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Bibliometric analysis in the international context of the "Construction & Building Technology" category from the Web of Science database

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HIGHLIGHTS

- Characterize research activity in the field of "Construction & Building Technology" in the last 15 years.
- Study focus on "Construction & Building Technology" category from 1997 to 2011 from the Web of Science.
- Analyze all the articles and reviews through bibliometric analysis.
- Establish a ranking of leading countries and research centers in this field.
- Analyze the evolution of the most important research topics.

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ABSTRACT

This study analyzes the evolution of publications in the category of "Construction & Building Technology", the research activity carried out by countries and the most productive research institutions, and the internationalization and diffusion of the journals of this category. Reference levels have been designated for productivity indicators, diffusion, and impact, which must be taken into account for the evaluation of the merits of researchers and research institutions. Research trends within this category have also been identified, allowing us to identify current themes, as well as those that have ceased to arouse the interest of journals and researchers. The characterization of productivity and publication quality of each country makes it possible to compare the importance of each study in the construction sector to other countries. This may be useful for evaluation of the effectiveness of national policies and investment in this sector. The characterization of productivity and quality of the research institutions could prove to be highly useful in analyzing the effectiveness of the strategies being carried out by each center. Moreover, this will help researchers in selecting quality research institutions for collaboration and work. Journal analysis could be useful for editors when comparing their effectiveness of diffusion and internationalization to the work of other journals.

1. Introduction

The boom of scientific activity in the last few years has also increased the interest of researchers and institutions in publishing their studies [1]. The number of journals and publications in ISI databases increases every year. The ISI databases, particularly the Science Citation Index, are used for measuring research performance [2]. The articles published in journals of the Science Citation Index and the derived bibliometric indicators are parameters utilized in the majority of international rankings of universities and research centers. They are also used by national accreditation organisms, which makes it necessary for potential candidates to have a sufficient number of articles published to have access to certain posts and professional promotions. On the other hand, it is essential for indexed journals to increase the diffusion of articles that are published since by increasing the number of citations they will succeed in increasing their impact factor and international importance.

In spite of the importance that is granted to these indicators, few tools exist for researchers, research institutions, and countries to evaluate the weighted productivity and impact of the whole of their work with respect to others in an area of specific knowledge and in a temporal context and specific territory. This information could be useful to design and evaluate their strategies, investments, or investigative policies.

In order to analyze globally the previously mentioned parameters, it is necessary to resort to bibliometric analysis. Bibliometric analysis includes quantitative and visual processes to identify patterns and dynamics in scientific publications [4]. Bibliometric analysis has been guided by the objective of revealing global trends

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in certain areas of research [5–7]. Current research mainly intends to fulfill three objectives: reveal author trends, institutions, countries, and research categories; summarize research trends from other perspectives; and offer a sample of research development that may serve as a guide for future research [6,8–10].

In the area of construction and building technology, research results are articulated at a global scale through the "Construction & Building Technology" category in the Web of Science database. According to the definition of Thomson Reuters, "Construction & Building Technology includes resources that provide information on the physical features and structure design (e.g., buildings, dams, bridges, tunnels) and the materials used to construct them (concrete, cement, steel). Other topics covered by this category include heating and air conditioning, energy systems, and indoor air quality". According to data from the Journal Citation Reports (JCR), in 2011 the "Construction & Building Technology" category included the publications of 56 journals, with an IF between 0.085 and 3.382. In this category, there is only one prior bibliometric study, which limits its study to one country (Spain) and a 10-year time period [3].

In this context, we introduce the methodology of research analysis carried out in the construction and building technology sector that will be of use in filling the existing information gap. For this reason, a bibliometric analysis of the information contained in the Web of Science for the last 15 years (1997–2011) has been undertaken. More specifically, the research carried out characterizes the global evolution of research published; analyzes the evolution of thematic research during these 15 years, identifying new areas of interest, as well as those that have suffered decline; analyzes the evolution of weighted production and the impact of publications identified through the impact factor and number of citations received; establishes a rank of countries and research centers leading in construction and building technology; analyzes collaboration among different countries and research institutions; and studies the nationality of researchers that publish in each journal and its relation to quality indicators.

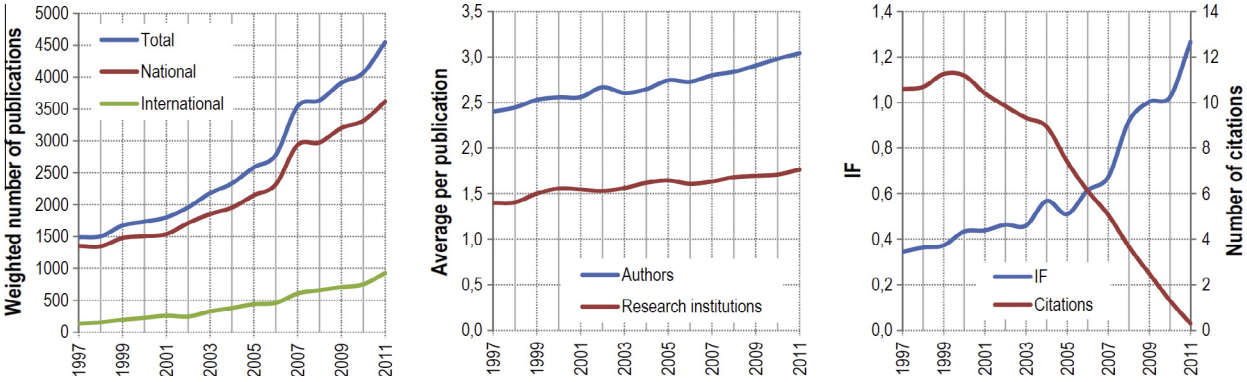

Fig. 1. Evolution of average weighted number of national and international publications, IF per article, number of citations, authors, and centers.

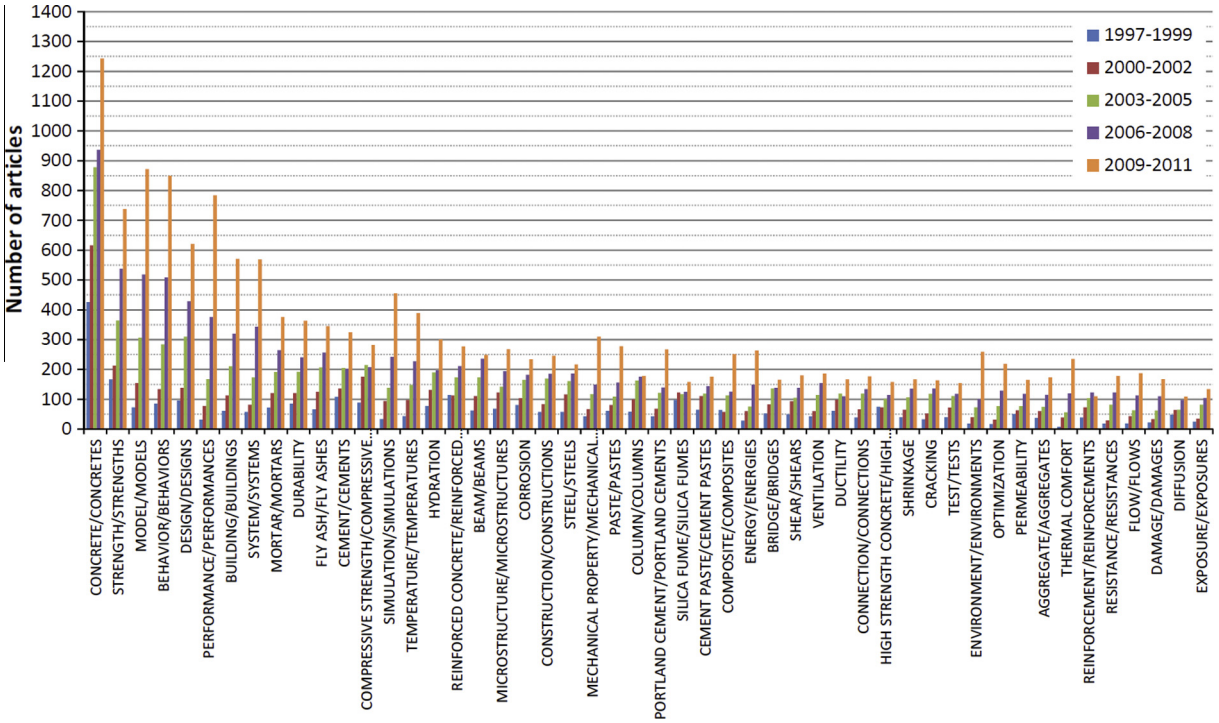

Fig. 2. Evolution of the number or research articles with appearance of most frequently used keywords between 1997 and 2011. Terms are analyzed without distinction between simple and compound keywords.

The results provide a global vision of the area of study, fixing reference levels for comparison and evaluation of the merit of the research undertaken; shed light on the themes at play in order to determine which ones have been maintained for long periods of time, and which ones have ceased to captivate the interest of researchers as well as journals; and allow detection of preferences of journals for research publication according to country of origin. In addition, it could be useful to compare the importance of research in the construction sector with respect to other countries and to evaluate the effectiveness of national policies or investment in the sector, to determine the effectiveness of the strategies undertaken by each research centers, and to select research institutions for work and collaboration.

2. Materials and methods

The analysis carried out is based on data provided by the Web of Science (WoS) database. WoS is the most frequently used indexed database in this kind of analysis [3,11,12]. The extraction process of the sample for the study took place for all "Article(s)" and "Review(s)" published under the "Construction & Building Technology" category, excluding the other types of documents in the search, such as editorial materials, letters, reprints, and so on. All documents [Article(s) and Review(s)] published within the last 15 years (1997–2011) were selected. The total number of articles and reviews analyzed for this period was 39,725 (consultation realized in April of 2012).

For each publication, all information relevant to the analysis was exported to a bibliography manager (End Note). Concretely this was: Author(s), Editor(s), Title, Source, Addresses, Times Cited, Keywords, Language, and Web of Science Category. The data for Times Cited refers to the moment of download. Thus, when it is interpreted, one must keep in mind that it is a framework common to all for impact comparison with the same temporal perspective. The bibliography manager was used to organize and format the information as a preliminary step for posterior treatment.

As opposed to the majority of existing bibliometric analyses, the present work analyzes the impact factor of each article individually, assigning to each article the impact factor of the journal in the year in which it was published. It was necessary to compile the impact factor of all journals in the category that were available in the Journal Citation Reports for each of the years included in the period of study. This approximation allows for quantification of the impact in a more realistic manner since the diffusion of an article increases with the impact factor of the journal in which it was published.

A new application was created through Visual Basic programming to process the information. The application undergoes a pre-processing of the information under the header address, identifying the participating centers or institutions and the countries of origin. In the analysis, 1438 records (3.6%) did not contain any information in the address field in reference to countries or research institutions. Furthermore, the application assigns the journal the corresponding impact factor and year of publication. It also counts the number of authors per article and the number of research institutions that participated in each of them.

Based on this data, the application calculates the different indicators that characterize the research activity of each country and research center, grouping the data by year in order to analyze the historical evolution that each of them underwent.

In some countries/territories with special characteristics, one is able to find that a university or research center is classified in another country depending on the author. In an attempt to prevent this, the countries of the United Kingdom (England, Scotland, Wales, and Northern Ireland) have been assigned a common country/territory field denominator, just as in other bibliometric studies [9,13,14]. In the same way, the articles from Hong Kong have been designated as pertaining to the country/territory field of People's Republic of China [15].

The indicators concerning the universities and investigation centers have been carried out drawing on the names used by the author of each article, except in the case of "Tsinghua Univ" and "Tsing Hua Univ", which have been grouped together since it has become clear that they represent the same center.

The parameters used for the analysis of each country and research center are explained in the following paragraphs:

(a) Weighted number of articles. The number of articles allows us to quantify the scientific production from a quantitative point of view. Most bibliometric analysis assigns one article to each center and/or country that participated in that article. This system presents the inconvenience of favoring centers and countries that publish in collaboration with other entities carrying out a portion of the overall work and penalizes those who publish independently and carry out the work on their own. Because of this, in this study the weighted number of articles is based on the number of research institutions/countries that participated in the creation of the article, assigning a fraction to each of the corresponding entities. In this way, for example, if four different institutions participate in an article, each of these will be granted 1/4 of the article. When elaborating the weight of these, the number of authors has not been taken into account since the information that places the authors in relation to the centers/countries is not always available in the Web of Science database.

(b) Impact Factor (IF). The quality and article diffusion during the period of study is analyzed through Impact Factor. Each article has been assigned the impact factor of the journal in the year of publication in which it was published. This is the way in which the average IF value of publications from each center/country for a specific time period is calculated.

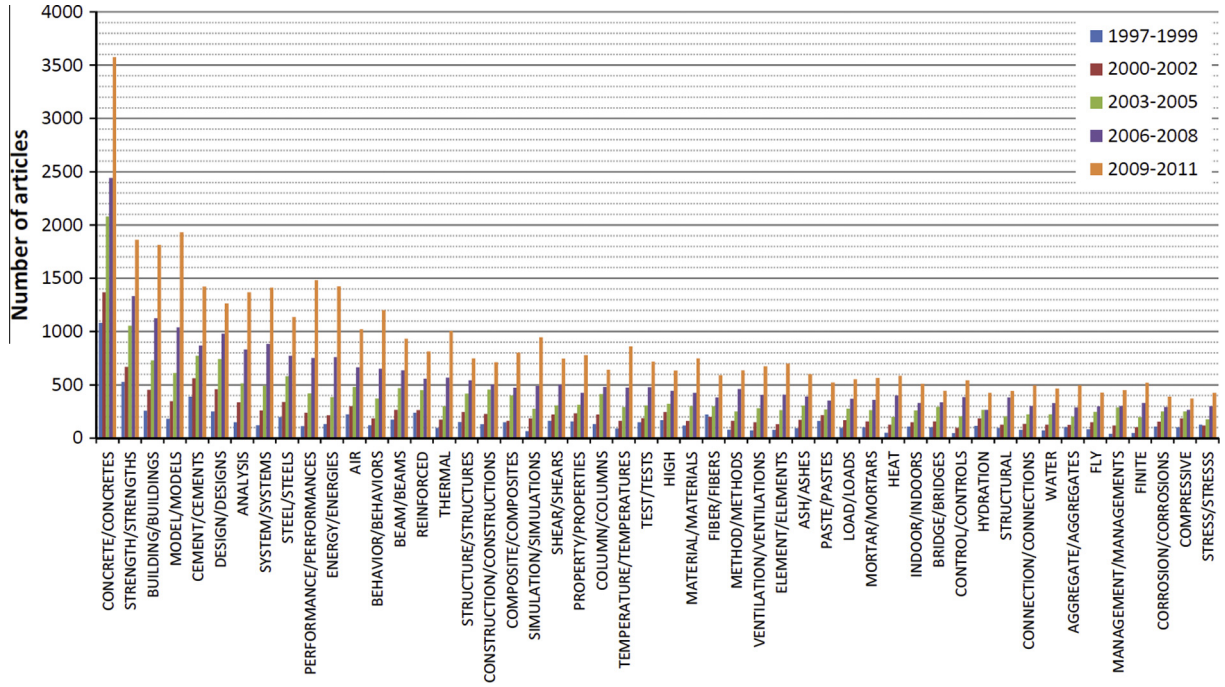

Fig. 3. Evolution of the number of research articles with appearance of the most frequently used keywords between 1997 and 2011. Terms are analyzed individually, counting whether they appear as a single keyword or as a part of a compound keyword.

(c) Number of citations per article. The citations indicate the diffusion and relevance of each article with respect to its category. It is calculated as the average value of the number of citations per publication of each center/country during a specific time period.
(d) Collaboration. The proportion of the work from each research institution/country in which collaboration has been established with other countries has been identified. Furthermore, the average number of authors and research institutions that participate in each article has also been included in the analysis.
(e) Language. The language of publication of the studies completed in different countries has been considered.

The analysis of the centers and countries has been completed through the analysis of the evolution in the research topic and taking into account the nationality of research centers that publish in each of the journals that cover this field of study.

(f) Research topic. It has been analyzed through the identification of keywords. All keywords in the category have been processed (Author Keywords and Keywords Plus), studying the evolution through time of the most important ones. The hyphens used to separate the words in compound keywords have been interpreted as spaces, avoiding in this way differentiating the words simply by the presence of the hyphen (for example: high-strength concrete and high strength concrete). Additionally, singular and plural terms have been counted together (for example: Building/Buildings). A double analysis has been carried out—on the one hand studying the keywords just as they have been defined and on the other hand counting separately the terms that make up compound keywords (like simple keywords as well as the words that are part of compound keywords) with the intention of studying the use of specific terminologies relating to the same subject.
(g) Journals. Every nationality of research centers that publish in the journals in this category has been determined. An analysis of its relationship with the impact factor in the last few years has been carried out. The study has focused on the last five years when the impact factor was available (2007–2011).

3. Results

Through the completed bibliometric analysis, the evolution of the publications in the "Construction & Building Technology" category, the research activity carried out by the most productive countries and research institutions, and the internationalization and journal diffusion under this category have been analyzed.

3.1. Evolution of publications under the "Construction & Building Technology" category

Research publications under the "Construction and Building Technology" category have been gradually increasing up to today, reaching 4544 publications in the year 2011, which is more than

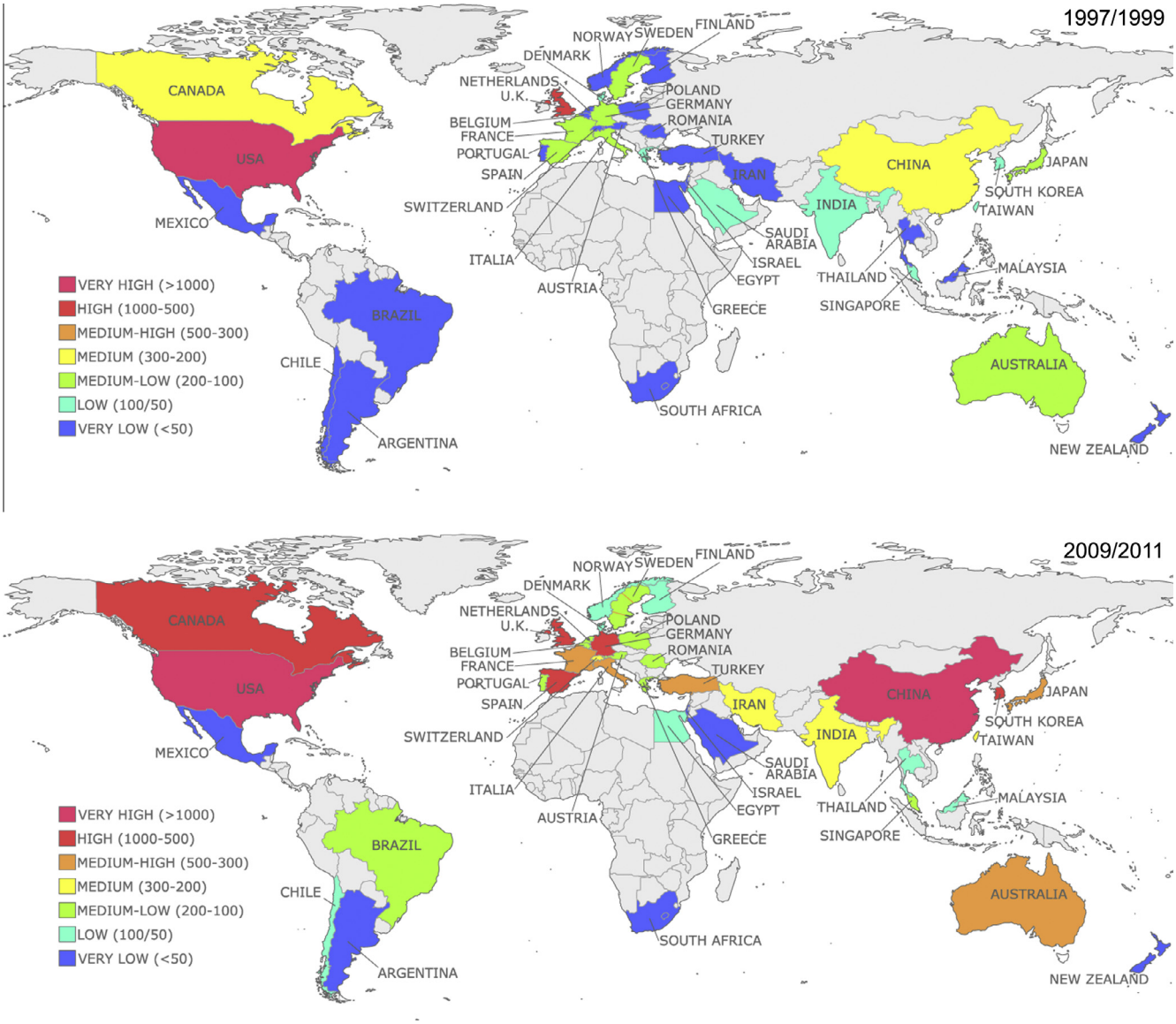

Fig. 4. Production of weighted articles from the 40 countries with the highest production in the periods 1997–1999 and 2009–2011.

three times that of 1997 (1490). This growth is superior to that of related categories (Engineering, Civil; Materials Science, Multidisciplinary; Engineering, Environmental), where publications during 2011 range between 2.4 and 2.7 times more than in 1997.

International collaboration between research institutions from different countries has increased significantly since 1997 (Fig. 1). The proportion of articles published in collaboration with other countries has gone from 9% in 1997 to 20% in 2011. Research in this category has experienced an increase in the amount of collaboration between authors and research institutions. The average number of authors per article has increased from 2.4 in 1997 to 3.0 in 2011. The number of research institutions that share article authorship has grown from 1.4 in 1997 to 1.8 in 2011 (Fig. 1).

The expansion of this category is also reflected in the increase of its impact factor. The average impact factor per article went from 0.34 in 1997 to 1.27 in 2011 (Fig. 1). The average number of citations per article reached its maximum in the articles published from 1997 to 2000 with an average of 11 citations per article. The average number of citations decreased over time to less than 1 citation in 2011 (Fig. 1).

The predominant language of publication is English (94.2%). German is the second most important language, making up 4.6% of publications during that period. Other languages, such as Spanish or French, do not reach 1%.

Table 1
Main scientific production indicators per country. Average values during the 1997–2011 time period. N_P: weighted number of articles; N_P (%): percentage of articles considered; Col (%): percentage of articles with international collaboration; IF: Impact Factor per article; N_{CI}: Number of citations per article; N_A: number of authors per article; N_{RI}: number of research centers per article.

Country	1997–2011						
	N_P	N_P (%)	Col (%)	IF	N_{CI}	N_A	N_{RI}
USA	8522	21.5	26.5	0.67	7	2.7	1.8
People's Republic of China	3444	8.7	28.0	0.88	6	3.2	1.7
United Kingdom	2910	7.3	30.9	0.70	7	2.8	1.7
Germany	2086	5.3	19.5	0.49	3	2.7	1.7
Canada	1928	4.9	36.6	0.72	7	2.8	1.8
Japan	1375	3.5	33.5	0.80	5	3.2	2.0
South Korea	1338	3.4	35.9	0.78	4	3.1	2.1
France	1266	3.2	31.5	0.99	8	3.5	2.0
Spain	1236	3.1	22.1	0.84	6	3.5	1.7
Turkey	1186	3.0	16.9	0.84	6	2.7	1.5
Australia	1059	2.7	38.2	0.77	7	2.6	1.7
Italy	1048	2.6	27.9	0.87	6	3.1	1.7
Taiwan	879	2.2	16.5	0.86	6	2.8	1.7
India	804	2.0	15.7	0.79	5	2.7	1.6
Singapore	610	1.5	34.6	0.64	7	2.8	1.6
Sweden	600	1.5	29.0	0.89	8	2.8	1.8
Greece	573	1.4	23.5	0.82	8	3.1	1.6
Switzerland	537	1.4	40.1	0.87	7	3.0	1.9
Brazil	423	1.1	34.0	0.94	5	3.2	1.9
Iran	422	1.1	23.9	0.96	3	2.7	1.6
Portugal	415	1.0	24.8	0.92	5	3.1	1.9
Netherlands	408	1.0	40.2	0.90	6	3.1	1.9
Denmark	339	0.9	49.6	1.18	13	3.4	2.3
Belgium	328	0.8	43.0	1.02	7	3.8	2.0
Poland	277	0.7	23.8	0.83	3	2.5	1.6
Austria	276	0.7	28.4	0.55	2	2.9	1.8
Israel	272	0.7	33.8	0.67	7	2.5	1.6
Egypt	261	0.7	53.3	0.72	5	2.5	1.9
Finland	241	0.6	28.5	1.01	8	3.5	2.0
Romania	219	0.6	10.4	0.53	2	3.4	1.8
Norway	206	0.5	41.6	1.02	6	3.5	2.4
Thailand	205	0.5	39.7	0.89	6	2.9	1.9
Saudi Arabia	192	0.5	25.1	0.70	6	2.6	1.4
Czech Republic	160	0.4	29.3	0.86	4	3.5	1.8
Malaysia	158	0.4	43.3	1.04	3	3.2	1.8
South Africa	150	0.4	32.4	0.69	6	2.5	1.7
Mexico	131	0.3	50.5	0.79	6	3.7	2.2
New Zealand	121	0.3	53.1	0.84	5	3.2	2.1
Argentina	114	0.3	27.6	0.84	7	3.1	1.9
Chile	106	0.3	53.0	0.61	1	3.0	2.2

3.2. Evolution of the most important research topics

Through the analysis of keywords, one can detect research trends during the time period. 48,641 keywords were detected, appearing 231,875 times, out of which 33% appear in more than one article, 6% in more than 10, and 1% in more than 100. On the other hand, there is a small group of keywords that are widely-used, whereas most keywords are not employed frequently. This power-law distribution has also been observed in other bibliometric studies [7]. So, the 100 most widely used keywords represent 25% of the total number of times that keywords were used; the percentage increases to 53% for the first 1000 and to 73% for the top 5000 most used keywords.

Analyzing the keywords just as they appear in the database (without any distinction between simple and compound keywords), we can observe how a reduced group of words are widely used by researchers and occupy the top positions in the ranking during the entire period (Fig 2). Concrete/Concretes (4098 articles) is the most widely used term and is indeed used more than twice as much as the second most used term (sum of the entire period). Other terms related to materials like Mortar/Mortars (1024), Fly ash/Fly ashes (999), Cement/Cements (976) and Steel/Steels (736) follow far behind.

Together with the previously mentioned terms, terms of a general character widely used by researchers stand out since they involve topics common to numerous lines of investigation, such as Strength/Strengths (2020), Behavior/Behaviors (1861), Model/Models (1923), Design/Designs (1592), Performance/Performances (1438), Building/Buildings (1276), System/Systems (1224), and Durability (1003). These terms demonstrate that studies on the design, properties, and the behavior of materials, structures, and buildings make up the pillars of research carried out in the construction field.

All the previous terms have experienced noteworthy growth in the last years. Especially noticeable in the last 6 years are the terms Performance/Performances, Model/Models, and Behavior/Behaviors. Outside the top 10 , the growth of terms related to indoor environment and energy efficiency, such as Simulation/Simulations, Temperature/Temperatures, Energy/Energies, Environment/Environments, and Thermal Comfort stands out. Terms related to materials and structures also stand out, such as Mechanical Property/Mechanical Properties, Paste/Pastes, Portland Cement/Portland Cements, and Composite/Composites.

On the other hand, other terms have experienced an extremely reduced growth, losing relative importance compared to other keywords. Among these terms Reinforced Concrete/Reinforced Concretes (from 3rd in 1997–1999 to 19th in 2009–2011), Compressive Strength/Compressive Strengths (from 7th to 17th), Silica Fume/Silica Fumes (from 5th to 49th), Corrosion (from 10th to 28th), Cement Paste/Cement Pastes (from 17th to 38th), High Strength Concrete/High Strength Concretes (from 12th to 50th), Chloride/Chlorides (from 23rd to 105th), and others stand out. In some cases a decrease in the total value of articles is observed, despite the generalized increase in articles and the corresponding increase in keywords, such as Prestressed Concrete/Prestressed Concretes, Precast Concrete/Precast Concretes, Ion/Ions, and so on.

Nevertheless, the previous terms make reference to specific denominations that have been substituted by equivalent new terms or definitions of a more general nature. On the other hand, it is also important to analyze the materials or generic structures without particularizing. Therefore, to compliment the study all

the terms have been studied separately (like simple keywords as well as the words that are part of compound keywords).

Just as in the previous analysis, Concrete/Concrete continues to be the keyword that stands out most (Fig. 3). Nevertheless, in this case it is close to doubling the second term in the ranking of each of the periods analyzed. This can be explained by the numerous topics in which this term figures: reinforced concrete, high strength concrete, high performance concrete, concrete structure, prestressed concrete, and so on. Terms of a general nature continue to hold important positions. Studies related to materials, such as Cement/Cements, Steel/Steels, Composite/Composites or Fiber/Fibers, also stand out. This analysis also reflects the increasing interest in topics related to energy, thermal comfort, and ventilation of buildings.

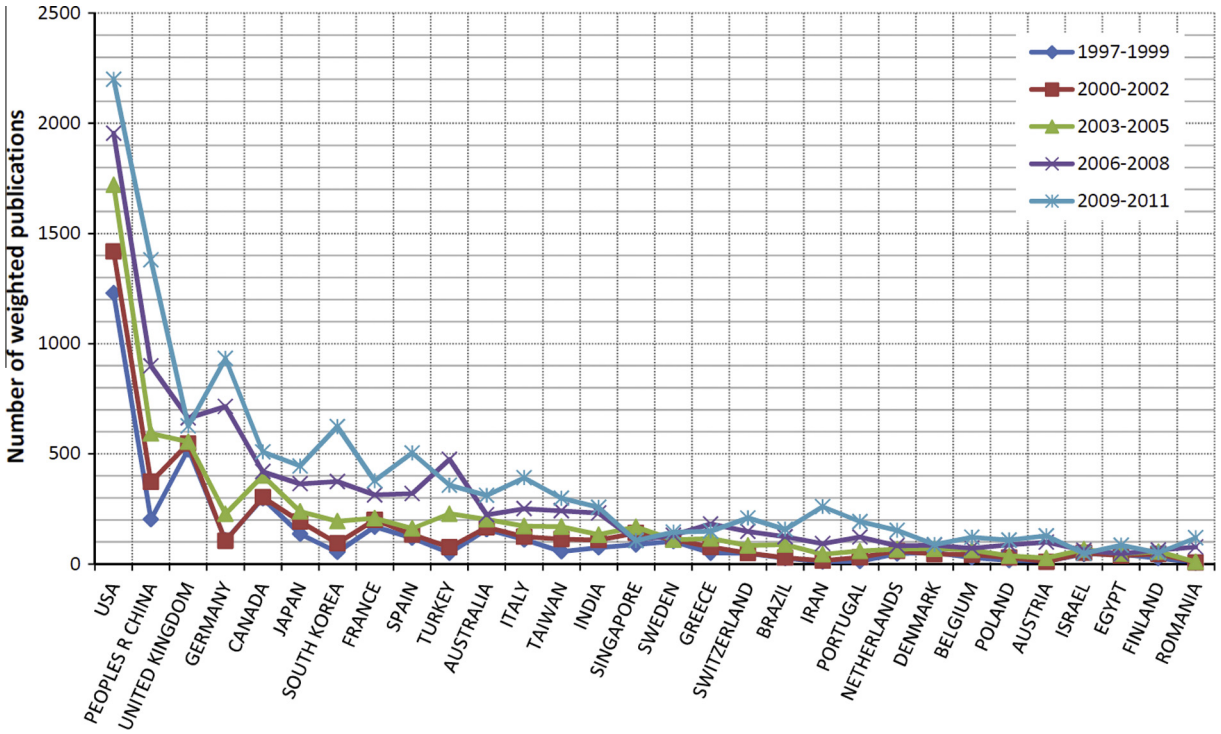

Fig. 5. Evolution of the weighted number of articles published by principal countries.

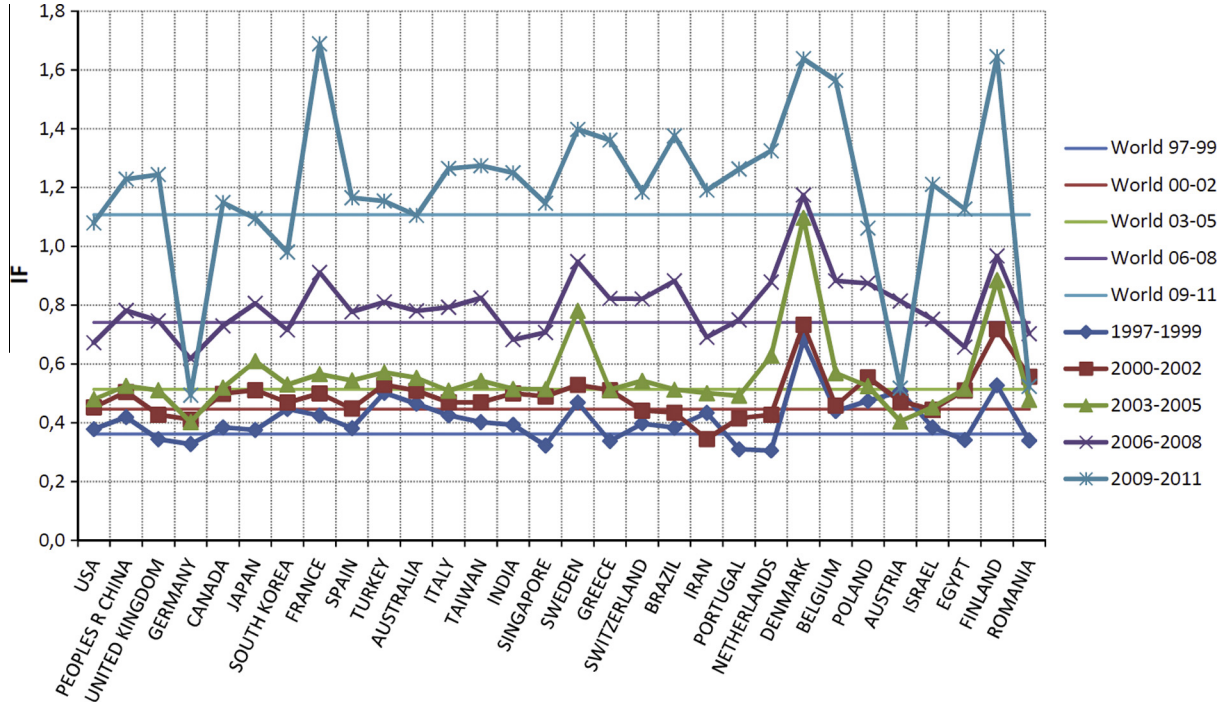

Fig. 6. Evolution of the average IF per article in principal countries.

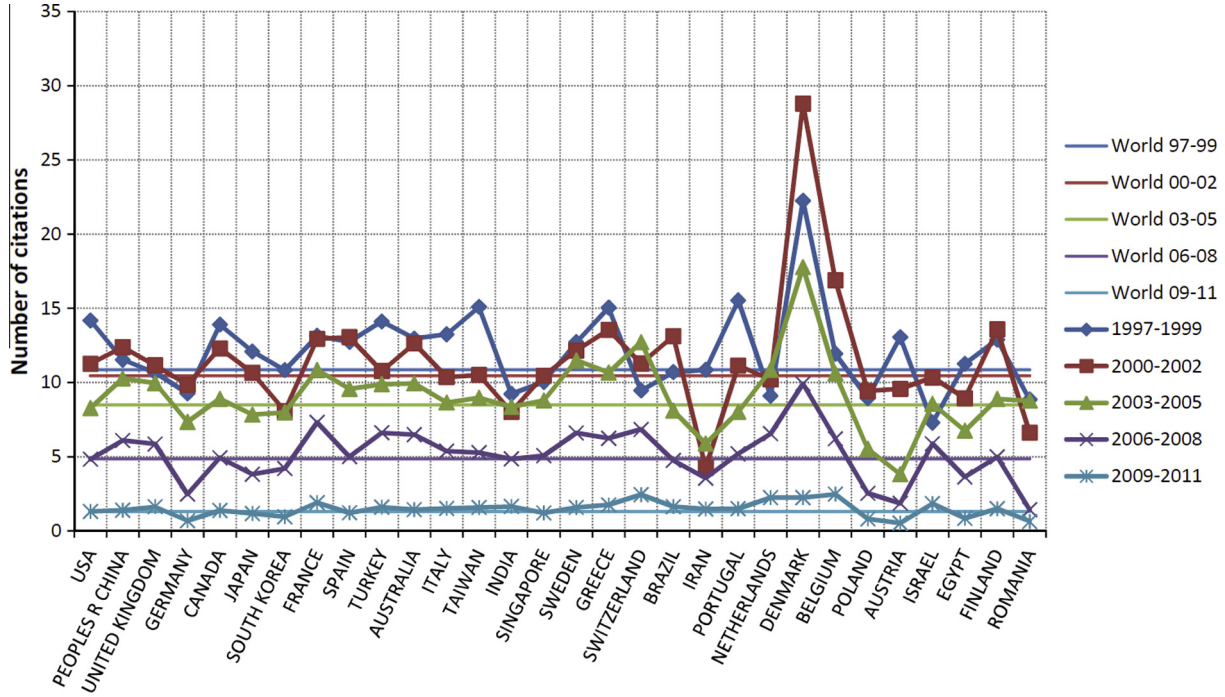

Fig. 7. Evolution of the average number of citations per article in principal countries.

Table 2
Main scientific production indicators per research center. Average values during the 1997–2011 time period. N_p: weighted number of articles; N_p (%): percentage of articles considered; Col (%): percentage of articles with international collaboration; IF: Impact Factor per article; N_{CI}: Number of citations per article; N_A: number of authors per article; N_{RI}: number of research centers per article.

Research institution	Country	1997–2011						
		N_P	N_P (%)	Col (%)	IF	N_{CI}	N_A	N_{RI}
Hong Kong Polytech Univ	People's Republic of China	587	1.5	19.9	0.80	9	3.1	1.7
Natl Univ Singapore	Singapore	328	0.8	30.6	0.69	7	2.9	1.5
Univ Calif Berkeley	USA	286	0.7	31.6	0.86	11	3.1	2.0
Purdue Univ	USA	257	0.6	27.6	0.83	8	2.8	2.0
Tongji Univ	People's Republic of China	257	0.6	25.5	0.79	4	3.1	1.8
Tsing Hua Univ	People's Republic of China	252	0.6	30.5	0.89	6	3.4	2.0
Univ Illinois	USA	239	0.6	33.8	0.66	9	2.8	2.0
Indian Inst Technol	India	219	0.6	14.3	0.75	6	2.6	1.6
City Univ Hong Kong	People's Republic of China	214	0.5	20.7	0.90	6	3.3	1.8
Nanyang Technol Univ	Singapore	212	0.5	36.1	0.60	7	2.8	1.6
Univ Hong Kong	People's Republic of China	202	0.5	25.5	0.81	7	2.9	1.8
CSIC	Spain	201	0.5	26.3	0.77	11	3.5	1.7
Delft Univ Technol	Netherlands	178	0.4	43.0	0.86	6	3.1	1.8
Univ London Imperial Coll.	United kingdom	175	0.4	31.3	0.69	9	2.9	1.8
Univ Michigan	USA	171	0.4	34.1	0.75	8	2.9	1.9
Texas A&M Univ	USA	166	0.4	24.5	0.74	5	3.0	2.0
Tech Univ Denmark	Denmark	163	0.4	53.0	1.22	14	3.5	2.4
Technion Israel Inst Technol	Israel	161	0.4	31.0	0.64	7	2.4	1.6
Natl Tech Univ Athens	Greece	158	0.4	18.4	0.75	8	3.3	1.6
Suny Buffalo	USA	156	0.4	20.6	0.69	10	2.6	1.7
Hong Kong Univ Sci & Technol	People's Republic of China	153	0.4	19.0	0.69	8	2.8	1.7
Univ Sheffield	United Kingdom	152	0.4	37.4	0.84	8	3.1	1.8
Penn State Univ	USA	151	0.4	35.5	0.66	9	2.9	2.0
Univ Sherbrooke	Canada	146	0.4	44.8	0.71	10	2.9	1.9
Univ Tokyo	Japan	143	0.4	37.4	0.95	5	3.2	2.1
Natl Res Council Canada	Canada	136	0.3	26.2	0.73	7	3.1	1.9
Univ Sydney	Australia	135	0.3	30.6	0.73	8	2.5	1.7
Georgia Inst Technol	USA	132	0.3	30.7	0.82	7	3.0	2.1
Univ Toronto	Canada	130	0.3	39.8	0.72	11	2.7	1.9
Univ New S Wales	Australia	127	0.3	24.7	0.70	8	2.5	1.6
Northwestern Univ	USA	120	0.3	35.8	0.75	16	3.2	2.2
Univ Colorado	USA	119	0.3	32.3	0.75	10	2.6	1.9
Univ Politecn Madrid	Spain	119	0.3	11.6	0.75	4	3.0	1.6
Univ British Columbia	Canada	116	0.3	31.1	0.69	7	2.8	1.7
Natl Taiwan Univ Sci & Technol	Taiwan	115	0.3	13.6	0.82	6	2.8	1.6
Univ Texas	USA	115	0.3	32.5	0.51	8	3.1	2.3
Politecn Torino	Italy	115	0.3	22.8	0.91	5	2.9	1.6
King Fahd Univ Petr & Minerals	Saudi Arabia	111	0.3	13.5	0.58	8	3.0	1.3
Concordia Univ	Canada	109	0.3	35.6	0.92	7	2.8	1.8
Univ Waterloo	Canada	108	0.3	38.7	0.74	7	2.7	1.9

As could be expected, the majority of terms that make up the category "Construction & Building Technology" are widely utilized by researchers and occupy relevant positions in the classification of keywords. Thus, counting all occurrences of each term for the entire period, terms related to structures like Building/Buildings (4377 appearances, 3rd ranking) or Bridge/Bridges (1333, 38th) are found among the top fifty; others like Tunnel/Tunnels (587, 107th) are positioned out of the top 100. On the other hand, the scarce use of the term Dam/Dams (61 appearances, out of the top 1000) is noteworthy. Regarding materials, the three materials named in the definition are the most employed by researchers: Concrete/Concretes (10543, 1st), Cement/Cements (4014, 5th) and Steel/Steels (3024, 9th) (Fig. 3). Regarding other topics, many of the terms that make them up stand out, such as Energy/Energies (2916), Air (2692), Heating (420), and so on.

3.3. Evolution of research activity by country

The analysis carried out has the establishment of a ranking of countries leading in construction and building technologies research as its objective. In order to do so, the main indicators of productivity (number of articles), impact and research diffusion (IF and number of citations), as well as the main collaboration indicators (% of international collaborations, number of authors/article, and number of research institutions/article) have been considered and used in analyzing the evolution of these elements in the last 15 years.

When analyzing scientific production of countries from a quantitative perspective, it becomes apparent that a small number of countries are responsible for a significant part of total production (Fig. 4). Only 10 countries were responsible for 64% of all of the articles published during that period; 89% of production was carried out by the top 30 countries; and 95% was carried out by the top 50. The United States is the country with the highest production level with more than 21% of the total, followed by three countries/territories that surpass 5%: China (8.7%), the United Kingdom (7.3%), and Germany (5.3%) (Table 1).

The average percentage of international collaboration during the period of study is highly heterogeneous. Among the 30 most productive countries, the high percentage of international collaboration in Switzerland, the Netherlands, Denmark, Belgium, and Egypt stands out with values superior to 40% of the articles. On the other hand, countries such as Germany, Turkey, Taiwan, and India have percentages below 20%. The percentages vary widely in the case of the remaining countries. The differences among countries in the number of authors and the number of research institutions per article do not prove to be significant. The majority of countries have a range between 2.5 and 3.5 authors per article, and between 1.5 and 2.0 research institutions per article. Among the most productive countries, France and Spain present the highest number of authorship per article; Japan, South Korea, and France have the highest number of research institutions per article. In countries with lower production levels the magnitude of

Table 3
Evolution of the number of weighted articles of the most productive research centers. N_P: Total number of articles considered in the study; Rank: position in the ranking of the total number of articles published during that time period.

Research institution	Country	1997–1999		2000–2002		2003–2005		2006–2008		2009–2011	
		N_P	Rank	N_P	Rank	N_P	Rank	N_P	Rank	N_P	Rank
Hong Kong Polytech Univ	People's Republic of China	41	4	78	1	145	1	170	1	154	1
Natl Univ Singapore	Singapore	46	2	73	2	97	2	58	6	54	18
Univ Calif Berkeley	USA	51	1	56	3	58	4	54	10	67	8
Purdue Univ	USA	32	10	39	8	55	5	67	3	64	9
Tongji Univ	People's Republic of China	11	64	29	17	43	7	62	4	111	2
Tsing Hua Univ	People's Republic of China	17	34	30	14	54	6	57	8	94	3
Univ Illinois	USA	21	22	46	5	42	8	58	7	73	6
Indian Inst Technol	India	19	28	30	16	40	12	72	2	60	12
City Univ Hong Kong	People's Republic of China	15	41	33	10	30	20	55	9	81	4
Nanyang Technol Univ	Singapore	27	17	53	4	59	3	40	17	34	49
Univ Hong Kong	People's Republic of China	10	86	27	21	34	17	58	5	74	5
CSIC	Spain	35	6	43	6	40	9	49	11	34	50
Delft Univ Technol	Netherlands	18	31	27	20	29	24	33	29	71	7
Univ London Imperial Coll Sci.	United Kingdom	27	18	31	13	29	23	48	12	41	32
Univ Michigan	USA	32	9	25	23	30	22	48	13	36	45
Texas A&M Univ	USA	14	46	22	31	34	16	37	20	59	14
Tech Univ Denmark	Denmark	20	25	17	48	30	21	45	14	52	20
Technion Israel Inst Technol	Israel	34	8	33	11	35	14	32	30	27	72
Natl Tech Univ Athens	Greece	16	35	23	27	40	11	41	16	38	41
Suny Buffalo	USA	41	3	42	7	29	25	20	73	24	89
Hong Kong Univ Sci & Technol	People's Republic of China	17	33	32	12	37	13	30	36	37	42
Univ Sheffield	United Kingdom	29	13	20	34	26	30	35	25	43	29
Penn State Univ	USA	29	11	28	19	34	15	29	41	31	59
Univ Sherbrooke	Canada	28	16	30	15	30	18	26	46	32	57
Univ Tokyo	Japan	8	108	17	43	15	68	41	15	62	10
Natl Res Council Canada	Canada	28	15	19	39	28	27	32	31	30	65
Univ Sydney	Australia	35	7	22	28	29	26	22	68	28	68
Georgia Inst Technol	USA	9	95	17	45	27	28	33	28	46	27
Univ Toronto	Canada	24	20	23	25	30	19	31	33	22	101
Univ New S Wales	Australia	23	21	22	30	23	38	36	23	24	91
Northwestern Univ	USA	29	12	28	18	23	37	29	43	12	216
Univ Colorado	USA	20	23	18	41	26	29	28	44	27	76
Univ Politecn Madrid	Spain	6	142	4	277	14	79	36	22	59	13
Univ British Columbia	Canada	28	14	23	24	14	74	19	86	31	60
Natl Taiwan Univ Sci & Technol	Taiwan	5	188	22	29	17	54	29	40	42	30
Univ Texas	USA	19	27	25	22	40	10	31	32	0	–
Politecn Torino	Italy	15	39	12	76	10	122	22	62	55	16
King Fahd Univ Petr & Minerals	Saudi Arabia	36	5	19	38	24	36	20	74	13	198
Concordia Univ	Canada	15	42	12	80	18	51	22	66	42	31
Univ Waterloo	Canada	11	65	14	55	20	42	29	38	33	54

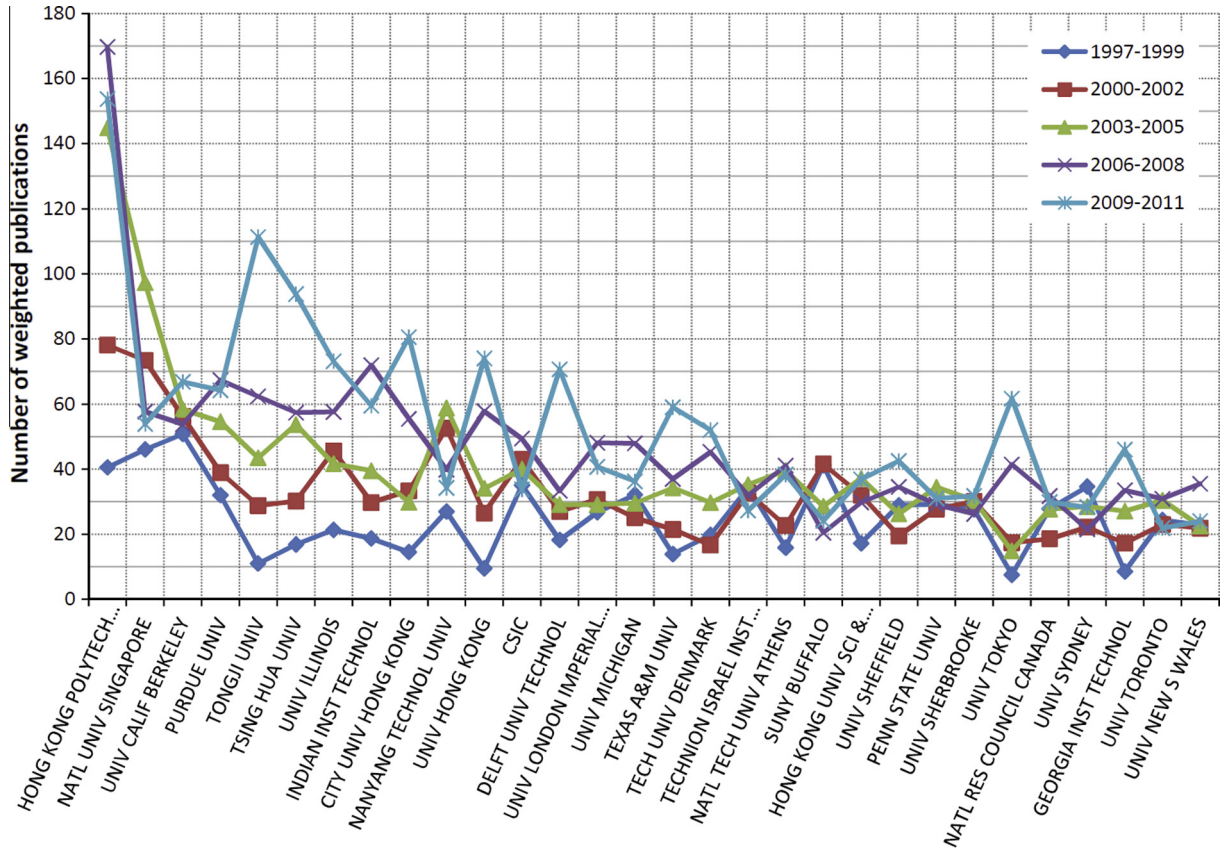

Fig. 8. Evolution in the number of weighted articles of principal research institutions.

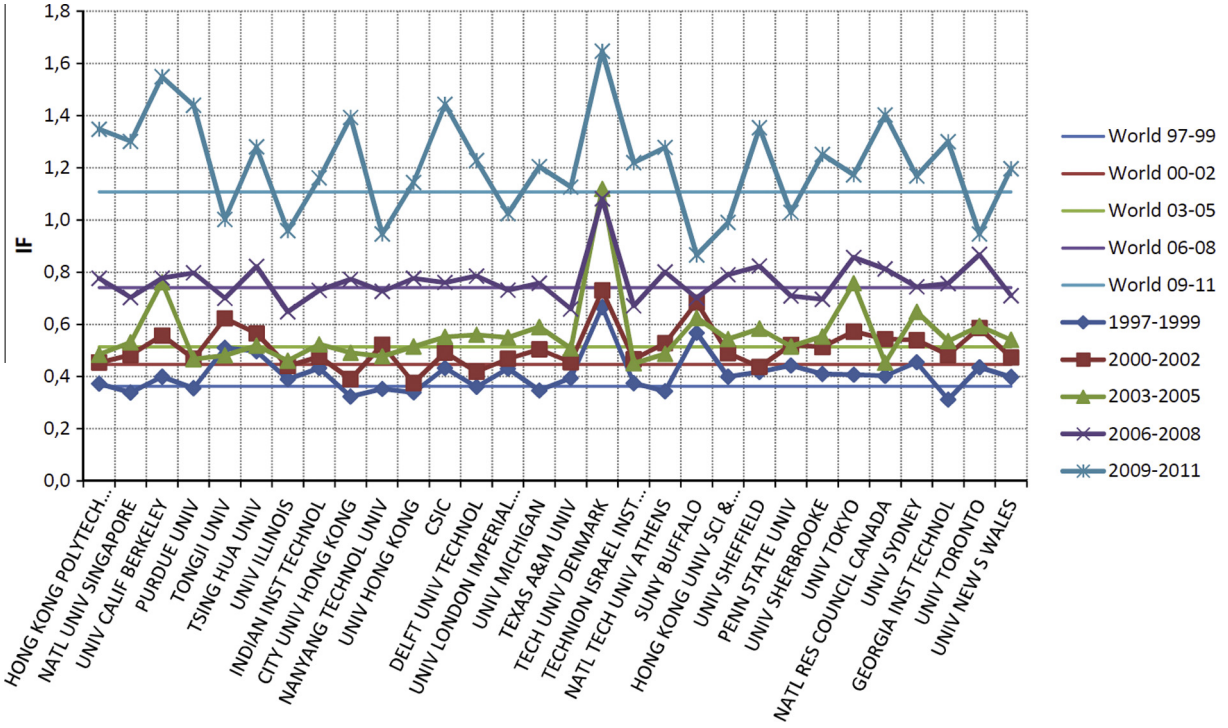

Fig. 9. Evolution of IF per article in principal research institutions.

collaboration indicators of Belgium, the Nordic Countries, and Mexico stands out.

Concerning the average IF throughout the time period, there are not great differences among countries. The majority of the principal countries being studied have values that range between 0.6 and 0.9. Among the top 10 countries, France stands out with a higher IF and a higher number of citations than the rest (Table 1). The opposite occurs in the case of Germany, which has a low IF as well as a low number of citations—a consequence of the high percentage of articles that are published in German (superior to 50%). Nevertheless, the average IF of the entire period is affected by the number of articles published in the last few years, when the IF has been steadily increasing. Because of this, it is necessary to analyze the evolution of the indicators over time exhaustively.

By analyzing the evolution of the number of published articles throughout the time period, one can see how in the last few years there has been a general increase in publications in the majority of countries (Fig. 5). Certain growth rates stand out due to their magnitude, such as those of China, Germany, and South Korea, which have occupied the 2nd, 3rd, and 5th positions respectively during the time period between 2009 and 2011 and have pushed the countries that occupied these positions during the first few years of study down the list: the United Kingdom (from 2nd to 4th), Canada (from 3rd to 6th), and France (from 5th to 10th). The great magnitude of growth in publications by Chinese researchers is noteworthy and increasingly nears the output of the USA. In 2011, the number of weighted articles of Chinese research institutions reached 531 while the USA reached 791 articles.

Impact factor experienced a significant increase from 2006 onward (Fig. 6). The countries with greatest production generally present an average impact factor per article close to the global average of all time periods. France stands out by having a superior impact factor than the rest of countries with high production levels in the last 6 years, reaching an average 1.91 per article during 2011. Germany is on the opposite end, with an impact factor that has plummeted in the most recent period. The same tendency occurs with Austria—the fall of its impact factor seems to be due to the low level of diffusion of journals published in German since both countries are responsible for more than 50% of their publications in this language. Among the countries with low production levels, the high impact factors of Denmark, Belgium, Sweden, Finland, and Norway stand out.

Just as in the case of IFs, the number of citations received per article seems to be heavily influenced by the year of publication and most countries have values close to the global average (Fig. 7). Countries such as China and France show values that are slightly superior to the average, while those of Germany and South Korea remain below average during most of the time period. Denmark stands out with an elevated number of citations of articles published throughout the entire time period, reaching an average of 29 citations per article during the 2000–2002 time period.

3.4. Evolution of research activity of research institutions

The analysis carried out has the establishment of a ranking of the research institutions leading in the topic of construction and building technologies as its objective. In order to do so, the main indicators of productivity (number of articles), impact and research diffusion (IF and number of citations), as well as the main collaboration indicators (% of collaboration, number of authors/article, and number of centers/article) have been considered and used in analyzing the evolution of these centers in the last 15 years.

Among the more than 12,800 institutions and research institutions that have participated in "Construction & Building Technology" research, the Hong Kong Polytechnic University leads institutional production with 587 weighted articles (1.5%) (Table 2). None of the remaining research institutions surpasses 1% of the total, showing a progressive decrease in production. The top 30 centers represent 15% of the production during the entire time period and mostly belong to the countries with highest production levels. Among the 100 most productive research institutions, the USA represents the highest number (23), followed by the People's Republic of China (12), the United Kingdom (11), Canada (10), Germany (4), Turkey (4), and South Korea (4).

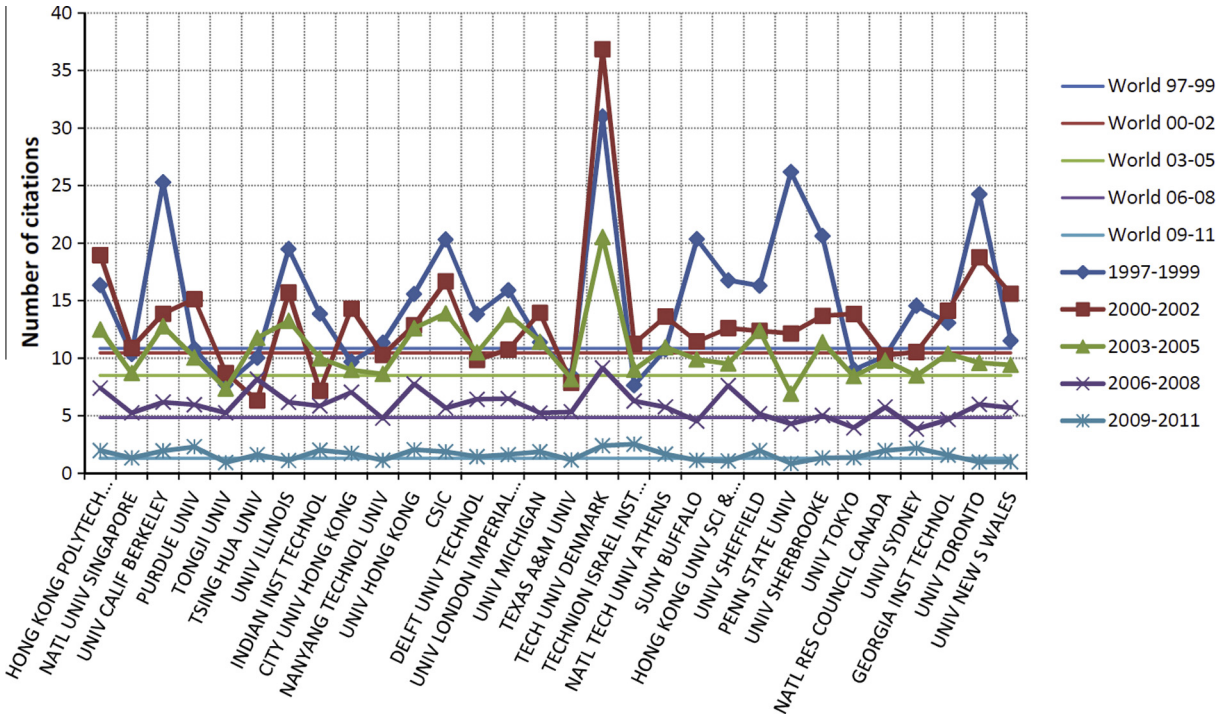

Fig. 10. Evolution of the average number of citations per article of principal research institutions.

Table 4
Percentage of total number of weighted articles in each of the journals attributed to one of the 30 most productive countries, and their relation with the average impact factor. Period 2007–2011.

Abbreviated Journal	Mean IF 2007–2011	USA	People's Republic of China	United Kingdom	Germany	Canada	Japan	South Korea	France	Spain	Turkey	Australia	Italy	Taiwan	India	Singapore	Sweden	Greece	Switzerland	Brazil	Iran	Portugal	Netherlands	Denmark	Belgium	Poland	Austria	Israel	Egypt	Finland	Romania
Indoor Air	2.70	35	10	0	2	3	4	3	3	1	1	2	2	3	1	1	7	0	1	1	0	0	1	8	0	0	0	0	0	2	0
Comput-Aided Civ Inf	2.03	37	8	5	2	3	4	3	3	3	1	4	2	8	1	1	0	4	1	0	1	2	1	0	0	0	0	1	0	0	0
Cement Concrete Res	1.98	15	4	7	5	5	4	2	21	5	1	2	2	0	1	0	1	1	6	2	0	1	1	1	3	0	0	1	0	0	0
Energ Buildings	1.69	9	17	7	2	3	3	2	3	5	3	2	6	2	3	1	2	3	1	2	3	1	1	2	2	1	0	1	1	1	0
Build Environ	1.67	9	16	8	1	3	6	5	2	2	10	2	2	4	2	2	2	3	1	1	1	1	2	2	2	1	0	0	0	2	0
Cement Concrete Comp	1.61	14	9	4	3	7	3	3	7	4	5	2	3	2	3	0	0	2	3	4	1	3	2	1	1	0	0	0	0	0	0
Build Res Inf	1.33	9	3	32	6	6	2	1	2	0	0	10	0	0	0	0	4	0	4	0	0	2	6	2	0	0	0	0	0	0	0
Automat Constr	1.29	19	12	6	1	4	2	10	1	3	2	4	1	15	1	1	1	1	1	0	1	1	2	0	0	4	0	1	2	1	0
Constr Build Mater	1.29	9	11	4	1	2	2	4	5	6	11	2	4	2	3	0	1	2	1	3	2	4	1	0	1	1	0	0	1	0	0
Lighting Res Technol	1.07	20	3	24	4	6	0	0	2	2	0	1	3	1	4	1	2	1	1	0	0	0	3	1	2	1	1	0	0	0	0
Struct Control Hlth	1.05	26	11	3	0	4	9	1	2	2	0	2	12	8	5	0	0	1	0	0	2	1	0	1	0	0	1	0	0	0	0
J Constr Steel Res	0.96	10	17	8	1	4	2	6	1	3	3	8	4	3	1	2	0	1	0	2	9	2	1	0	1	0	0	0	1	0	0
Indoor Built Environ	0.89	10	19	5	1	3	1	16	1	0	7	0	2	4	4	0	1	3	1	1	1	1	1	2	0	1	1	0	0	2	0
Mater Struct	0.86	9	8	4	4	5	3	1	10	4	5	3	5	1	4	0	3	2	3	3	1	2	1	2	2	1	1	1	0	0	0
J Struct Eng-ASCE	0.86	44	7	4	0	9	3	4	0	0	1	5	5	2	1	2	0	1	1	0	1	1	0	0	0	0	0	1	0	0	0
Build Simul-China	0.82	20	20	4	0	4	9	0	3	0	0	0	6	1	4	1	0	1	2	2	0	1	3	1	3	0	6	1	0	0	0
Aci Mater J	0.79	36	9	3	2	8	4	5	2	3	4	2	1	1	2	1	0	1	1	1	1	1	1	0	0	0	0	1	0	0	0
Aci Struct J	0.78	37	3	3	1	12	2	9	0	1	3	2	5	1	2	1	2	3	4	1	1	1	0	0	0	0	0	0	2	0	0
HVAC&R Res	0.76	42	15	3	2	5	6	1	2	2	0	0	2	1	2	0	1	0	0	1	0	1	0	4	1	0	0	0	0	1	0
Tunn Undergr SP Tech	0.72	8	16	4	1	7	4	7	3	5	6	2	2	6	2	2	5	1	2	0	5	0	1	0	0	1	0	0	0	0	0
J Build Perform Simu	0.72	14	2	18	7	21	3	1	1	0	0	1	0	0	3	0	3	1	10	1	0	1	2	0	2	0	4	0	0	0	0
Build Serv Eng Res T	0.68	2	25	46	0	3	0	4	1	0	0	1	0	2	0	0	1	1	0	2	0	0	1	0	2	1	0	0	0	1	0
Adv Cem Res	0.67	3	17	6	4	6	1	3	7	8	8	0	2	0	3	1	1	1	2	2	2	0	0	1	0	0	1	0	7	3	0
J Mater Civil Eng	0.66	38	12	3	0	6	2	3	1	1	3	2	3	2	8	1	0	1	0	2	1	2	0	0	0	0	0	0	1	0	0
J Constr Eng M ASCE	0.63	44	13	3	0	7	0	4	0	1	2	5	0	3	1	2	0	0	1	0	1	0	1	0	0	0	0	0	2	1	0
J Build Phys	0.61	11	5	4	2	6	1	0	3	2	0	0	2	0	0	0	8	0	0	2	1	2	6	3	6	2	1	2	0	7	0
Comput Concrete	0.58	9	13	2	4	4	2	8	5	1	9	1	0	11	6	1	1	2	0	2	3	2	1	1	0	1	1	1	0	0	0
J Adv Concr Technol	0.56	8	5	0	2	1	50	6	2	0	1	1	2	1	2	0	0	1	0	0	1	1	2	2	0	0	2	0	1	0	0
Mater Construcc	0.56	0	0	2	1	0	0	0	1	71	2	0	2	0	0	0	0	0	0	1	0	3	1	0	1	1	0	0	1	0	0
Steel Compos Struct	0.55	6	15	3	0	2	2	15	0	3	14	2	3	5	3	0	0	1	0	1	6	4	1	0	1	2	1	0	2	0	0
Wind Struct	0.55	11	31	5	3	11	3	5	0	1	1	7	3	1	2	1	0	0	0	1	1	1	1	0	1	2	0	0	0	0	0
Struct des Tall Spec	0.47	28	16	2	0	3	2	14	0	0	4	2	2	2	2	0	0	5	0	1	11	0	1	0	0	0	0	3	0	0	0
Leukos	0.44	47	3	3	4	9	2	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	4	0	0	0	0	4	0
Int J Archit Herit	0.43	3	0	9	4	3	1	1	0	6	4	0	33	0	0	0	2	5	0	0	1	10	1	0	3	1	0	0	0	0	0
Adv struct eng	0.41	8	34	6	0	2	4	9	0	1	4	9	4	1	3	2	0	0	0	0	4	1	1	0	0	0	0	0	2	0	0
Mag Concrete Res	0.41	5	15	13	1	2	1	16	3	2	4	5	2	1	4	4	3	2	1	1	1	1	1	1	1	0	0	0	1	0	0
Int J Pavement Eng	0.40	53	3	4	1	8	1	1	1	1	0	2	2	0	4	0	4	2	0	1	0	1	3	0	0	0	1	2	2	0	0
P I Civil Eng-STR B	0.39	5	8	37	2	3	0	3	1	5	3	2	4	0	1	0	0	1	1	2	1	4	2	0	0	0	0	0	1	0	0
J Perform Constr Fac	0.36	52	7	1	1	8	0	2	0	1	6	4	2	2	3	1	0	1	0	0	0	1	0	0	0	0	1	0	1	0	0
Int J Steel Struct	0.35	7	11	4	0	1	17	38	0	0	1	2	1	2	1	1	0	2	0	0	3	0	1	1	1	0	0	0	0	0	1
Rev Rom Mater	0.34	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	93
Adv Steel Constr	0.32	2	30	9	3	0	5	2	1	0	1	6	9	1	3	4	0	0	0	1	3	3	3	1	2	2	0	0	0	0	1
Beton–Stahlbetonbau	0.31	0	0	0	77	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	13	0	0	0	0
Eng J AISC	0.30	67	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Eng J AISC	0.30	73	0	0	0	6	2	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Int J Vent	0.28	6	8	16	0	1	12	0	5	2	1	2	3	0	5	1	6	6	1	2	2	2	0	2	1	2	0	0	0	6	0
Ashrae J	0.28	74	1	1	0	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Road Mater Pavement	0.28	37	6	3	1	2	1	1	12	1	1	2	4	1	2	0	5	0	2	1	1	2	3	0	1	1	0	1	0	0	0
Struct Concrete	0.27	3	2	7	3	1	6	0	1	6	0	2	8	0	5	0	6	3	2	4	1	2	4	2	2	0	2	0	2	0	0
Stahlbau	0.26	0	0	1	77	0	0	0	0	1	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	2	11	0	0	0	0
Bauphysik	0.20	1	0	1	71	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	2	7	0	0	0	1
PCI J	0.19	59	1	0	1	4	1	2	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ZKG Int	0.17	2	2	1	57	0	0	0	1	0	2	0	2	0	2	0	0	1	3	1	0	0	1	1	0	1	3	0	1	0	0
Cem Wapno Beton	0.16	0	2	9	9	0	5	0	2	0	4	0	0	0	1	0	1	0	0	0	3	0	1	0	0	38	0	0	1	0	0
Inf Constr	0.16	1	0	1	2	0	0	0	0	73	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Bauingenieur-Germany	0.16	0	0	0	72	0	0	0	0	0	0	0	0	0	0	0	0	1	11	0	0	0	0	0	0	0	9	0	0	0	0
Rev Constr	0.09	1	0	1	0	0	0	0	1	18	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0
J Asian Archit Build	0.07	2	7	0	0	0	42	30	0	1	1	0	0	9	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

The average percentage of institutional collaboration with other countries during the time period studied varies highly. Institutions such as Delft University of Technology, Technical University of Denmark, and Université de Sherbrooke represent a percentage of collaboration higher than 40%, while that of other institutions, such as Hong Kong Polytechnic University, Indian Institutes of Technology, National Technical University of Athens, Hong Kong University of Science & Technology, and Universidad Politécnica de Madrid, do not exceed 20%. Similarly to what we saw with countries, the differences in the number of authors and the number of institutions per article are not very significant. The majority of research institutions have a range of 2.5 and 3.5 authors per article and between 1.5 and 2.0 research institutions per article. The case of the Technical University of Denmark is worth highlighting, which not only has high quality levels, but also has the highest number of authors and institutions per article.

There are not large differences in the average IF among the different institutions and tends to be between 0.6 and 0.9. Among the 30 most productive institutions, the quality of research stands out in the cases of Technical University of Denmark (1.22), University of Tokyo (0.95), and Tsinghua University (0.89). Among the 100 most productive institutions, Shanghai Jiao Tong University stands out with 1.08 and 103 weighted articles; Southeast University with 1.02 and 88 articles; Dalian University of Technology with 1.04 and 79 articles; the University of Texas at Austin with 1.16 y 70 articles; and Katholieke Universiteit Leuven with 1.15 and 67 articles. The institutions that have been cited the most during this period have been Technical University of Denmark (14), University of California, Berkeley (11), CSIC (11), and University of Toronto (11).

By analyzing the evolution of the number of articles published throughout the time period, one can observe a general increase in publications by Chinese research institutions in the last few years, reaching the highest positions in the ranking (Table 3). From 2009 to 2011, the 5 institutions at the highest levels are Hong Kong Polytechnic University, Tongji University, Tsinghua University, City University of Hong Kong, and University of Hong Kong. Universities from the United States have maintained their positions despite competition from Chinese universities. The University of Illinois, the University of California, Berkeley, and Purdue University hold the highest positions. The increase in the number of articles published in the last years by Delft University of Technology, Texas A&M University, and University of Tokyo (Fig. 8) also stands out. Inversely, institutions that occupied the highest positions during the 1997–1999 time period, such as University of Sydney, University at Buffalo, King Fahd University of Petroleum and Minerals, Pennsylvania State University, Northwestern University, and Technion Israel Institute of Technology, have experienced a fall of more than 40 slots in the rankings with moderate decreases in certain institutions, such as National University of Singapore. In the particular case of the University of Texas, if the articles of the different institutions into which it has been divided since 2008 (University of Texas at Austin, University of Texas El Paso, and so on), were counted as coming from the same institution, its position in the rankings would increase from 14th in the years between 2006 and 2008 to 11th from 2009 to 2011.

As for qualitative indicators, the impact factor has experienced a significant increase from 2006 (Fig. 9). There does not seem to be a correlation between impact factor and number of publications. There are substantial differences in impact factors that surpass 0.5 points among institutions with similar numbers of articles in the latest period. The four institutions with the highest productivity levels have successfully combined productivity with the impact and diffusion of their work, reaching IFs superior to 1.2 in the latest period. The high IFs of Tsinghua University and City University of Hong Kong also stand out at third and fourth in productivity levels during that period, as well as other centers with lower production levels, such as CSIC. The Technical University of Denmark has reached the highest IF values in the last 15 years.

Just as in the case of IF, the average number of citations received per article seems to be conditioned by the corresponding period and values range close to the total global average (Fig. 10). Again, the Technical University of Denmark has reached the highest number of citations, surpassing the average of 30 citations per article between 1997 and 2002. The Hong Kong Polytechnic University, University of California, Berkeley, University of Illinois, University of Hong Kong, and CSIC also stand out by maintaining a significantly higher number of citations per article than the average during the entire time period.

3.5. Internationalization and diffusion of journals in the last few years (time period 2007–2011)

The analysis that has taken place allows for the identification of the principal countries that publish in each of the journals of the category in the last few years. This information is complemented by the average IF for the period between 2007 and 2011, which was calculated solely with the information available for each year. For this reason it should be considered as a guiding indicator and not be taken as a strict indicator when used to compare the impact of different journals.

The journals with the least impact generally have less international diffusion and an elevated percentage of articles come from a reduced number of countries (Table 4). This phenomenon is especially distinguishable in German journals, limiting the international diffusion of the results. In consequence, the impact index of German publications has experienced a strong fall in the last few years. On the other hand, publications from journals with a higher average impact factor during the time period are the most internationalized and the countries with higher production levels have especially important influence.

On the other hand, journals with lower average impact indexes tend to have a high percentage of publications in the country where the journal is edited. This fact seems to indicate a preference towards publishing in the country of origin, which could be explained due to factors such as language, higher diffusion, or the tradition of the national journal. In journals with higher impact indicators, the nationality of researchers that publish in the articles is much more heterogeneous and it is common to find a prominent participation by countries with higher production levels.

4. Conclusions

The main contribution of this study is to offer a global vision of research activity in the field of construction and building technology in the last few years. The results of this study can be of great utility for organization and research planning in the construction field. Among our diverse findings, we would like to highlight that the study:

1. Demonstrates the great expansion of research activity in the field of construction and building technology in the last few years by quantifying the increase in weighted production, impact, and collaboration on a global scale, national scale, and research center scale. This information will provide reference levels for comparison and evaluation of the merit of the research undertaken according to determined contexts.
2. Identifies the evolution of research topics over the years and highlights the most relevant and fastest growing topics in the last few years (Concrete, Strength, Performance, Paste, Composite, and so on). This demonstrates the increasing interest in research related to efficient energy

and comfort in construction (Simulation, Environment, Energy, Thermal Comfort, and so on). It also identifies those topics that have aroused less interest in the last few years (Reinforced Concrete, Silica Fume, and so on). It demonstrates that there exists a great heterogeneity of research topics and that a small group of said topics appear with great frequency while the majority appear in a small number of articles. It will allow researchers to shed light on the themes at play in order to determine which ones have been maintained for long periods of time and which ones have ceased to captivate the interest of researchers and journals.

3. Determines the evolution of geographic and institutional distribution of publications. This information can be used by national players and research centers to value their positions in an international context and to determine the effectiveness of investments and plans of action. We have highlighted that scientific production is extremely concentrated in few countries (30 countries are responsible for 89% of scientific production). The great increase in importance of Chinese research centers also stands out. They have positioned themselves at the top of the list in the last few years and have maintained excellent levels of impact.
4. Establishes the publication preferences in the journals of this category for different countries and relates the results with productive and impact indicators. This will allow researchers to see what journals their colleagues do and do not publish in. Additionally, it demonstrates the trend of journals of lesser impact to publish articles from national centers and shows the low impact of research from certain countries due to the concentration of their articles in national journals.

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