

Soundscape: technological mapping

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ABSTRACT

This paper presents an overview of technical-scientific developments related to soundscape. The results are obtained from the database of technological information on patents and scientific articles. The results indicate that the developments related to the theme are recent, presenting a significant growth of publications from 2014, when about 50% of the invention patents were filed in industrial property offices around world.

Keywords - Soundscape, Patents, Technology prospection

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I. INTRODUCTION

As a result of industrial and technological development, various sources of environmental pollution have caused a series of damages to the environment and to human quality of life. Due to the increase in problems caused by urban noise, noise pollution has become one of the main aggravating factors for human health, leading to a deterioration in the quality of life in cities, losing only to air and water pollution [1].

Over the years, the sound evaluation was based on the epidemiological aspects of noise, with the implementation of international environmental policies with the purpose of noise control [2]. In this sense, from the quantitative approach to sound, European countries were pioneers in terms of measures and legislation aimed at noise mitigation, such as the Green Paper and the European Directive 2002/49/EC. However, some studies point out that the reduction in noise levels does not necessarily result in an increase in the positive perception and quality of the acoustic environment [3].

The quantitative approach to noise in cities is directed towards the assessment of acoustic environments and comparison with reference values of noise levels present in technical standards and legislation [4]. Calculations, measurements of sound levels and computer simulations can be performed to prepare acoustic maps, which illustrate the configuration of environmental noise in a given area, so that they can be used in the management of noise in cities, identifying areas where there is excess noise, to assist in urban planning.

From the 1970s on, this approach starts to be questioned by a group of researchers coordinated by Murray Schaffer, Canadian professor, writer and musician. Schaffer and his colleagues believed that in order to assess the sound environment, it would be

necessary to consider the numerous human aspects involved in sound perception. Thus, they defined the term "soundscape", which can be translated as sound landscape, being characterized as a multidisciplinary field, in areas such as architecture, acoustics, psychology and sociology [5].

The concept of soundscape proposes the evaluation of sounds perceived in an environment, not only in its physical dimension, but in all its complexity, thus, are considered the context, human perception and their correlations. Soundscape takes into account the assessment of all sounds perceived in an environment, considering all its complexity [6]. Recent studies have shown that the assessment of urban soundscape are very complex, because numerous factors should be considered.

The field of study in soundscape is gaining strength in recent years, due to the need to overcome the management approach of urban environments based only on noise control policies. Thus, there was an increase in the number of scientific publications related to soundscape [3].

In 2014, the first standard on soundscape was launched, ISO 12913:1 - Acoustic Soundscape - Part 1: Definition and conceptual framework [6]. Considered an advance for the field of study in soundscape, the standard provides a definition and conceptual structure for soundscape, presenting relevant aspects, as well as for the planning, design and management. In this standard, soundscape is defined as "the acoustic environment perceived, experienced and/or understood by a person or people, in the context. The second part of the standard was released in 2018, ISO 12913:2 - Acoustic Soundscape - Part 2: Methods and Measurements, and presents the procedures for data collection and requirements for application in the assessment of sound landscape [8].

For the assessment of soundscape can be used, for example, predictive models, indexes and parameters. The descriptors of the sound landscape are evaluated through methodological processes and seek to measure how people perceive the acoustic environment [5]. There is a wide variety of methods used by researchers in the evaluation of the sound landscape, such as in loco observations, interviews, questionnaires, soundwalks, binaural acoustic measurements and computational simulations.

As an example of described developed, it is worth mentioning the paper [8], who developed a model to represent a perceptual study for characterization of a soundscape, identifying two components: enjoyability and agitation. Reference [6] presents the literature review of research related to descriptors linked to the perception of acoustic characteristics, used for the assessment of the sound landscape, such as noise nuisance, sound agradability, similarity with music, among others.

Soundscape research has received significant attention in the last fifteen years. It is worth highlighting the publication of a special edition in *Acta Acustica e Acustica* (Journal of the European Acoustics Association) in 2006 [9]. The importance of soundscape has been recognized by government organizations and funding bodies in Europe, in view of the potential for promoting public health and quality of life, with the implementation of research projects, such as the Noise futures network, in association with the Positive Soundscape projects funded by EPSRC, UK (Engineering and Physical Science Research Council).

The understanding of soundscape assists in urban planning strategies, i.e. in the decision-making process of architects, engineers and city managers. Reference [9] points out, the high quality of soundscape can be obtained through solutions from the expectations of users, so that measures and strategies can be implemented to reduce or eliminate unwanted sounds. Sound masking techniques can be adopted, making use of psychoacoustic phenomena, or divert the attention of listeners to other more pleasant sounds, for example.

The present work aims at carrying out prospective studies on the basis of patents and scientific studies aiming at evaluating the development of technologies linked to soundscapes.

II. METHODOLOGY

The exploratory study carried out involved technological prospection in national and international bases, in addition to bibliographic research in scientific articles. The "technological prospection" can be defined as a systematic way of mapping future scientific and technological

developments capable of significantly influencing an industry, the economy or society.

For the prospecting of patents, the bases were used as tools: Wipo - Patent Scope, Espacenet and Patentinspiration. The choice of the mentioned tools was made after an evaluation of the available search systems and with allowed access. A previous survey was conducted in order to define the search bases to be adopted in the study. The keyword (soundscape) was used as a way to assess the ability to retrieve documents in the theme in question.

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III. RESULTS AND DISCUSSIONS

In the first survey, using the keyword (soundscape), 575 entries were retrieved in the Inspiration Patent tool, based on the search term present in any of the following fields of the patent documents: title, abstract, claim table or descriptive report. With this survey, it was possible to make a first analysis of the world scenario in relation to the types and areas of application of protected technologies.

Analyzing the distribution of the families of patents by the IPC, the technologies focused on the term "soundscape" are classified in 51 subclasses and are presented predominantly in the form of "Input provisions to transfer data to be processed to a form capable of being manipulated by the computer". The United States has the largest number of patent applications filed (317), followed by Holland (46), Japan (44), United Kingdom (37), Canada (30), Germany (19), Finland (15), Singapore (12), France (12), Israel (10), Belgium (9), Switzerland (8), France(8) and China (8), among other countries in lesser prominence, as can be observed in Fig 1.

The analysis of the temporal evolution considering the filing dates of the patents, revealed that since 1994 patent applications for technologies linked to the term "soundscape" have been registered (Fig. 2). In the years 2001, 2003 and 2006, the number of patents filed showed a representative growth. As of 2013, the number of applications started to show an exponential growth, reaching a peak in 2017. It is observed, however, that due to the confidentiality period of 18 months, the data for 2018-2019 are not complete. Probably, considering the evolution of technology, the results will continue to grow when these figures are computed.



Figure 1: Patents' countries which "soundscape"

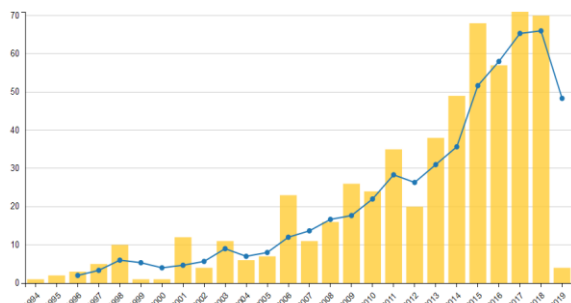


Figure 2: Temporal evolution patents

The analysis reveals that among the 575 patent publication registrations in the Inspiration Patent database relating to the term soundscape, only 269 applications were granted. The index of 46.78% of patent applications still under examination further reinforces the recent interest in the development of the technology cited.

Among the patents linked to soundscape technologies related to IPC G06F, E04H and H04R, it appears that out of a total of 262 applications, only 144 have been granted, indicating that 45.03% of patent applications are still pending. This fact proves that the search for patent protection of this technology is extremely recent.

To search for scientific articles in the Scopus platform database, the keyword (soundscape) was used, resulting in 3278 records. The data obtained were treated in order to enable a general evaluation in terms of subject area, historical evolution and country of publication.

The historical evolution of the publication of the articles reveals that since 1985 publications relating to the soundscape theme have been carried out, but only from 2003 onwards a more significant growth in the number of publications is observed, with emphasis on the exponential growth projected from 2009 onwards, with a peak in 2017, as can be seen in Fig 3. It is worth noting that the data for 2019 are not consolidated, given that the data collection was completed on August 16, 2019.

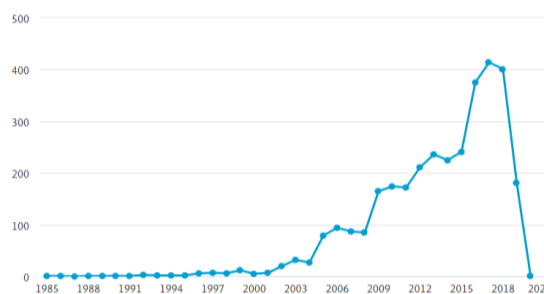


Fig 3: Historical evolution of paper soundscape

With regard to the country of publication of the articles, Graph 9 shows that the United States (710), United Kingdom (618), China (206), Germany (188), France (182), Italy (182) and Canada (179), Australia (179) and China (162) together represent 72.24% of the publications in the area. Although the authors of articles on this topic tend to publish in national journals due to the inherent nature of the theme, it is important to note that the indication of the country used in this graph refers to the country of origin of the journal. Brazil stands out with 68 publications, occupying the 17th position.

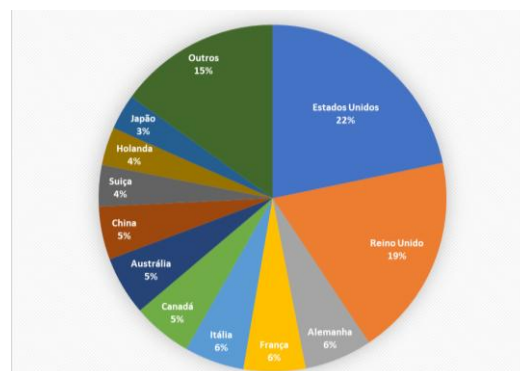


Figure 4: The countries that have published the most articles on the soundscape theme

When analyzing the institutions that have most published scientific articles on the soundscape theme, it is observed the absolute predominance of universities, which occupy the top 10 positions in this ranking, differently from what was demonstrated with the analysis of the largest patent applicants, which are companies, mostly from the technology area, as shown in fig 5.

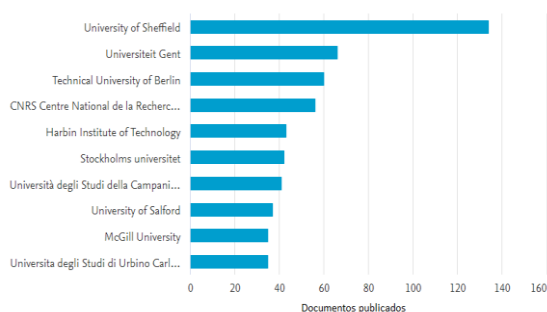


Figure 5: The institutions that have published the most articles on the soundscape theme

Regarding the type of publication, there is a predominance of articles in journals (1474), publications in conferences (1225), book chapters (235), review articles (164), review articles in conferences (164) and books (55).

IV. CONCLUSION

The results of the technological prospection in patent databases reinforced that the developments related to the soundscape theme are relatively new, considering that 44.4% of the patent deposits are concentrated in the last 5 years. This motivation may be related to the publication of the first part of ISO 12913:1 - Acoustic Soundscape - Part 1: Definition and conceptual framework [6], which occurred in 2014.

It was also possible to note that the United States, the Netherlands, Japan, and the United Kingdom stand out respectively as the largest patent applicants with technologies aimed at soundscape. However, with regard to patents involving the direct application of soundscape in urban planning, the United Kingdom leads the patent deposit. This is also observed in relation to scientific production, according to the results of publication data on a scientific basis.

The scientific production reached the maximum percentage in 2018, which coincided with the publication of the second part of ISO 12913:2 - Acoustic Soundscape - Part 2: Methods and Measurements, which presents the procedures for data collection and requirements for application in the evaluation of the sound landscape [7].

The technical-scientific production in Brazil in the current study area was practically inexpressive, distant from the great powers both in quantitative terms, given that there are no patented products or methods, as well as a low scientific production related to the theme, occupying only 170 place in the world position. Such information shows a gap in this area of study in the country, and it is necessary to advance in view of the importance of the theme for urban planning. Based on the results obtained, it is clear that prospective studies are tools

that can significantly contribute to the formulation of national public policies.

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