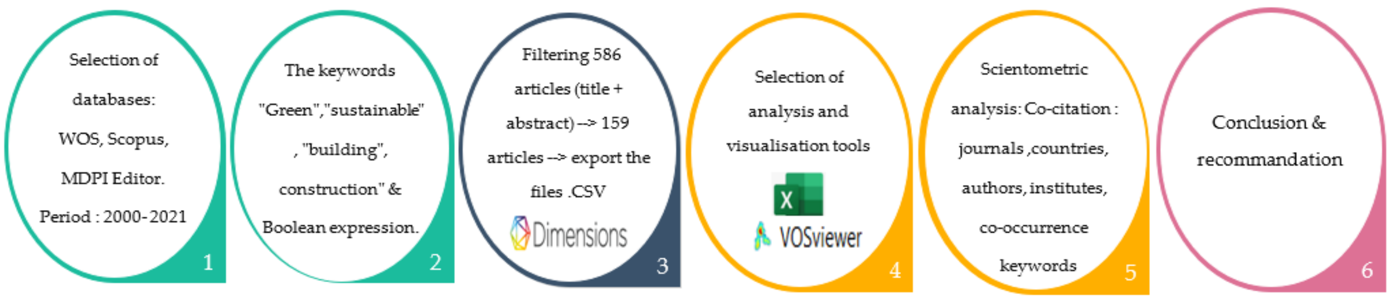

Figure 1. Outline of review design.

2.2. Survey Instruments

A questionnaire survey was used to understand the current situation of GB adoption in Morocco and to classify the barriers that are hindering their deployments. The survey consisting of seven questions divided into three parts was developed and distributed to over 575 Moroccan construction professionals.

2.2.1. Survey Design

The survey structured the parts of the questionnaire according to a funnel logic, from the general to the specific. The first section contained questions about the sustainable construction situation. The second section asked participants to rank the criticality of the most significant obstacles to the adoption of GB in the construction sector in Morocco using a five-point Likert scale from 1 (not critical) to 5 (extremely critical), the questionnaire ending with the profiling of the participants.

For survey sampling, purposive sampling methods were employed (including snowball sampling), and questionnaires were transferred to practitioners in the field of architecture, project managers, engineering, accredited professional, academia, as well as members of the Moroccan Green Building Council. These professionals were selected from both the private and public sectors in Morocco. A total of 302 questionnaires were distributed to respondents manually and by email in February 2022, and 167 completed with a response rate of 55.2%. The profiles of the respondents are shown in Supplementary Materials (Table S1 and Figure S1).

2.2.2. Pilot Study

After the survey has been drafted, three experts (two construction experts and an academic) with at least five years of experience were interviewed in a pilot study. The aim of the pilot study was to check the thoroughness and significance of the survey. The feedback from the pilot study was used to refine the questionnaire (Appendix A).

2.2.3. Data Analysis

The collected data subjected to descriptive statistics and the ranking analysis using SPSS V26 statistics software (IBM Corp., Armonk, NY, USA).

- Cronbach's alpha technique

The reliability of the data was calculated using Cronbach's alpha method. For barriers, the values of Cronbach's alpha coefficient are 0.864. These test results are above the 0.7 criterion [20]. Therefore, the data of this study using the five-point Likert scale are reliable at the 5% significance level.

- Ranking analysis technique

The relative ranking of the GB barriers was established using the mean score. When two or more items had the same mean score, the standard deviation was used to determine the ranking.

- Agreement analysis techniques

Kendall's coefficient of concordance (Kendall's W) is a nonparametric test regularly utilized to determine the overall agreement among sets of rankings [21]. The null hypothesis of the Kendall's W test is that "there is no agreement among the rankings given by the respondents". If the Kendall's W value generated by the test is at a low significance (significance level $\leq$ 0.05), the null hypothesis can be rejected, and it can be concluded that some degree of agreement exists among the respondents [21]. Kendall's ranges in value from 0 to 1, with 0 signifying "no agreement" and 1 signifying denoting "complete agreement". In complement to the Kendall's W test, the analysis of variance (ANOVA) was used to determine whether there were differences in mean scores from the four respondent groups (architects, academics, consultant, and public service managers), and it was crucial to determine whether there are any major disparities between responders' groups [22]. A p-value of less than 0.05 shows that survey groups' opinions on the obstacles in implementing GB are inconsistent. To identify which groups have influenced the consistency of responses in our sample, we use the Tukey test.

- Hierarchical cluster technique

Cluster analysis is a method for regrouping a group of items to one another [23]. A key component of the analysis is repeated calculation of distance measures between objects (barriers), and a dendrogram will be generated, which contains the principal clusters.

3. Results and Discussions

3.1. Scientometric Analysis

3.1.1. Annual Publication Trend

The green building concept has been discussed since 1970 [24], but GB research worldwide has largely been in progress since the first International Conference Sustainable Building in 2000 (Maastricht, the Netherlands) [25]. Indeed, the reporting year is 2000 in this paper. Figure 2 presents the distribution over time of 159 papers corresponding to the topic of green building in the MENA countries from 2000 to the end of 2021. That indicates that GB has received more attention in the last 20 years, as evidenced by the significant growth in the number of papers published and the number of authors per year. The number of papers published per year increased from 2 in 2006 to 25 by the end of December 2021.

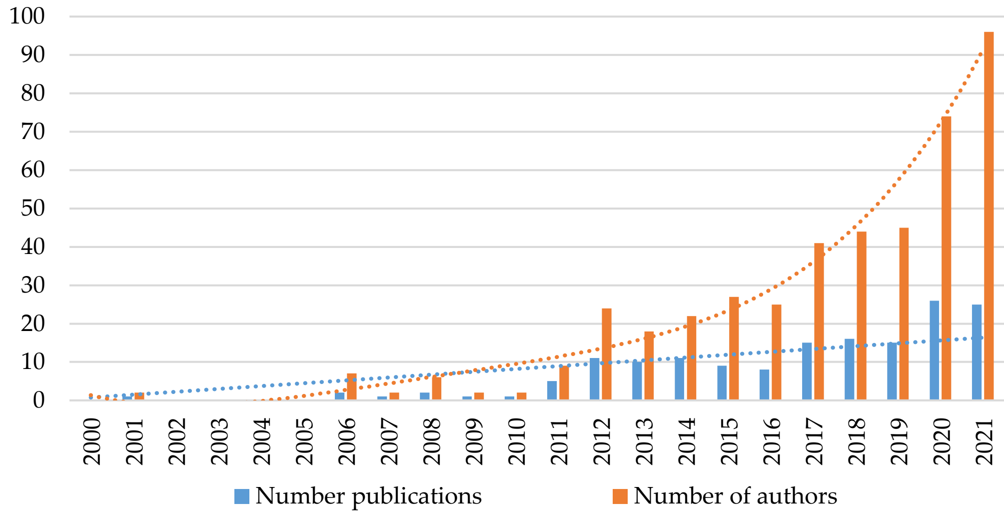

Figure 2. Characteristics of publications from 2000 to 2021.

Between 2006 and 2012, the rate of publication on GB expanded by about 200%. It then declined temporarily in 2015–2016, with a steady increase each year. After 2016, the publication rate shows an annual average of about ten articles, although the COVID-19 confinement period paralyzed academic and research activities. Therefore, the average number of authors per article in the MENA region was 2 in 2001, which has steadily augmented to 3.84 in 2021. Similarly, the average number of references increased (13 in 2001 to 50.92 in 2021), but the quality of the 2133 references in the 159 publications is disputable; using co-citation analysis we found only 324 references mentioned two times, i.e., 1809 references cited only once in the articles. Our choice of academic papers including articles published in conference proceedings may affect the quality of the references.

This trend of increasing scientific production in GB was observed in scientometric analyses globally by previous researchers, such as [12,25,26]. The gradual increase in publications and references reflects an increasingly prominent level of communication in GB over the last 20 years in the MENA region.

However, the low number of green building research in the region, compared to the significantly high number in developed countries [10,27], indicates that countries in the region are still lagging behind in the adoption of GB. The study of Mars et al. (2020) [28] indicated that the main obstacles to the adoption and implementation of GB in emerging countries is the lack of awareness and education of stakeholders, the lack of professional knowledge and expertise, and the absence of green building laws and regulations.

3.1.2. MENA Country Contribution

The contribution of the member countries is analyzed according to the location of the case study or questioning. We have excluded studies that are the subject of regional collaborations between MENA countries. A total of 18/19 MENA countries contributed to the GB research by publishing related articles in the databases.

The territory's productivity is ranked with the total number of papers, which contains papers applying international collaboration. As shown in Table 1 and Figure 3, Saudi Arabia is the largest contributor, with 27 papers, followed by the United Arab Emirates (16), Iran (15), Qatar (14) and the Kingdom of Jordan (13). The result is not surprising, as these countries have universities in the top 300 of the world university rankings. The Times Higher Education (Research) ranking for 2021 puts Saudi universities in the 31–300 range, while Moroccan universities are for example in the 200–400 range. However, when analyzing the citations by country, we find Jordan (315 citations), Israel (148), United Arab Emirates (114), Iran (93), and Saudi Arabia (67) to be among the most influential countries in green building research in the MENA region.

Table 1. Characterization of the contribution of countries between 2000 and 2021.

Country	TP	R	TP (%)	SP (%)	CP (%)	FP (%)	C	C (%)	Ambassador Scientists (%)
Saudi Arabia	27	1	16.98	29.62	22.22	(5/6) 83.33	3	50.00	(13/27) 48.15
UAE	16	2	10.06	56.25	12.50	(2/2) 100	2	100.00	(5/16) 31.25
Iran	15	3	9.43	53.33	26.67	(4/4) 100	3	75.00	(1/15) 6.67
Qatar	14	4	8.80	50.00	35.71	(1/5) 20	0	0.00	0.00
Jordan	13	5	8.17	69.23	23.08	(2/3) 66.66	2	66,66	(1/13) 7.69
Iraq	9	6	5.66	77.77	11.11	(1/1) 100	0	0.00	(1/9) 11.11
Oman	9	6	5.66	33.33	55.56	(1/5) 20	0	0.00	(1/9) 11.11
Egypt	8	7	5.03	87.50	12.50	(1/1) 100	1	100.00	0.00
Israel	8	7	5.03	100	-	-	-	-	-
Lebanon	8	7	5.03	75.00	12.50	(1/1) 100	1	100.00	0.00
Bahrain	7	8	4.40	28.57	28.57	(2/2) 100	0	0.00	(1/7) 14.29
Kuwait	7	8	4.40	57.14	-	-	-	-	(3/7) 42.86
Libya	5	9	3.14	40.00	40.00	(2/2) 100	1	50.00	(1/5) 20.00
Palestine	4	10	2.51	75.00	-	-	-	-	(1/4) 25.00
Yemen	4	10	2.51	50.00	-	-	1	10.00	(1/4) 25.00
Morocco	2	11	1.25	50.00	50.00	(1/1) 100	1	100.00	0.00
Tunisia	2	11	1.25	50.00	0.00	0	0	0.00	(1/2) 50.00
Algeria	1	12	0.62	(1) 100	0.00	-	-	-	-
Syria	0	13	0.00	-	-	-	-	-	-

TP: number of Total Publications, R: Rank, SP: Single country Publications, CP: international Collaboration Publications, FP: the First author's country Publications, C: the Corresponding author's country publications, and Ambassador Scientists: researchers based in other countries through scholarship or brain drain.

We analyze the publications of each country according to scientific and international cooperation. Saudi Arabia is the leader in the number of publications, but 13 of them are contributions from "Saudi ambassadors" working in research units located in developed countries such as the United Kingdom (UK) and Australia, confirmed by the SP (Single country Publications), while countries such as Egypt and Israel are making their efforts to develop scientific research on the subject of GB in their homeland. Other territories, such as Oman, are interested in South–North scientific collaborations (five papers), and there is only one paper with the first author being from an Omani laboratory (Table 1).

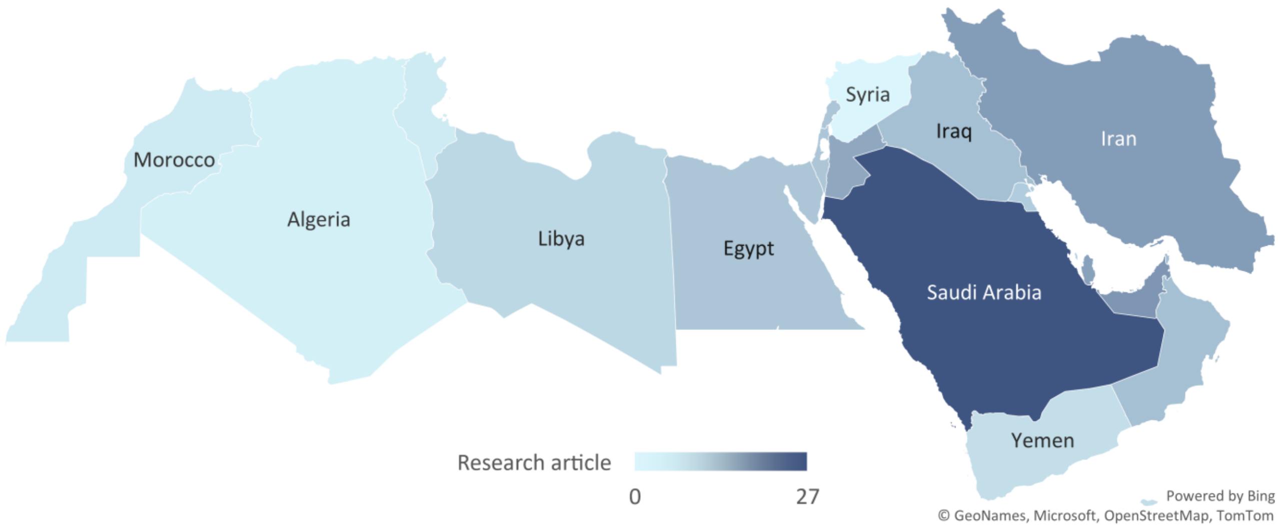

Figure 3. Research articles published per MENA country (2000–2021).

3.1.3. Science Mapping of Research Outlets

This section presents the trend of GB papers by document sources that can be used for young researchers in MENA countries to find the strongest sources of information, and for authors to find the most appropriate journals to publish their papers. In this research, a direct citation analysis was conducted to enable the importance of journals that publish research in the GB. Table 2 shows the top ten journals publishing the research of MENA authors classified by total linkage strength. Among these journals, *Building and Environment* is ranked first for links and the number of citations. This journal is in the top 25% of Scopus metric 2021. Conference papers are published in proceedings indexed in Scopus such as *Energy Procedia* and *Procedia Engineering* between 2009 and 2019.

Table 2. Top ten journals on green buildings classified by total link strength.

Journal	Total Link Strength	Liens	Documents	Citations
Building and Environment (Q1) *	16	6	7	451
Journal of Cleaner Production (Q1)	9	5	5	44
Sustainable Cities and Society (Q1)	9	3	5	197
Smart and Sustainable Built Environment (Q2)	6	4	4	29
Sustainability (Q1)	6	4	9	20
Energy and Buildings (Q1)	4	3	3	114
Energy Procedia (Dispose of in 2020)	3	2	3	31
Procedia Engineering (Dispose of in 2019)	3	3	3	109
International Journal of Construction Management (Q2)	1	1	3	32
Journal of Sustainable Development (NC)	1	1	3	24

* Quartiles (SJR2021); NC: Non-Classified.

To improve the classification, two conditions concerning the minimums for documents of a source and citations have been added, consisting, respectively, of three articles and 20 citations. From 77 identified sources, ten achieved these criteria and were included in the resulting network, which consisted of 16 links (Figure S2 in Supplementary Materials). The three journals *Building and Environment*, *Journal of Cleaner Production*, and *Sustainable Cities and Society* have relatively larger nodes, which demonstrates their impact on GB research publications in the MENA region.

3.1.4. Analysis of Articles Citations

Based on the visualized analysis of 159 papers with VOSviewer (version 1.6.17, CWTS, Leiden University, Netherlands), a document citation network with 13 nodes and 37 links was obtained. The nodes represent the location of the referent author, and the links represent the citation connections between one node and another [29]. Larger nodes refer to the most frequently cited papers. The documents with a citation frequency of more than ten times are selected for analysis.

Figure 4 shows the top frequently cited papers from 2000 to 2021 in the selected 159 articles.

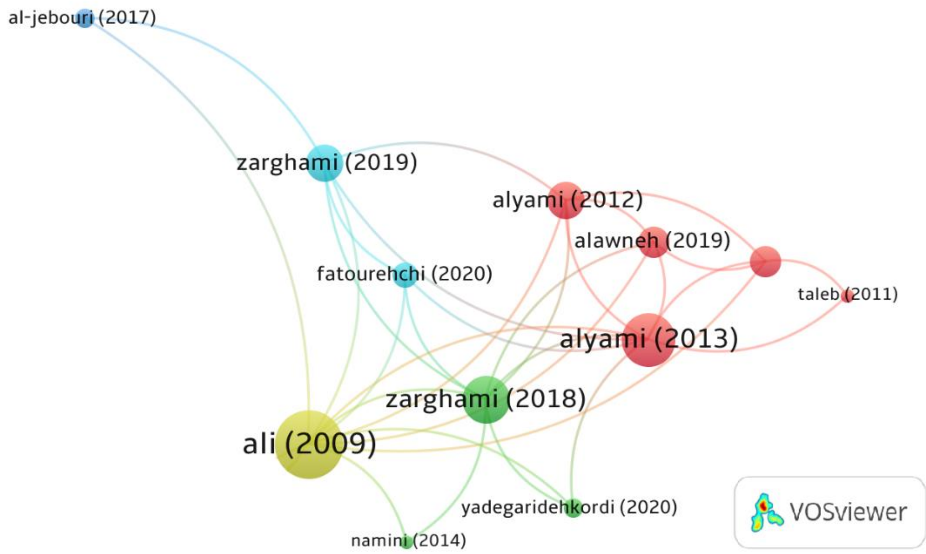

Figure 4. Document citation network analysis.

Ali and Saba (2009) developed a green building assessment tool for residential buildings in Jordan. It is one of the first papers in the field of the development of rating systems, and they proposed "cost and economic aspects" as a new category in sustainability assessment. Three years later, Salih et al. (2012) [30] continued the same topic in Saudi Arabia. They started with the identification of sustainability categories according to climatic and cultural specificities and then developed a consensus study using the Delphi technique to choose the assessment indicators for each category ([31]). The Iranian team Esmaeil et al. in 2018 [32] implemented an Iranian Sustainability Assessment Tool (ISAT) for sustainability improvement in residential buildings. Esmaeil et al. (2019) [33] developed a holistic sustainability analysis framework for residential buildings in Iran, with a well-developed social pillar in a 2020 paper [34].

3.1.5. Co-Occurrence Network of Keywords

The keyword mapping identified the principal research topics. For this, we used "co-occurrence" and the counting method has fixed to ''fractional counting", proposed in the VOSviewer guidelines manual [35]. A total of 3191 keywords were extracted from the titles and abstracts of all 159 articles. The "minimum number of occurrences" fixed at ten was achieved with 68 words. After excluding generic terms such as buildings, country, discovery, etc., the resulting network describing the main clusters of current scientific research in the MENA region consisted of 41 nodes and 796 links in three clusters, as shown in Figure 5. The strength of the link between two words is calculated according to the number of articles that appeared. In addition, keywords that are in proximity indicate their co-occurrence in the database. Each cluster designates the keywords that co-exist most frequently. For example, keywords such as applications, awareness, barriers, construction industry, benefits, implantation, policy, and sustainable construction frequently co-existed. In addition to the keywords in Figure 5, the new domains related to psychology, education, and health have emerged in international green building research [29]. This indicates that GB research becomes indissociable from well-being, occupant behavior, and social development. This indicates a multidisciplinary transversal tendency.

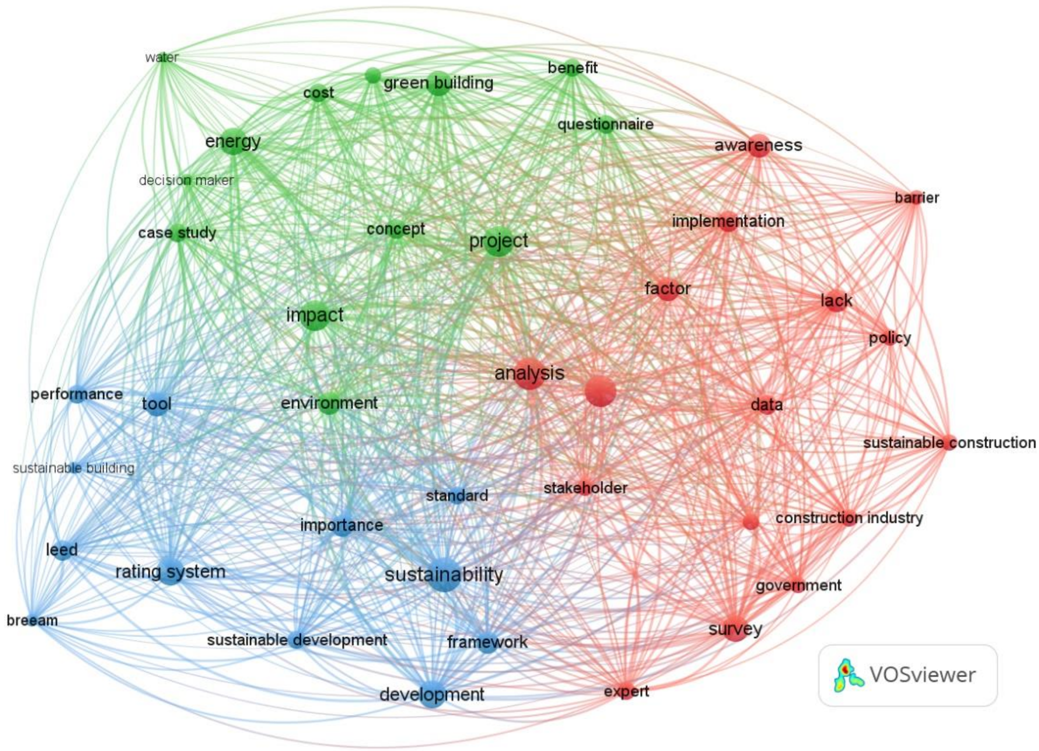

Figure 5. Clusters of main research areas.

As a complement to Figure 5, Table S2 (in Supplementary Materials) presents statistics on the node significance and total link strength of the keywords. The keywords sustainability and green building are in the headline of the scientific research trend in the scientometric analysis in Africa and around the world. In contrast, the MENA studies are more interested in the development of national sustainability assessment systems for buildings in their contexts.

The relationship between research areas is shown in Figure 5, which highlights two major areas of current research in the MENA region:

- Cluster 1 (red): Establishment and deployment of GB.

The development of green buildings faces obstacles commonly found in all countries (developed and developing), but to different degrees. However, the adoption of GB in the MENA countries or other regions of the world appears relatively slow. Generally, in developing countries, the obstacles to the deployment of GB are related to government, awareness, demand, cost, risk factors, and the resistance of stakeholders to accept the changes [36]. However, the government is proving to be a driver and a barrier to the adoption of green building policies. It motivates the adoption of GB with incentives (fast-track approval of construction, property tax exemptions, etc.), enforced GB policies, increased awareness, and a certification process [37]. Currently, governments in the MENA countries do not oblige sustainability in the construction sector, and the same builders choose to construct GB voluntarily. In emerging economies such as Bahrain, the barrier "cost of technology and materials" is the main barrier to developing GB [36], but in Israel, Shoshi and Boris (2020) [38] demonstrated that the consumers most aware of the benefits of green buildings agree to pay 9.25% of the initial costs against 7.74% of the acceptable additional costs for less aware consumers. In the context of countries with developed economies in the region such as the Gulf countries and Iran, the barriers are not economic but mostly regulatory, political, technical, and awareness [39]. However, to meet these obstacles, Darko et al. (2017) [40] illustrated 64 drivers in the literature and categorized them into individual, project, enterprise, and external level drivers. A similar study identified 51 key drivers from an empirical study in Saudi Arabia [41].

- Cluster 2 (blue): Assessment of sustainability performance.

Green Building Rating Tools (GBRTs) are well known as a system for assessing the sustainability of buildings. Thus, many countries have developed specific GBRTs, conforming to their climatic, economic, and social characteristics. The international tools, which have achieved a large recognition in the MENA region, are BREEAM (Building Research Establishment Environmental Assessment Method), LEED (Leadership in Energy and Environmental Design), and HQE (Haute Qualité Environnementale) in the French-speaking countries (Morocco, Algeria, Tunisia) [42]. Although these tools originate from developed countries, they are applied or integrated for deployment in several other countries around the world. For example, the LEED is used in more than 165 countries, which is based on local sustainability priorities (LEED-UAE). In the absence of rating systems in MENA countries, they have started to use previous systems as a basis and a contribution to particularize and revise the assessment tools according to the context. For example, Ali and Saba in 2009 [43], Farah et al. in 2012 [44], and Saleh et al. in 2013 and 2015 [30,31] developed a GBRT adapted to the Jordanian/Lebanese/Saudi context using multiple-criteria decision analysis tools (expert survey, Delphi, AHP, FAHP, etc.) to determine assessment indicators according to local conditions [45]. Nevertheless, in Iran, researchers Hossein et al. (2012) [46] started studies on the development of a sustainability assessment tool for buildings based on environmental, economic and social criteria. Then, in 2018, Hossein et al. [47] designed a national evaluation system of green schools in Iran based on international "school systems", and Esmaeil et al. (2018, 2019) [32,33] developed the categories and sustainability indicators to assess the Iranian multi-family residential buildings.

In parallel, the green building councils of some MENA countries and governmental organizations, such as Saudi Arabia (KSA), Qatar, Lebanon, Egypt, and the UAE have developed their sustainability assessment systems (Table 3).

The results show that most of the MENA countries have a national building sustainability assessment system, except the northern African countries (Morocco, Algeria, and Tunisia). In addition, in certain countries, researchers have tried to develop the different categories and weighting of indicators, but this is not valorized by the current governments, such as Jordan, Iran, and Oman. On the other hand, some countries in the Gulf have deployed GBRT, namely, the MOSTADAM suitable rating system of Saudi Arabia, IS 5281 (Israel), Qatar Sustainability Assessment System (QSAS) and Green Pyramid Rating System (GPRS). The MOSTADAM although only approved in 2019, has already a considerable number of certified buildings (more than 4800), which is higher than other international systems (81 LEED + 1 BREEAM). A digital platform has developed to manage the registration and certification process, with an accredited professional to assist building contractors in the certification phase. The Emirati PRS and GPRS systems in Egypt were created in the early 2010s, the number of certified buildings is still low compared to the international GBRT (29 BREEAM and 295 LEED). This demonstrates the barriers to the deployment of these two systems with the two dominant systems in the region (BREEAM and LEED).

Table 3. Comparison of GBRT developed in the MENA region.

	PRS [48]	QSAS [42]	SRS [32]	SAB [43]	SBRS [49]	IS5281 [50]	Mostadam [51]	GPRS [52]	ARZ [53]	HQE [54]	LEED [55]	BREEAM [56]
Version	V1.2010	V1 2009 V.2019	2018	2009	2017	V1.2005 V.2014	V.2019	V1.2011 V.2017	V1.2011	V1.1996 V.2016	V1.1998 V.2019	V1.1990 V.2017
Organisation	UAE (SAS)	Qatar (GORD)	Iran	Jordan	Oman	Israel (SII)	KSA (SBC)	Egypt (EGBC)	Lebanon	France (Afnor)	US (USGB)	UK (BRE)

Table 3. *Cont.*

	PRS [48]	QSAS [42]	SRS [32]	SAB [43]	SBRS [49]	IS5281 [50]	Mostadam [51]	GPRS [52]	ARZ [53]	HQE [54]	LEED [55]	BREEAM [56]
Category (%) EE	24	24	30.1	23	10	29	27	32	74	10.62	30	19
Category (%) WE	24	16	28.1	27.70	10	17	24	20	8	14.6	9	6
Category (%) SS	13	17	17.5	10.30	9	19	9	10	-	11.5	22	10
Category (%) MR	15	9	15	10.30	9	7	4	12	5	7.08	12	12.50
Category (%) IEQ	-	19	9.3	11.80	12	9	14	16	6	26.11	14.5	15
Category (%) I	2	-	-	-	-	2	4	5 bonuses	-	-	7	10
Category (%) P	-	-	-	6.40	-	-	-	-	-	-	-	10
Category (%) W	-	-	-	-	8	4	-	-	-	17.7	-	7.50
Category (%) M	-	5	-	-	9	4	4	10	7	11.95	-	12
Category (%) CS	-	2	-	-	16	8	7	-	-	-	-	-
Category (%) Eco	-	2	-	10	8	-	-	-	-	-	-	-
Category (%) Other	-	6	-	-	9 Gov	1 Tran	7	-	-	0.44	5.5	8
Number of certified buildings	110 in 2015 [57]	63 (3 in Kuwait)	N/A	N/A	N/A	955 (2015) [58]	4800	2 [59]	-	56 (MENA)	612 (MENA)	12 (MENA)
Fees [1] (USD)	-	1373 + 2 per m^2	-	-	-	No charge	110–750/Unit	-	100 + 6 per m^2	-	9350	5790

WE: Water Efficiency; EE: Energy Efficiency; MR: Material and Resources; SS: Sustainable Site; IEQ: Indoor Environmental Quality; M: Management, I: Innovation; P: Pollution; W: Waste; Eco: Economy; CS: Cultural and Social aspects; Other: regional priority and integrated design process; Governance (Gov); Transport and connectivity (Tran); N/A: Not Applicable.[1] Certification requirement for a new residential building.

A comparative analysis has been conducted between GSAS, PRS (Estidama), LEED, and BREEAM by Omair Awadh (2017) [60]; subsequently, a more general study was conducted by Esmael Zarghami's team in 2020 [42], who compared the green building rating tools in developed and developing countries. Table 3 summarizes the difference in terms of points in each category for the assessment schemes in the case of new residential buildings. The rating systems of the MENA countries gave almost the same attention to the energy efficiency category with a difference of 2% the average score of the international systems (HQE, LEED, and BREEAM). However, the Lebanese system (ARZ) contributed 74% to the "energy efficiency" category in consideration of the electricity crisis in 2010, and accompanied the "National Action Plan for Energy Efficiency and Renewable Energy" [61]. On the other hand, there is a major difference between the weights in the water category in the MENA and international certification schemes. This is related to the availability of water in the MENA region, while the weighting of the sustainable site in the Qatari, Iranian, Israeli and LEED is double that of the other eight countries' systems (Table 3) and IS5281 (Israel) has prioritized the site category with a percentage of 19% due to the limited availability of building land due to the geopolitical situation with Palestine. Although, the category related to occupant comfort and health (IEQ) in hot and desert countries that affect air quality such as Qatar, KSA and Egypt has a higher weighting than in other countries in the region and is of equal importance with other international systems that are more concerned with health and comfort.

It should be noted that these categories need flexibility and regular updating to remain efficient. As demonstrated in the COVID-19 pandemic, sustainability requirements had to change to meet the need for a healthy and comfortable living space for mental and physical well-being [62]. As an example, Aidana et al. (2021) [63] proposed new indicators for the sustainability assessment of residential buildings, such as prevention of virus propagation, private space, and local service (delivery). Environmental sustainability has been almost covered by all certification schemes; however, cultural and social aspects and economic categories are not directly included in the main categories of the rating systems (LEED, BREEAM, and HQE). In contrast, the two rating systems (QSAS and SBRS) of MENA countries have defined these categories as their main categories.

However, in future revisions, the GBRT should focus more attention on service quality and innovation. The results of this analysis of the second cluster show that the establishment of a national sustainability certification at a reasonable cost in this specific context is crucial while taking the balance between the three pillars of sustainability, environmental, social, and economic sustainability (Figure 5).

3.1.6. Scientific Collaboration Networks in GB in the MENA Region

Knowledge of existing scientific collaboration networks in the MENA region can facilitate access to specialists and experts in the field of GB, reinforce existing cooperation and establish new collaborations inter-regionally and South–North. In this perception, an analysis of the network of institutional and national co-authors was conducted based on the 159 articles produced in the MENA region over the last twenty years. The cooperation network is useful to help research partnerships and decision-makers to move towards strengthening and establishing new partnerships through the academic exchange programs and mobility between the MENA territories. The type of analysis was "co-authorship", the unit of analysis was "organizations", and the counting method was "fractional counting". Only nine institutes are found to have collaborative links (Figures S3 and S4). The most productive institutions in GB research, such as Qatar, Israel, and Iran, did not show collaborative research with inter-regional universities, but they have interesting South–North cooperation with the UK, Australia, Malaysia, and the United States (USA). United Kingdom is the most influential country in the GB collaboration network with Saudi Arabia, Iran, Jordan, and Egypt, while Saudi Arabia's greater collaboration with the UK coincides with high-rate contribution by Ambassador Scientists (Table 1). However, USA links with the United Arab Emirates and Qatar are weak. This is explained by cultural, historical, linguistic, and socio-political aspects. For example, the case of the UK, which is the preferred destination for academic mobility or brain drain from its former colonies in the MENA region, especially from the Gulf countries, such as the UAE and Qatar [64]. France seems to be one of the preferred destinations for scientists from North African countries such as Morocco, Algeria, and Tunisia. The researchers from Egypt and Jordan have mainly migrated to Saudi Arabia, prior to the USA [64]. These strategic relations translate into facilitating mobility according to scientific-researcher visa, promoting the training of academics and technology transfer and access to scientific infrastructure. In addition, geopolitical and instability such as in Syria or Yemen and travel bans affect mobility links as in the case of Iran [65].

Consequently, institutions most productive in MENA countries (Saudi Arabia, UAE, Qatar, Iran, Egypt) need to reform their policies to encourage inter-regional collaboration and expanded international cooperation, through academic exchange programs, and researcher mobility.

3.1.7. Framework for Scientific Collaboration

In the previous sections, it has been demonstrated that the academic collaboration between the members of the MENA region is limited. We propose future directions for a common development of scientific research on the theme "green building". It is difficult for researchers in the region to maintain the same rhythm of research development. Therefore, collaboration is considered an approach to develop an innovation in green building [66]. To achieve this objective, the collective vision on scientific research and innovation will have to be developed, taking in consideration the common interests of each country from the region.

Recently, several studies have discussed collaboration in green building under various aspects, such as bilateral cooperation between universities and industries [67], the optimization of collaboration networks in green building projects [68] and the influence of building certification systems on cooperation and innovation in architectural projects [69]. All these studies have identified the importance of inter-organizational cooperation. Therefore, we need to develop a network of research and development collaboration between MENA countries based on the World Green Building Council (WGBC) on two levels:

- At the level of each country in the MENA region

We propose firstly to establish green building councils in the MENA countries and to coordinate their actions with all stakeholders. For example, the United Kingdom (UKGBC) used the Kumu tool to create a map of actors, organizations, and initiatives. The researchers will adopt the recommendations commonly chosen by the councils and specifically to avoid the existing knowledge gaps.

- At the level of a regional (MENA) green building council

The WorldGBC MENA could add other sessions to the annual meeting, to discuss the different reports of the national councils and to define roadmaps according to common topics in the region, particularly to consider the themes that we have demonstrated in the last part of this study, which will be discussed with the research units from different countries and collaborating countries such as the UK, the USA, and Malaysia. Any project for a common vision of scientific research and innovation must be based on a compromise between the national and collective interests of the MENA countries. It will need to focus on national strengths and potential while producing a regional impact. The question of financing is one of the most important. Funding for research projects with a multilateral partnership and the mobility of researchers must be prioritized. To achieve this, universities and other research structures should be encouraged to regionalize their activities.

3.1.8. Knowledge Gaps and Considerations for Future Research

According to the visualization map of the word co-occurrence network (Figure 5), the existing research focuses on the development of sustainability assessment systems in MENA countries. Indeed, there are topics related to the implementation of assessment systems that are not covered in the literature in the MENA region. For example, it is necessary to examine the status of the application of the different GBRT adopted in the region, examining the post-occupancy performance of the certified building and occupant satisfaction. Furthermore, the presence of LEED and BREEAM as certification schemes contrasts with the absence of local schemes (Mostadam, GPRS, and PRS); this requires a careful examination of the perceptions of the project stakeholders, including the designer, contractors, suppliers, as well as occupants.

Nevertheless, there are research gaps related to social responsibility, material sustainability, waste management, and governance in the development of GB projects. However, the MENA region is experiencing severe water stress. Although buildings are directly responsible for only 12% of global water consumption, they are indirectly responsible for a larger proportion of total water demand as the manufacture of building materials accounts for 46% of total housing water demand [70]. Therefore, reducing the life cycle water footprint in the construction industry could be an important objective for future research in the region. Thus, areas of technical and scientific developments have also been neglected in current research, such as the application of BIM, big data, and the application of Information and Communication Technology (ICT) in the GB project, and artificial intelligence and automatization have not yet been fully integrated in the MENA region. In addition, areas such as recycling, reuse, optimization, and building materials are not studied. Meanwhile, much more regulatory effort is needed to move from voluntarism to the mandatory stage.

Finally, the green financing for GB needs the development of new mechanisms in the current funders (GEEREF. MENA-OCSE and Islamic Development Bank).

3.2. Results for Moroccan Professional Survey

3.2.1. The Current Situation of GB Adoption in Morocco

Among the answers to the question on the deployment of GB in Morocco, only a third consider that it is being developed, while 44% of participants review that it is only a start and that 22% consider that it has not started yet. We also analyzed the rate of stakeholders implicated in the process of certification of the environmental performance of buildings.

The questionnaire data showed that 60% of the participants had contributed to at least one certification project, almost 40% had never used the certification systems, while 48% felt that the projects in which they were involved used a sort of sustainable assessment tool (Figure 6). This indicates that these certifications are gradually taking hold in the Moroccan construction sector. Of the 99 participants who had experience with international certification, 43.50% used HQE, 20% applied LEED (the most used worldwide) and 10% of participants chose BREEAM (Figure 6).

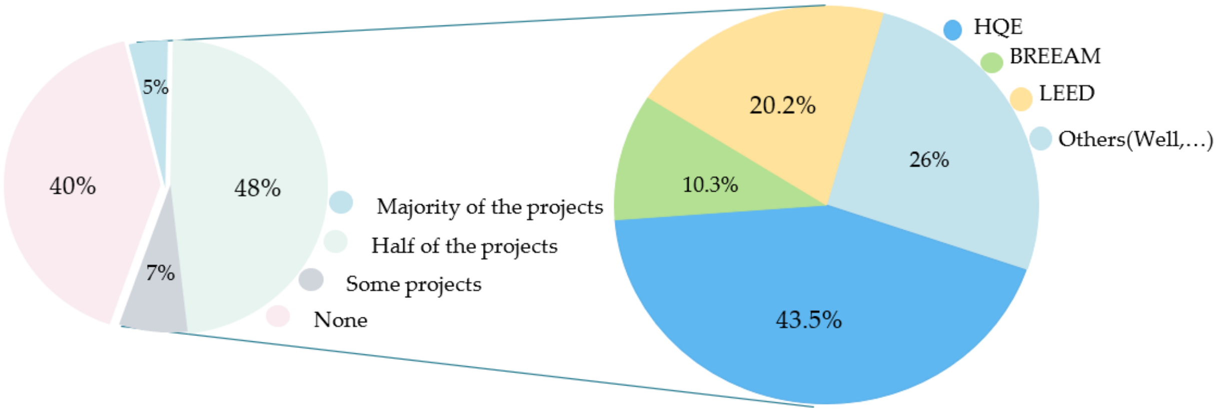

Figure 6. Distribution of Moroccan construction projects according to the use of sustainable assessment tools.

The French HQE reference system was the first tool used in Morocco for its flexibility in the choice of performance objectives as well as for accessibility through the French language and the training provided [71].

3.2.2. Ranking Analysis of Barriers

The reasons for the low development green building certification have been analyzed. For those who thought that green buildings in Morocco are still not sufficiently developed, they were asked to rate the importance of the obstacles based on the Likert scale from 1 to 5 (Table 4). Some of the main barriers to the development of GB in Morocco were selected from the literature [13,28,72] and from word cluster competition analysis (Figure 5).

The range of average obstacle criticality ratings is 1.53 to 3.56. Seven of the twelve initial obstacles, which are shown in Table 4 to have normalized values of more than 0.50, are critical obstacles. "Lack of national GB codes and regulations (B6)" was classified first with the highest mean score (M = 3.56; SD = 0.804), indicating that regulation and standardization are holding back adoption GBs on the Moroccan construction market. The second, as classified by respondents, was "Lack of interest expressed by customers and market demand (B5)", which confirms that green building has not attracted enough attention from construction industry stakeholders. Next in the ranking are "project complexity (B7)" with an average of 3.47, "unavailability of green building technologies (B12)" (average = 2.87) and "lack of government support (B2) (average = 2.84).

Kendall's W values for the ranking of the main barriers indicate that a strong degree of agreement exists between all respondents in each group. There are no statistically significant differences in the perceptions of the criticality of these obstacles by the respondents of the four groups. However, the other barriers (B1, B5, B6, B7, B8, B11, B12) present a statistically significant difference (<0.05) for the classification of obstacles to the development of GB by the four groups. For example, the "architects" group (G1) gives more importance to obstacle B11 compared to the other barriers, unlike the three other groups (G2, G3, G4). This interpretation is confirmed by Tukey's range test, which indicates a significant difference between G1<>G2, G1<>G3 and G1<>G4. Similarly, the "researchers" group ranks initial training in sustainable building in engineering and architectural schools and professional expertise among the top five obstacles.

Table 4. Ranking of barriers for GB adoption in Morocco.

	All Respondents				G1_Architects			G2_Academics			G3_Consultant			G4_State Framework			ANOVA - TUKEY
	M	SD	R	N	M	SD	R	M	SD	R	M	SD	R	M	SD	R	
B1. Lack of professional expertise and training.	2.33	1.351	11	0.39	2.43	1.309	10	3.11	1.449	2	2.10	1.263	11	2.10	1.370	11	0.007 * G2<>G3
B2. Lack of government support.	2.85	1.451	5	0.65	2.67	1.356	7	2.75	1.295	4	2.99	1.526	5	3.20	1.687	3	0.568
B3. Availability of ecological materials.	1.53	1.005	12	0.00	1.36	0.906	12	1.75	1.351	12	1.51	0.837	12	1.60	1.265	12	0.440
B4. Investment cost.	2.50	1.496	8	0.48	2.33	1.476	11	2.46	1.666	8	2.53	1.465	7	2.90	1.595	5	0.741
B5. Lack of interest expressed by customers.	3.56	1.310	2	1	3.86	1.201	1	2.96	1.374	3	3.64	1.307	3	3.10	1.370	4	0.025 * G1<>G2
B6. Absence of national codes and regulations.	3.56	0.804	1	1	3.17	0.908	4	3.75	0.752	1	3.64	0.742	2	4.10	0.568	1	0.001 * G1<>G2 G1<>G3 G1<>G4
B7. Project complexity.	3.47	0.863	3	0.95	3.55	0.889	3	2.68	0.772	5	3.68	0.768	1	3.80	0.632	2	0.000 * G1<>G2 G2<>G3 G2<>G4
B8. Financial risks.	2.77	0.910	6	0.61	3.07	0.973	5	2.32	0.819	11	2.84	0.875	6	2.20	0.632	10	0.001 * G1<>G2 G1<>G4 G2<>G3
B9. Stakeholder resistance to change.	2.49	0.719	9	0.47	2.55	0.803	8	2.54	0.637	7	2.44	0.734	8	2.30	0.675	8	0.723
B10. Attitudes, culture, lifestyle and behaviors.	2.38	0.733	10	0.42	2.50	0.804	9	2.43	0.573	9	2.27	0.755	10	2.60	0.516	6	0.282
B11. Lack of integrated design for lifecycle management.	2.70	0.954	7	0.58	3.76	0.656	2	2.36	0.870	10	2.32	0.733	9	2.20	0.422	9	0.025 * G1<>G2 G1<>G3 G1<>G4
B12. Green building technologies not available.	2.87	0.800	4	0.66	2.67	0.612	6	2.61	0.832	6	3.13	0.817	4	2.50	0.850	7	0.001 * G1<>G3 G2<>G3
Kendall's W Sig.	0.232 0.000				0.322 0.000			0.177 0.000			0.310 0.000			0.329 0.000			-

Note: M = Mean; SD = Standard Deviation; R = Rank; N: Normalized value = (mean − minimum mean) ÷ (maximum mean − minimum mean); Consultant = engineers, accredited professional (HQE. LEED.BREEAM); G . . . <>G . . . : A significant difference between the two groups. * p-value less than 0.05.

3.2.3. Implications of Barriers

The hierarchical cluster analysis (Figure 7) was performed by SPSS statistical software using the Classify module [23]. The first 11 classified barriers in order of importance are grouped into 4 clusters.

- Cluster 1: Obstacles related to government authorities: B6, B2

This cluster is represented by two critical barriers: (B2) Lack of government support and (B6) Absence of specific codes and regulations. In fact, the role of government is essential for the approval and promotion of GB, and this is especially true in developing countries where the deployment of GB is still in its infancy. To stimulate the adoption of GB, the government must take a more proactive role by taking various relevant measures both financial and non-financial. Thus, the lack of funding mechanisms might explain why the higher costs of GBs were also ranked among the top five barriers. The Moroccan government could thus provide more broadly financial incentives (e.g., bank loans) and non-financial incentives (e.g., accelerated authorization) to encourage adaptation to GB. In the United States, for example, many states have adopted incentives (e.g., income tax credit, and density bonus) to stimulate demand from stakeholders. (Example: in California, the Pasadena program submits USD 15,000 in grants for applicants who achieve LEED certification and USD 30,000 for LEED Platinum.) There are other non-financial incentives. The Gross Floor Area (GFA) scheme is an example. The GFA means floor area can be deducted from the total GFA, with the prerequisite of having BEAM certification (Hong Kong) [73]. Currently, the Moroccan government finances green projects through various international funds, or programs for the renovation or construction of new sustainable buildings. This financial incentive is only of interest to industrial building companies whose turnover is less than 200 million MAD (USD 1 = 10 MAD) [74], but it excludes construction projects by individuals. This exclusion deprives part of the population of having access to the necessary financial assistance for carrying out GB.

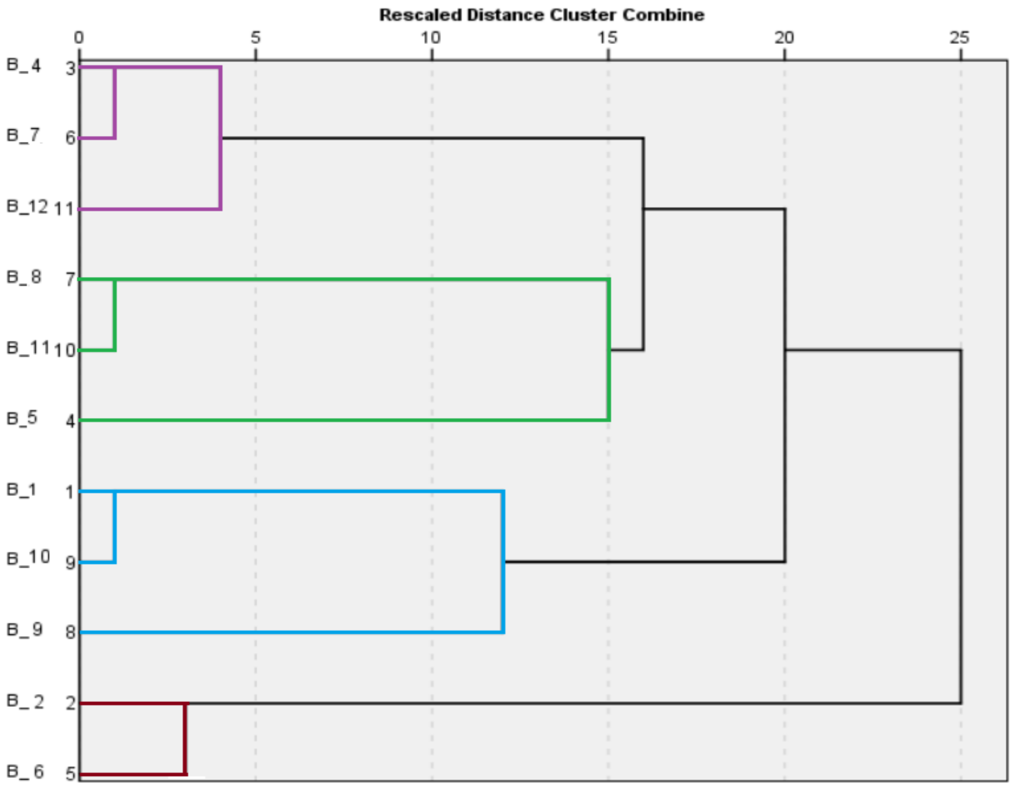

Figure 7. The results of hierarchical cluster analysis.

The lack of a comprehensive regulatory framework for green building is a barrier, although Morocco has made progress in building regulations. The government policies and regulations are crucial strategies to promote GB adoption. This result is in conformity with those of research conducted in Malaysia [75] and Kuwait [76]. This implies that the Moroccan government should play a more proactive role in implementing sustainability in the construction sector by developing policies, a green building regulatory framework and monitoring and inspection mechanisms as well. The lack of green building rating systems and certification programs is another critical barrier in this group. This indicates that governmental and non-governmental organizations should provide support to encourage the construction industry to develop green building rating systems, with much more attention to local sustainability priorities to ensure high effectiveness. Governments funded demonstration projects to accelerate the adoption of GBs and test their performance in a local context; they also help to take a strategy to move from prototype development to wider user adoption.

- Cluster 2: Social and awareness barriers: B1, B9, B10

The critical obstacles in this group are related to the knowledge, information and behaviors of customers and stakeholders. The use of green ecological technologies (GBT) is a principal element in the implementation of GB projects. Consequently, a lack of education of personnel involved in GB projects from conception to completion can have a negative impact on the success of green building projects. It would be challenging for an organization to implement GBTs due to a lack of professionals with the essential knowledge, skills, and expertise. There is currently no specific training available in Moroccan public universities, except for a few private initiatives limited to certain course modules. Strong government intervention is needed.

However, the network of national schools of architecture offers a solid basis for future architects in terms of eco-design. Some universities offer modules related to energy efficiency in engineering courses and specialized masters related to energy efficiency.

Beyond direct energy consumption, the construction sector has a potentially considerable environmental impact, in terms of consumption of natural resources and greenhouse gas emissions. The green building is therefore not only a low-energy building. It must promote the conservatory for biodiversity, contribute virtuously to the management of the water cycle, and consider the health and comfort of its users, while limiting primary natural resources during the life cycle. It is therefore necessary to develop the Research and Development (R&D) of the GBs. S. Yih and B. Li (2018) [77] highlighted the importance of R&D for green ecological technology transfer from university research institutes to local businesses. This development requires significant financial support for the creation of specialized research institutes and centers. This can be achieved through either the public sector or a public/private partnership.

The barrier of resistance to change from conventional construction processes has been recognized as the extremely critical barrier to GB adoption in some latest research ([76,78]), which is not the case for this study. The last obstacle related to "Attitudes, Culture, Lifestyles and Behaviors", corresponds to the socio-political acceptance of green buildings by three components: political decision-makers, investors and the public [79]. When there are not any public demonstration projects, it is difficult to convince the public to provide positive feedback [80]. Social acceptability often predominates the market, although market acceptance will vary depending on regional economic conditions and ecological awareness. Education and training are essential for the development of GB [81]. The different approaches to teach the "Green Buildings" are based on "learning by doing" experiences such as school green buildings from kindergarten to higher education [82]. Morocco launched the Eco-School (Label) program in 2006 by the Foundation for Environmental Education. This is a proactive teaching strategy, which engages students in role play and promotes active learning to evaluate their common living space, with the aim of improving it and remedying the various environmental issues (energy efficiency, water, air quality, biodiversity, and climate change). This eco-school program now has 1930 schools registered and more than 875,522 eco-schoolchildren who adhere [83]. Studies have shown that promotion and communication strategies, such as television programs, generic marketing, and education and training programs are effective for promotion [84]. More efforts are therefore needed to develop awareness of stakeholders in the construction sector through continuing education on the environmental, social, and economic aspects organized by the building trades federation, as well as to strengthen the green skills in engineering training.

- Cluster 3: Design phase barriers: B5, B8, B11

We observe that the upstream professionals (architect, consultant) of the construction have ranked the lack of interest on the part of customers as the critical obstacle to the development of sustainable buildings. Generally, when the green market is getting started, there is typically little consumer demand [85]. This indicates that most private clients and managers of real estate companies are not convinced that it is necessary to demand such ecological measures. Hence, increased awareness of the benefits would drive the market demand for GBs.

The lack of an integrated building design is perceived as the second major obstacle to the deployment of GB by the group of "Architect" respondents. Since the high complexity of green building construction processes, and the multidiscipline employer, it is necessary to restore an Integrated Design Process (IDP) to define and mitigate all issues (rework, clashes, and misunderstandings) and the definition of risks in the design and construction process. Demonstration projects have shown the importance of IDP in GB projects in the United States, Denmark, and Germany [86]. Thus, in the United States, the "Integrated Project Delivery Guide" was prepared by the American Institute of Architects, to strengthen the skills of the architect in the management of design teams and provides a platform for collaboration. Another IDP guide, the Integrated Design Build Method (IDBM MT), was developed in Denmark by practitioners as a sustainable architecture approach based on collaboration between academics, engineers, and contractors [87]. For example, the guide project for sustainable construction initiated by the National Council of Architects of Morocco should be inspired by the experiences of developed countries.

- Cluster 4: Economic and technology: B4, B7, B12

Cost has consistently been a major obstacle to adopting green practices in the construction sector, not just in Morocco but also in many developed countries [88]. Green building projects generally cost more than conventional buildings [89]. The overhead barrier can also be overcome by assessing the life Cycle Cost (LCC). For example, a study in Sri Lanka demoted that in terms of life cycle costs, green buildings are 17% cheaper than conventional buildings [90]. The benefits of GB come mainly from energy and water savings, and productivity increases in the operation phase, which can last several decades. The return on investment typically takes 20 years and accrues to the end owners or users of the building, not the developers [91]. Inflation, volatility of interest rates and currencies, and uncertainty in investment estimation have an effect on the opportunities to invest in sustainable projects [92]. Therefore, it is recommended that governments take a proactive role in improving the current situation and provide financial incentives and subsidies. Risk compensation, subsidized loans, and the security of a slightly higher return on investment would stimulate corporate behavior.

In green projects, certain materials, equipment, and installations specifically intended for green construction are likely to be imported from abroad, requiring several weeks or months to be delivered to site. In addition, few alternative sources of supply make replacement difficult in the event of a delay in shipment. Thus, any technical incident on the delivery of imported materials, especially those concerning critical activities in a schedule will have a negative impact on the project schedule [92]. This suggests that the current supply chain related to the GBs industry is immature with a shortage of local suppliers.

3.2.4. Comparison with MENA and Developed Countries

The results of this survey were compared with other surveys carried in some countries of the MENA region and two developed countries, the USA and the UK (Table 5). Extending the comparison with leading countries in the field, such as the United States and the United Kingdom, and countries in the MENA region provides useful information for policy makers and practitioners in these countries.

Table 5. Occurrence of the top five barriers to GB deployment from Morocco in selected countries.

Top Five Barriers to GB Adoption in Morocco	**KSA** [93]	**Iran** [94]	**Oman** [95]	**Jordan** [96]	**US** [88]	**UK** [17]
Lack of GB codes and regulations (Rank 1)	Rank 2	×	×	Rank 2	×	×
Lack of client interest and market demand (Rank 2)	Rank 5	Rank 1	Rank 4	Rank 1	×	×
Complexity of the project (Rank 3)	×	Rank 2	Rank 5	×	Rank 1	Rank 2
Unavailability of green building technologies (Rank 4)	Rank 1	×	Rank 2	Rank 3	×	×
Lack of government support (Rank 5)	Rank 2	Rank 4	Rank 3	Rank 4	×	×

Obstacles that did not place in the top five hurdles in any of the selected countries are marked with the "×" symbol. It is interesting to note that the obstacles "lack of awareness and market demand" and "lack of support from governments" are the only obstacles appearing among the five main obstacles to the adoption of GBs in Morocco and in the four countries from the MENA region selected, with a similar rank. Higher investments and economic instability are the most critical barriers to green building adoption in developing countries. This comparison reveals that the most critical GB adoption barriers in MENA countries differ globally from those in the two developed countries of the US and the UK. The reason for the differences could be attributed to the fact that these two countries started the development of green buildings in the 1990s and have matured through the development of mandatory procedures (standards) and incentive and awareness mechanisms.

4. Conclusions

Increasing concerns about sustainability in the building industry have become crucial interests of practitioners, government institutes, and multidisciplinary research teams. The number of papers on the green building topic has been increasing over the past two decades, but with great differences between regions of the world. The MENA region is still hardly involved in this evolution, with 159 articles on green construction published between 2000 and 2021, with significant progress made in the Gulf countries. In terms of national analysis, Saudi Arabia (27), UEA (16), Iran (15), Qatar (14), and Jordan (13) are the most influential countries in green building research. In terms of the subject of GB research, keywords such as sustainability performance, rating systems, energy, standards, policies, survey methodology and cost are relatively important. However, certain topics still need to be studied more; these include the level of deployment of the MENA certification, water/ecological footprint in industrial buildings, integration of BIM and ICT for the implementation of green buildings, project management and financing mechanism for green buildings. To complete the study on the MENA region through a case study, 167 Moroccan construction experts were invited to express their opinion on the status of green construction and the criticality of the 12 important barriers to the deployment the GB in Morocco, using a five-point Likert scale. The results indicate that seven of the twelve barriers identified were critical. The most critical obstacles are the lack of codes and regulations, the lack of interest expressed by customers, the technical complexity of GB projects, the lack of government incentives and the lack of innovative financing, for example, bank loans. These critical obstacles to the adoption of GB in MENA countries vary mainly from those of two developed countries: the United States and the United Kingdom. The findings of this article not only contribute to fill a knowledge gap on barriers to green building in developing countries such as Morocco, but also provide a valuable reference for other countries in the MENA region to help policy makers and practitioners to respond appropriately to mitigate barriers to GB adoption. It is also recommended to establish inter-regional collaborations between universities in MENA countries and international partners to facilitate the adoption and implementation of the GB concept in this region.

This study still has some limitations that should be mentioned. The criticality rating performed in this study was influenced by respondents' attitudes and experiences, as it was subjective. Although the sample size of this study was sufficient to perform statistical analyses, it was limited to Morocco. Thus, a survey of a larger sample of MENA countries would be useful to see if the results differ significantly from those reported in this study. This would make it possible to specify the strategies to carry out a wider adoption of GB.

In summary, to promote GB and remove the main barriers in the MENA region, governments should play a more proactive role by developing policies, green building regulatory frameworks and monitoring and inspection mechanisms with rating systems and certification programs included. These lasts items must be adapted to the specificities of each country, taking particular account of the socio-political aspects for the acceptance. Substantial financial support for the creation of specialized research institutes and centers is also necessary. This could be achieved either through the public sector or through a public/private partnership.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su141912594/s1, Table S1: Profiles of the respondents; Figure S1: Years of experience of participants; Figure S2: Network (Total link strength) of publishing scientific journals in the MENA region (2000–2021); Table S2: Comparison of research areas in the MENA region, Africa, and the world; Figure S3: Collaborative network of institutions in MENA region; Figure S4. Map of country co-authorship network based on "Total link strength".

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Appendix A The Questionnaire Survey "The Current State of Green Building Development in Morocco"

Section A: Generality
Please share your opinion on the state of the art of green building in Morocco:

1. Has not yet started
2. She has just started
3. In development
4. Very mature and internationally advanced

Of these international environmental building certification schemes, which have you used before (multiple answers possible):

1. LEED
2. BREEAM
3. HQE
4. Others

In the projects (buildings) in which you have been participating, how many of them have used the certification tools:

1. Most of the projects
2. Half of the projects
3. Some projects
4. None

Section B: Barriers for Green building (GB) adoption in Morocco
Please rate the criticality of the following barriers in the deployment of GB in Morocco construction projects:

	Not critical	**Slightly critical**	**Moderately critical**	**Critical**	**Extremely critical**
B1. Lack of professional expertise and training	❏	❏	❏	❏	❏
B2. Lack of government support	❏	❏	❏	❏	❏
B3. Availability of ecological materials	❏	❏	❏	❏	❏
B4. Investment cost	❏	❏	❏	❏	❏
B5. Lack of interest expressed by customers and by the market	❏	❏	❏	❏	❏
B6. Absence of national codes and regulations	❏	❏	❏	❏	❏
B7. Project complexity	❏	❏	❏	❏	❏

B8. Financial risks	❏	❏	❏	❏	❏
B9. Stakeholder resistance to change	❏	❏	❏	❏	❏
B10. Attitudes, culture, lifestyle, and behaviours	❏	❏	❏	❏	❏
B11. Lack of integrated design for lifecycle management	❏	❏	❏	❏	❏
B12. Green building technologies not available	❏	❏	❏	❏	❏

Section C: Respondent profile
Please provide the following information.
What is your profession:

1. Architect
2. Civil, structural engineer
3. Energy engineer
4. Environmental engineer
5. Consultant
6. Project manager
7. LEED/HQE auditor
8. Public service managers
9. Academics
10. Others __________

Your years of experience in the construction industry:

1. ≤3 Years
2. 4–10 Years
3. 11–20 Years
4. >20 Years

City: ____________

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