acoustics

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Comparing Turkish and European Noise Management and Soundscape Policies: A Proposal of Indoor Soundscape Integration to Architectural Design and Application

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Received: 3 October 2019; Accepted: 1 November 2019; Published: 8 November 2019

Abstract: Improving soundscape studies and policies states that the soundscape approach, which also considers noise interventions, should replace noise management. However, a considerable number of soundscape studies have been concerned with the quality of acoustic environments of open and urban public spaces. This study focuses on indoor soundscaping and its possible integration into the architectural design and application process. Therefore, the present and ongoing Turkish and European soundscape and noise management policies were evaluated in detail and compared in order to characterize the gap regarding the state of indoor soundscaping between the literature and the policy development level. Furthermore, we identified and classified factors and methods which have an influence on indoor soundscaping to be integrated into the final proposed model. As a result of the detailed evaluation regarding policies and indoor soundscaping principles, five stages were proposed that can be used in an integrated indoor soundscape model: (1) the establishment of a topic specific institution or working group on indoor soundscaping; (2) the preparation of a standard that includes definitions, indoor soundscape factors and methods; (3) the preparation of an indoor soundscape directive; (4) the preparation of indoor soundscape guidelines; and (5) the provision of maintenance and supervision by experts and authorities.

Keywords: soundscape application; soundscape policies; noise management policies; indoor soundscape factors; indoor soundscape methods

1. Introduction

Noise management applications have generally been used over the years to avoid the negative impact of noise exposure. However, "reducing the sound levels from certain sound sources may not necessarily result in an acoustic environment of high quality" [1]. The development of soundscape studies has brought a different perspective to the argument. When the noise management and soundscape approach are compared regarding their respective approaches toward handling acoustic environments, it can be seen that the soundscape approach tries to introduce a method which concentrates on attaining preferable and healthy sound environments with broader dimensions. These broader and differentiated methods and approaches of soundscaping are discussed and presented in various studies on open and enclosed environments with different functions, and presented as a collected work in the literature [2,3]. Thus, discussions have begun on the necessity of soundscape applications in practice. The first attempt was revealed by International Organization for Standardization (ISO) through the establishment of a working group called "perceptual assessment of soundscape quality"

(ISO/TC 43/SCI/WG 54) and the publication of two standards on urban soundscape principles [4] and data collection methods [5].

Although the studies and actions regarding the soundscape approach have focused on the urban scale, indoor soundscape frameworks should also be considered regarding governmental implementations to enhance indoor sound environments and life quality. Therefore, the integration of indoor soundscaping into architectural design and application processes is crucial, and initial research toward this has been conducted and presented [6].

When the existing implemented policies on noise interventions and urban soundscape are evaluated, process emerges for investigating the improvement of indoor soundscaping applications. Therefore, as a first step, soundscape and noise management policies in Turkey and Europe were assessed in detail to determine the present condition and identify the needs for the integration of indoor soundscaping. These considered Turkish and European policies are systematically reviewed, compared, and evaluated in detail. Secondly, the indoor soundscape factors were identified and related items under each factor are presented. These identified factors are integrated with the architectural design and application process in the proposed model for further investigation on the possibility of their standardization as part of the indoor soundscaping policy development. As the final step, the overall proposed indoor soundscaping integration model is presented in detail.

The preliminary literature review of this study and the detailed comparison and evaluation of Turkish and European policies were presented in the ICA 2019 conference in Aachen, Germany [7], and in the 13th Turkish National Acoustical Congress in Diyarbakır, Turkey [8], respectively.

2. Soundscape Policies

Soundscape studies have been developed progressively in recent years as soundscapes have considerable importance for improving life quality by enhancing urban and indoor sound environments. When attempts to address soundscape are evaluated under the scope of governmental/official institutions and organizations, it can be seen that European policies are well developed. In fact, institutional documents and actions related to the improvement of soundscape and funded by governments have been observed in the European Union (EU). Although documents and actions in Europe have operated within an urban scale framework, they might be used as guides, providing a starting point for indoor soundscape applications.

2.1. Published Documents on Soundscape

As a result of the investigations on soundscape policies in Europe, three publications stand out. The first is the ISO 12913-1 standard [4] that was published by the ISO working group ISO/TC 43/SCI/WG54 in 2014. This standard includes the related definitions and the factors interacting with and influencing each other in context. ISO 12913-1 shows that it is possible to standardize the factors of soundscape.

The second publication is the ISO 12913-2 standard [5], which was published in 2018 as the second part of the ISO 12913 series. This standard aims to specify the "requirements and supporting information on data collection and reporting for soundscape studies, investigations and applications". [5] However, these two standards were published for urban soundscape principles; therefore, an indoor soundscape standard has not yet been studied within a specialized scope.

The third publication is the ISO 12913-3 standard [9] that is under development. This document is a follow-up standard to the previously published standards on soundscape as Part 1 and Part 2 and focus on the data analysis.

Another publication, "Good Practice Guideline on Quiet Areas", was published by the European Environment Agency (EEA) in 2014 on open public quite areas, and suggests combining different methodologies identified as "(1) noise mapping by modeling and calculations, (2) actual measurements of sound-pressure levels in situ, (3) evaluation of user/visitor experiences (i.e., the soundscape approach), and (4) expert assessments" [10] in order to maintain and manage the areas with good environmental

noise quality [11]. This guideline also states that current noise measurement techniques do not have the ability to measure the acoustic quality of an area, which necessitates new approaches to assess the soundscape framework [10].

2.2. Soundscape Actions and Projects

In addition to the publications on soundscape, other operations include the "Soundscape of European Cities and Landscapes" project as a COST Action progressed between 2009 and 2013, and the Soundscape Indices (SSID) project, started in March 2018 and funded by the European Research Council (ERC) of the European Commission (EC).

COST Action had been purposed to provide practical guidance by organizing an international network consisting of 23 COST countries and 10 participants from non-EU countries, including Turkey [2]. The essential aim of the action is "to supply underpinning science of soundscape and improve the soundscape framework to more advanced position from the present condition, through coordinated international and interdisciplinary approach" [2]. COST Action had been aimed to advance soundscape into present policies and practice to enhance and/or preserve sound environments [2]. The other objectives stated in COST Action as the secondary objectives are as follows:

1. Understanding and exchanging by advancing the interdisciplinary exchanges, exchanging know-how on international/interdisciplinary basis, and examining the differences of cultures.
2. Collecting and documenting through; soundscape data gathering that is reanalyzed in an interdisciplinary approach.
3. Harmonizing, which includes reviewing and harmonizing the current methodology, developing a standard protocol, and laying the foundations for future European/international standards.
4. Creating and designing through the provision of practical guidance and tools for the design of soundscapes and providing guidelines for the preservation of architectural heritage sites.
5. Outreaching and training for the creation of awareness among the general public, stakeholders, and policy makers in addition to the provision of training for early-stage researchers [2,12].

After the finalization of COST Action, the Soundscape Indices (SSID) project began in 2018. This project states that noise level reduction is not sufficient to enhance the quality of life or the consideration of acoustic environments as perceived as being necessary [13]. The objectives of SSID are:

1. To characterize soundscapes by capturing them and establishing a comprehensive database, which will be a cornerstone for any proposed analysis and an invaluable resource for scientists for years to come;
2. To determine key factors and their influence on soundscape quality based on the database by conducting laboratory psychological evaluations, physical/psychoacoustic factors analysis and, more importantly, to perform research at a physiological/biological level, including the use of functional magnetic resonance imaging;
3. To develop, test, and validate the soundscape indices through analyzing the influences by various factors using a number of interdisciplinary and transdisciplinary approaches; and
4. To demonstrate the applicability of the soundscape indices in practice by establishing frameworks for soundscape prediction, design, and standardization [13,14].

The COST Action on "Soundscape of European Cities and Landscapes" led to the development of the already published standards on soundscape, and clearly shows the benefit of the comprehensively and professionally organized working groups under the EU COST program. However, ever since the COST Action and SSID projects were started in order to develop urban scaled sound environments, they both still do not specifically include an indoor soundscape approach.

3. Noise Management Polices and Applications

Noise and its adverse health effects are important to consider in related research fields. The soundscape approach is concerned with managing unwanted sounds in order to improve the quality of acoustic environments. Even if noise management applications are stated as insufficient to provide the best acoustic quality, the evaluation of present noise management policies is crucial in order to investigate the integration of soundscape principles into the architectural design and application process.

3.1. Noise Regulations in Turkey and Europe

When the present noise regulations/directives of the EU and Turkey were evaluated, six regulations on noise management were discovered. Table 1 presents a comparison of regulations in Turkey and the EU in terms of the scope and regulation numbers (official journal issue numbers are used for those which do not have regulation numbers, and these are indicated as issue number (IN)). As a result of the initial comparison, it was seen that four of the six Turkish regulations were prepared as directives equivalent to the European directives. These equivalent directives pertain to environmental noise management [15,16], protection of workers from the risks of noise exposure [17,18], noise emissions of outdoor equipment [19,20], and sound levels of motor vehicles [21,22]. Moreover, in Turkey, there is a regulation on the "protection of buildings against noise" [23]; however, an equivalent directive in the EU does not exist. Furthermore, the EU has a directive on noise-related operating restrictions at airports [24], which is not published in Turkey as an equivalent directive. The latest regulations/directives that are published in full text are used and cited in this study and are shown in bold.

Table 1. Comparison of noise regulations in Turkey and Europe (Data From [7]).

Scope of Regulation	Turkey	European Union
1. Environmental noise	**2002/49/EC** [15]	**Directive 2002/49/EC** [16]
2. Protection of buildings	**23616 (IN)** [23]	-
3. Protection of Workers	**18647 (IN)** [17] Reference: 2003/10/EC	**Directive 2003/10/EC** [18]
4. Airports	-	**Directive (EU) 598/2014** [24] Repealed 2002/30/EC
5. Outdoor equipment	**2000/14/AT** [19] Reference: 2005/88/EC Reference: 2000/14/EC	**Directive 2005/88/EC** [25] Amended 2000/14/EC
6. Motor vehicles	**70/157/AT** [21]	Regulation (EU) 540/2014 **Amended 2007/46/EC** [22] Repealed 70/150/EEC

Turkish regulations are all published and prepared by the related ministries. European regulations are published and prepared by the European Parliament and the Council of the European Union. The equivalent regulations have the same content and scope. The regulation on environmental noise in Turkey is one of the regulations that has been prepared as an equivalent regulation to the European directive, and they have the same content and scope. Environmental noise management regulations are prepared for open public areas where people are more exposed to environmental noise.

The regulation on protection of building against noise is published in Turkey, but its equivalent directive is not found in Europe. This regulation aims to regulate design, construction, usage, maintenance, and management rules to minimize the adverse effects of noise. To enhance people's welfare in an enclosure and control noise that arises during construction, management, and usage, several classifications and rules are indicated, depending on the functional properties of buildings and neighbor relations of the spaces by demonstrating construction materials and components, noise and

insulation indicators, acoustical performance rates, and usage of installation and service equipment. Moreover, this regulation stipulates the supervision and licensing of management and construction projects and license rules in order to maintain control during building use as well as over the obligations and responsibilities of authorities for maintenance. This regulation is promising, acting as a backbone and starting point for the preparation of a possible future indoor soundscaping regulations or standards, as the rules have been prepared according to the function of each building and the neighboring relations between spaces.

Another regulation pertaining to indoor spaces that is also mentioned in the regulation regarding building protection relates to the protection of workers from noise. The origin of this regulation is the EU, and the Turkish equivalent has been prepared with reference to Directive 2003/10/EC [18]. Hence, the content and scope of these regulations [17,18] are identical. These regulations aim to provide the minimum requirements for the protection of workers from the adverse effects of noise exposure, including hearing impairments, outlining exposure limit values as well as reducing and limiting exposure. These regulations also aim to inform workers about personal protection and raise employers' awareness of their obligations.

Another directive that is specific to the EU and does not have an equivalent in Turkey pertains to airports. This directive was published to determine the rules of noise-related operating restrictions at EU airports and the protection of people from the adverse effects of aircraft noise [24]. Directive 598/2014 includes the rules on aircraft noise management and assessment, noise performance information, exemptions for aircraft operations of an exceptional nature, and delegated acts of operation.

The last two regulations pertaining to noise emissions of outdoor equipment and motor vehicles are of EU origin, and were published in Turkey with reference to European directives. Regulations on outdoor equipment (some examples of equipment mentioned in the regulations such as combined high-pressure flushers and suction vehicles, compressors, concrete breakers or mixers, water pump units) aim to provide rules and standards on permitted sound power levels, noise marking and standards, conformity assessment procedures, placement on the market, market surveillance, and noncompliance of equipment [20].

The detailed information on the content and scope of the directives on motor vehicle noise emissions and exhaust systems were not included in this study since the content of these directives is not directly relevant to the subject, with the exception of the noise emission standards. They have, in fact, focused more on the exhaust systems of motor vehicles.

All the regulations cited in this study were prepared and published for managing noise by applying sanctions on rules and to integrate the relevant standards to application and maintenance processes. Noise policies and regulatory approaches in Turkey have progressed in line with the EU.

3.2. Noise Guidelines in Turkey and Europe

Other governmental documents that should be assessed in addition to regulations are noise guidelines because of their cooperation with the regulations. The essential aim of these noise guidelines is "to provide recommendations for protecting human health from exposure to environmental noise" [26] and to support the implementation of environmental noise directives [27]. In Europe, the World Health Organization (WHO) published a series of guidelines on environmental noise and the harmful health effects of noise exposure for the European region. The guidelines in Turkey, on the other hand, were prepared by the Ministry of Environment and Urbanization under the scope of the twinning project TR/2004/IB/EN/02 "Harmonization and Implementation of the EU Directive Related to Environmental Noise Management", which is promoted by the EC. Table 2 presents a list of these guidelines with full titles (titles of Turkish guidelines were translated into English) regarding environmental noise both in Turkey and in Europe.

Table 2. List of noise guidelines in Turkey and Europe. WHO, World Health Organization; EC, European Commission (Data From [7]).

Turkey	Europe—WHO and EC
1. Guideline on environmental noise measurement and evaluation [28] 2. Guideline on noise reduction precautions [27] 3. Noise mapping guideline [30]	1. Environmental noise guidelines for the European Region [26] 2. Guidelines for community noise [29] 3. Night noise guidelines for Europe [31] 4. Methodology for systematic evidence reviews for the who noise guidelines for European region [32] 5. Biological mechanisms related to cardiovascular and metabolic effects by environmental noise [33] 6. Burden of disease from environmental noise [34] 7. Results from the search for available systematic reviews and meta-analyses on environmental noise [35] 8. Good practice guide for strategic noise mapping and the production of associated data on noise exposure [36] 9. Good practice guide on noise exposure and potential health effects [37]

Guidelines in Turkey relating to environmental noise measurement and evaluation [28], noise reduction precautions [27], and noise mapping [30] have not been prepared with reference to WHO guidelines, as can be seen in the regulations. However, the Turkish guideline on noise mapping has been prepared with reference to the EC's noise mapping guidelines [36] and the Turkish guideline on environmental noise has been prepared with reference to the EEA's guidelines [37] under the twinning project. When the European noise guidelines are evaluated, a process of development can be clearly seen. The previous environmental noise guidelines of WHO were the Guidelines for Community Noise [29], published in 1999, and were more expert-based and included more detailed technical issues on sound measurements and sources. The Night Noise Guideline [31], published in 2009, is related to night noise exposure, sleep disturbance, and night noise levels. WHO's subsequent enhanced environmental noise guidelines [26,32–35] were published and included broader health outcomes of noise exposure, management of indoor noise levels, and management of noise policies and regulatory standards [26]. During this development process, WHO revealed the guidelines that focused more on adverse health effects to inform the public and to attract attention to the negative effects of noise exposure.

When the European and Turkish guidelines are compared, it can be seen that the Turkish guidelines are more similar to WHO's previous guidelines and past publications of the EC and EEA. Moreover, they have deficiencies in health outcome information. Since providing information to the public and related disciplines on the health effects of noise exposure is crucial to providing awareness of noise hazards, guidelines on the health effects of noise should also be developed in Turkey.

3.3. Turkish and European Standards on Noise Management

More than fifty standards in total can be found in the literature. These are published under the name "ISO/TC 43 Acoustics" by the technical committee, and include items such as recommended sound levels, acoustical measurement protocols, evaluation and rating scales that are being used in noise directives and guidelines. The Turkish Standard Institution (TSE) has translated most of these standards into Turkish. These translated Turkish Standards (TS) have been used in the Turkish regulations and guidelines.

Regarding the soundscape regulatory attitude, present standards on acoustics make it essential to use standardized sound levels, measurement techniques, and data collection methods. The conspicuous standards used in current directives and guidelines and presented in the Appendix can also be used or mentioned in possible future regulations and/or guidelines on indoor soundscape. The reason for the necessity of noise-related standards in soundscape design is the consideration of noise masking in

addition to positive sounds [12]. These standards are ISO 1996-1:9982 (TS equivalent: TS 9315 ISO 1996-1) [38] and ISO 1996-2:1987 (TS equivalent: TS ISO 1996-2) [39], which are related to environmental noise measurements, evaluations, and sound levels. Additionally, several standards published by the Building Acoustics Technical Committee (ISO/TC43/SC 2) and standards of the Noise Technical Committee (ISO/TC43/SC 1) may also require consideration for an indoor soundscape regulatory approach. Since an indoor space is exposed to environmental noise besides sounds originating from indoors, standards on environmental noise levels, management, and assessment need to be considered. In addition, further detailed study on the content of acoustical standards is required to determine the relationship between these standards and indoor soundscape factors, and to specify how these acoustical standards would contribute to the architectural design and application process of indoor soundscapes.

4. Indoor Soundscaping

4.1. Indoor Soundscape Factors

The most apparent characteristic of soundscape approach and by which it differs from noise management is the multifactorial context of the soundscape research field, in addition to acoustical measurements. The main focus of the soundscape approach is on user cognition and the factors that influence user cognition. The multifactorial approach of soundscapes makes it more complicated in application; therefore, the identification and standardization of factors is essential. Through the review of several studies on both urban and indoor soundscape factors in the literature [4,12,40–45] and the guidance of ISO 12913-1:2014 [4], it is possible to identify or propose a model for indoor soundscape factors.

As a soundscape heavily depends on the perception of the sound environment, urban soundscape research field deals with acoustical measurements and various contextual factors to evaluate user perception. ISO 12913-1:2014 indicates the seven main concepts as "context, sound sources, acoustic environment, auditory sensations, interpretation of auditory sensations, responses and outcomes" in order to define the process of "understanding" or "perceiving" the acoustic environment. These seven concepts are related and work interactively with one another. Context has an interaction with "person, activity and place in space and time", and it has an influence on a soundscape through the concepts of auditory sensation and interpretation of auditory sensations/auditory perception and responses. Moreover, these three concepts are influenced by different factors such as personal and cultural characteristics, expectation, attitudes, past experiences, activities, moods, temporal situations, lighting, and thermal conditions.

However, urban soundscape factors alone are not adequate for evaluating an enclosed soundscape and architectural factors should also be considered. Therefore, differently from soundscape on an urban scale, indoor soundscape factors can be classified into three main concepts as suggested in Dökmeci and Kang's model [43], where the architectural factors are integrated into acoustical and contextual factors. Torresin et al. also stated the factors of indoor soundscape for a study on residential areas [45]. In that study, in addition to acoustical, contextual, and urban-related factors, house-related factors were indicated as "room location", "building insulation", and "window opening position" [45]. Another model was suggested in Herranz-Pascual, Aspuru, and García's study [44] which defined user, activity, and place interaction to explain "environmental experience". Based on Herranz-Pascual, Aspuru, and García's model, it can be said that contextual factors answer questions such as "how people experience and perceive their built and acoustic environment", "what type of sensations they have", "how they evaluate them", and "what behavioral responses are obtained". When the contextual factors are assessed in more detail, the expectations mostly formed by past experiences [42] and preferences differ according to the place, activity, and function [12] stand out compared to the other dimensions. Moreover, expectation has an influence on behavioral outcomes, but the expected soundscape is not always the same as the preferred soundscape [7].

Architectural factors which are specific to an indoor soundscape framework can be assessed in three subgroups based on the studies in the literature [40,43,45,46]: function, architectural properties, and physical environment. While the architectural properties of a space are important for its remarkable influence on the formation of sound [43], the function of a space is important due to its direct relation to the expectation and preference of users.

A merged model for indoor soundscape factors, as in Figure 1, is prepared based on the related studies in the literature. The factors of indoor soundscape are assessed in three main concepts as "acoustical variables", "contextual factors", and "architectural factors" in the proposed model. Acoustical factors are needed in order to understand the physical properties of sound and the perceptual evaluations of objective outcomes. Secondly, contextual factors can be assessed in four main elements as temporal data, psychological conditions, behavioral attitudes to soundscape, and the personal/demographical information of users. Thirdly, the architectural factors, which have direct effects on indoor soundscape, are divided into three elements as function, architectural properties, and physical environment.

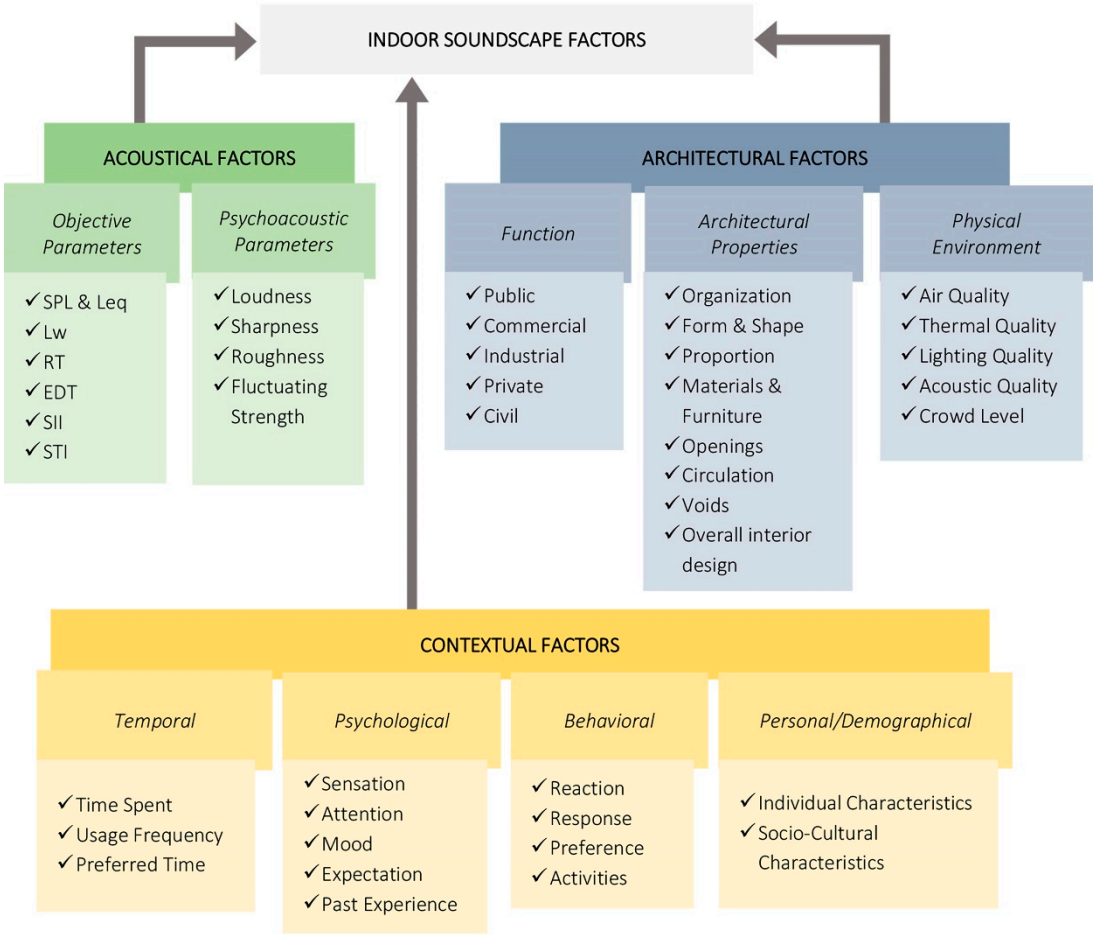

Figure 1. Merged classification model for indoor soundscape factors [4,7,12,40–46].

4.1.1. Acoustical Factors

Acoustical factors are needed to identify the physical characteristics of sound with objective parameters and subjective evaluations of sound regarding audience perception using psychoacoustic parameters. Objective parameters are used in both soundscape studies and the noise management approach, including governmental and institutional documents (regulations, guidelines and standards). However, because of perceptual data outcomes, psychoacoustic parameters are commonly used in soundscape studies.

4.1.2. Contextual Factors

Contextual factors of soundscape are directly based on an individual's cognition and the parameters that influence the individual's cognition. This can be mainly assessed in four categories as temporal, psychological, behavioral, and demographical characteristics. Temporal parameters rely on the relationship between person/audience and time within a space. The three temporal dimensions—time spent, frequency, and time preference—are determinant and distinctive for indoor soundscaping, and specify the frame of the study. Psychological factors (attention and mood while listening, past experiences and expectations) have an influence on the perception of soundscape and behavioral outcomes (reactions and responses of user to acoustic environment and soundscape preference of a place). Personal and demographical information have an importance in the soundscape study field in that they allow characterizing the users of a place or the participants of a soundscape study. Different user profiles may reflect different soundscape perceptions. Personal and demographical information (which can also be seen in the model of Herranz-Pascual et al. [44]), such as age, gender, cultural and social differences, personal characteristics, health conditions, and lifestyle, have an influence on soundscape expectations and preferences. Hence, the entities under the contextual factors have an impact on the soundscape perception of people and they work in an interactive manner with each other (Figure 2).

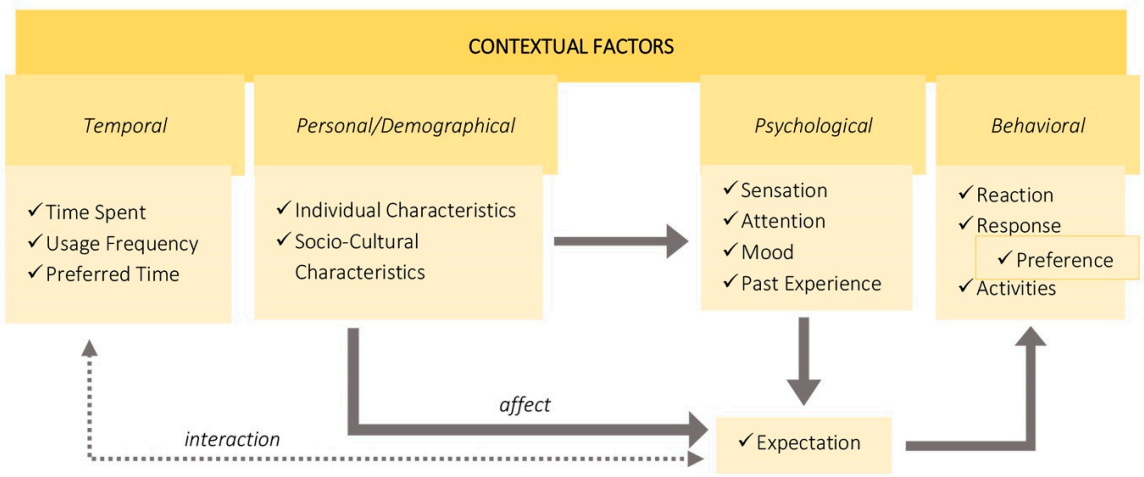

Figure 2. Relationship between the entities of contextual factors [12,42,44,47].

The two-way interactions between separate items of the contextual factors shown by dotted arrows and the one-way effect of identified items to others shown by bold arrows are presented in detail, as seen in Figure 2. Soundscape expectation is one of the most important items, and has an effect on behavioral outcomes. However, soundscape preferences may be thought of as being separate from other outcomes as the expected soundscape does not always match with the preferred soundscape of a place. Since expectations and preferences are the most significant dimensions that influence soundscape perception, they need to be assessed in more detail.

The soundscape expectation of a place is mostly composed of the past experiences of users. Therefore, while people identify the soundscape expectation, they make decisions using their informational background on similar places they have previously experienced. Bruce and Davies' study [42] indicates that soundscape expectation relies not only on the expectation of sound sources but deals with "expected places", "expected control", "expected behavior", "expected activity", and "expected information". In further detail, expected places refers to the overall place expectations of a user. "Expected control" relates to the expected rules that are derived from previous experiences in similar environments and if a soundscape fails to provide the expected environment, and a participant's "ability to control their activity within the soundscape". Moreover, the question is asked: "Can they

remove themselves or particular sounds from the current soundscape space or have the ability to control their interaction with the space?" [42]. Expected behavior and activity represents the user's expectation from other users' behavior and activities. Finally, Bruce and Davies explained "expected information" as "a combination of activity and source expectations related to an expectation of obtaining information" and exemplified it as the ability to hear conversations, announcements, or the phone ringing. When these six dimensions (expected sound, expected places, expected control, expected behavior, expected activity, expected information) meet users' expectations, the perception of users may not be negative despite the presences of any annoying sound [42]. As a consequence of this, expectations affect people's perceptions and evaluations of a soundscape as well as conclusions about whether a soundscape is pleasant or unpleasant.

The soundscape preference outcome of people differs in different places and for different activities or functions. For example, while the reasons for preference include "peaceful" or "tranquil" for a soundscape, another soundscape may be preferred because of its "lively" or "excited" properties [12]. Regarding the indoor soundscape approach, user preference is one of the most important factors for understanding the soundscape needs of an enclosure and to form a pleasant and acceptable soundscape.

Depending on the preference, the masking tool has been discussed as a promising key in soundscape studies. The masking tool can be used to design soundscapes considering the preference factor through the identification of wanted sounds and unwanted sounds, so that masking sounds can be promoted. In other words, preferred sounds should not be masked by unwanted sounds, or wanted sounds should mask unwanted sounds [12].

In conclusion, the soundscape approach is a rather subjective field because of its direct relationship with user perception. Therefore, a consideration of the contextual factors that ascertain user perception in the design process of soundscape is crucial.

4.1.3. Architectural Factors

The architectural factors, which are a distinctive field of indoor soundscaping, should be evaluated in the soundscape design process to characterize an enclosure and its relationship to the acoustic environment. Architectural factors can be evaluated under three main subjects of function, architectural properties, and physical environment (Figure 3). The two-way dotted arrows indicate the interactions between items from architectural factors with acoustical and contextual factors, whereas the two-way bold dotted arrows indicate the interactions between items within the architectural factors. Similarly, the one-way dotted arrows indicate the affected items by the identified architectural items, whereas the one-way bold arrow indicate the affected item within the architectural factors.

Information on the function of a space is important for the design process of a soundscape as it can help to collect possible future predictions regarding the preferences of users. The expectations of a soundscape that usually depend on the past experiences of users differs in different functions. Hence, regarding the architectural design process, the type of building or space and the purpose of the space should first be considered to address the needs of the soundscape specific to each case.

The architectural properties of an indoor space affect a user's perception of a soundscape through its influence on sound. This can be analyzed with the properties of two-dimensional organization, volumetric shape and proportion, materials and furniture used, openings, circulation patterns, and mechanical and installation voids. Before volumetric properties, the two-dimensional organization of an enclosure should be evaluated. The layout plan of an indoor space provides information about the general overview of that place and its space interactions, which forms the base of any indoor soundscape study. Since volumetric form as well as the shape and proportion of an interior have remarkable influence on the physical properties and formation of sound, they need to be analyzed in detail to control and sustain acoustic comfort. Similarly, construction and finishing materials as well as furnishings are determinant for sound formation, and can be used as affective applications to control acoustic formation and overall acoustic quality.

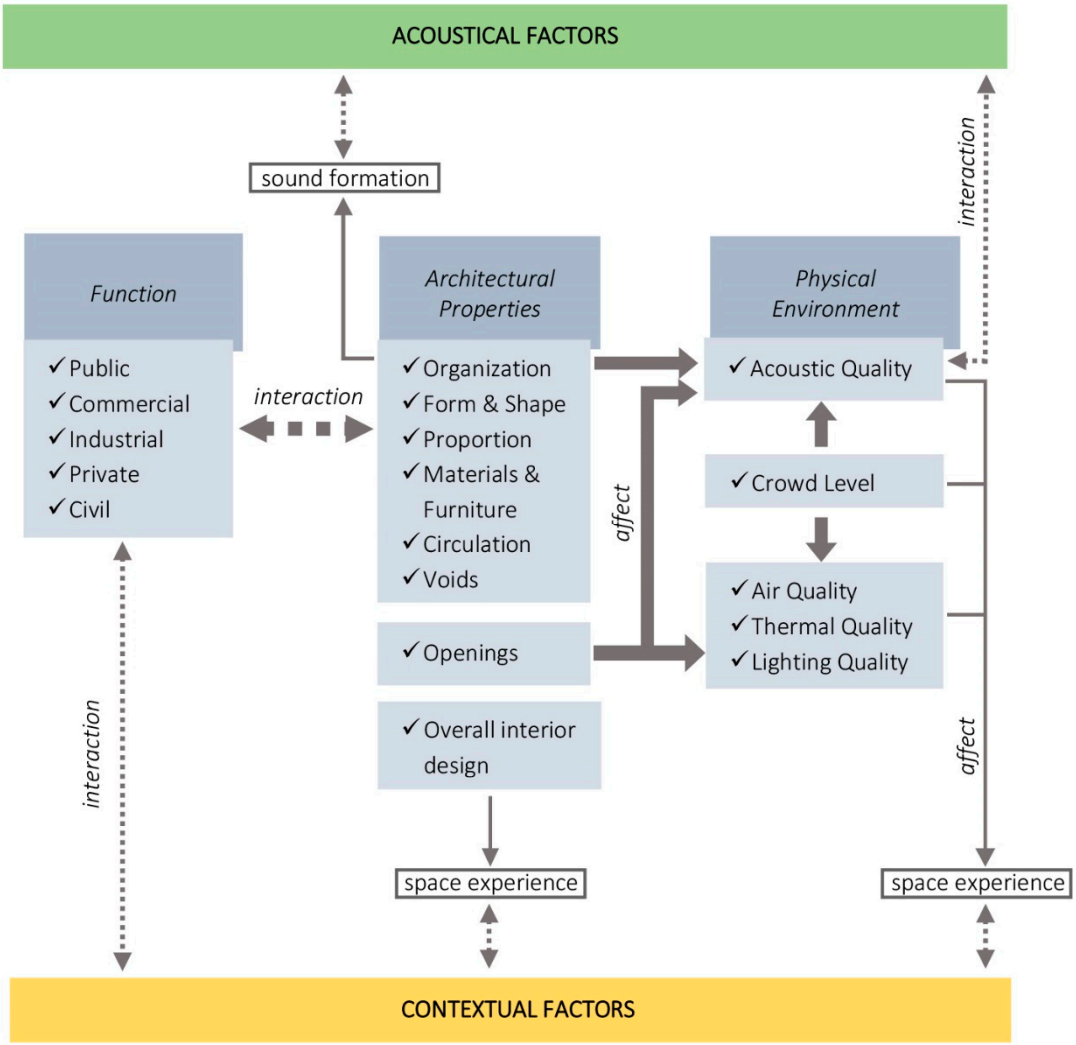

Figure 3. Architectural factors of indoor soundscape and their influence areas [40,43,46].

Openings in buildings are other architectural elements that should be considered for their direct connection with the outdoor environment. Openings affect the audial, visual, thermal, and lighting characteristics of indoor spaces. Even if there are materials which have high Sound Transmission Class (STC) ratings for window openings, transmission of sound from outdoor to indoor is usually provided by openings. Likewise, regarding thermal control, the air quality and usage of natural lighting and window openings should be the initial considerations for indoor environmental quality before indoor applications such as heating, ventilating, and air conditioning (HVAC) systems or artificial lighting design. In other words, building openings are the basic elements to design and control outdoor sound transmission, thermal and air quality, and natural light. Moreover, changes in physical environmental factors, including the crowding level of an enclosure, affect the psychological condition and soundscape perception of users and, as a result, can lead to differentiated overall space experience.

The other two architectural properties that should be underlined regarding indoor soundscape studies and the application process are circulation patterns of an enclosure or building and voids constructed for mechanical and installation purposes. Circulation areas are frequently used transition areas that provide integration between other spaces, and they have the possibility of owning a greater part of the crowd level. For this reason, the possible influence on soundscape and the requirement for it to be well designed should not be ignored. In addition, the voids in buildings such as elevator shafts and engine rooms, etc., are sources of noise generation and other voids for ventilation, plumbing, and electrical installations provide a path for sound transmission between spaces. Hence, for indoor

soundscape design, importance needs to be given to the management and design of these kinds of voids to avoid causing any unwanted soundscapes.

Finally, overall interior design, which includes visual integrity provided by two-dimensional organization, three-dimensional volumetric properties, finishing materials, and furnishing, can affect users' space perception and user's perceptions of correlations between spaces and sound environments.

In order to integrate the indoor soundscape approach into the design process, architectural factors are the primary subject to take into consideration. The functional information that forms the contextual factors, the architectural features that are used to manage sound, and the condition of a physical environment comprise the essential framework of an enclosure which is dealt with in studies or through design.

4.2. Indoor Soundscape Methods

The standardization and clarification of methods and data types which have been used for obtaining related factors should be the step following factor identification in order to integrate soundscape as a part of an architectural design.

Several urban soundscape studies related to the data types and methods in the literature demonstrate methods as in situ, online, and laboratory [1,48,49], and they are presented depending on audience experience with an interdisciplinary approach [50]. Aletta, Kang, and Axelson's study [1] presents a diagram which demonstrates the relationship between audiences' listening mode (in situ, in laboratory, or depending on the memory) data collection methods and tools. Similarly, Özçevik and Yüksel Can's study [48] divided soundscape analysis methods as in situ and laboratory experiments but were demonstrated together with urban soundscape factors. Davies et al. [50] indicated the urban soundscape methods which they had been using in their study for audience experiences from the perspectives of different disciplines, and listed them according to parts of their project.

In addition to these studies, the ISO 12913-2 standard also specifies the data collection methods of urban soundscape. In this standard, the five methods are indicated as (1) soundwalk, (2) questionnaire, (3) guided interview, (4) sound source taxonomy, and (5) binaural measurements [5]. These data collection methods could be used to gather detailed information on the contextual experience of the users while conducting an indoor soundscape study that was previously used in the literature [51].

Another study on indoor soundscape classifies methods, data types, and related soundscape factors for acoustical post-occupancy evaluation (POE) on three levels as "indicative" and "investigative" as the identification phase of soundscape and "diagnostic" as the evaluative phase of soundscape [40]. POE can be used in indoor soundscape studies in order to evaluate building performance, past design decisions, and occupant feedback together [52]. The indicative stage is suggested to determine the space characteristics and sound sources through observation and measurements. The investigative stage is used to search for more information about the space through architectural surveying and contacting users with interviews. The last stage of POE is the diagnostic stage, which includes methods as questionnaires and soundwalks for the final evaluation and feedback for future design [52].

Under the scope of standardization and integration of indoor soundscaping to the architectural design and application processes, it can also be useful to classify methods based on the factors of indoor soundscape in order to evaluate the factors and methods together. A classification of indoor soundscape methods, that can be seen in Figure 4, is prepared based on the factors proposed in Figure 1. In Figure 4, three main concepts of indoor soundscape factors and their methods for gathering data, types of data and, finally, the expected outcomes that are planned to be obtained through those methods are presented.

It would also be beneficial to identify the data-gathering methods of the architectural factors in detail, which are specific to the indoor soundscape framework, depending on the factors that are used. Table 3 presents the indoor soundscape architectural factors and the data-gathering methods that can be used in application.

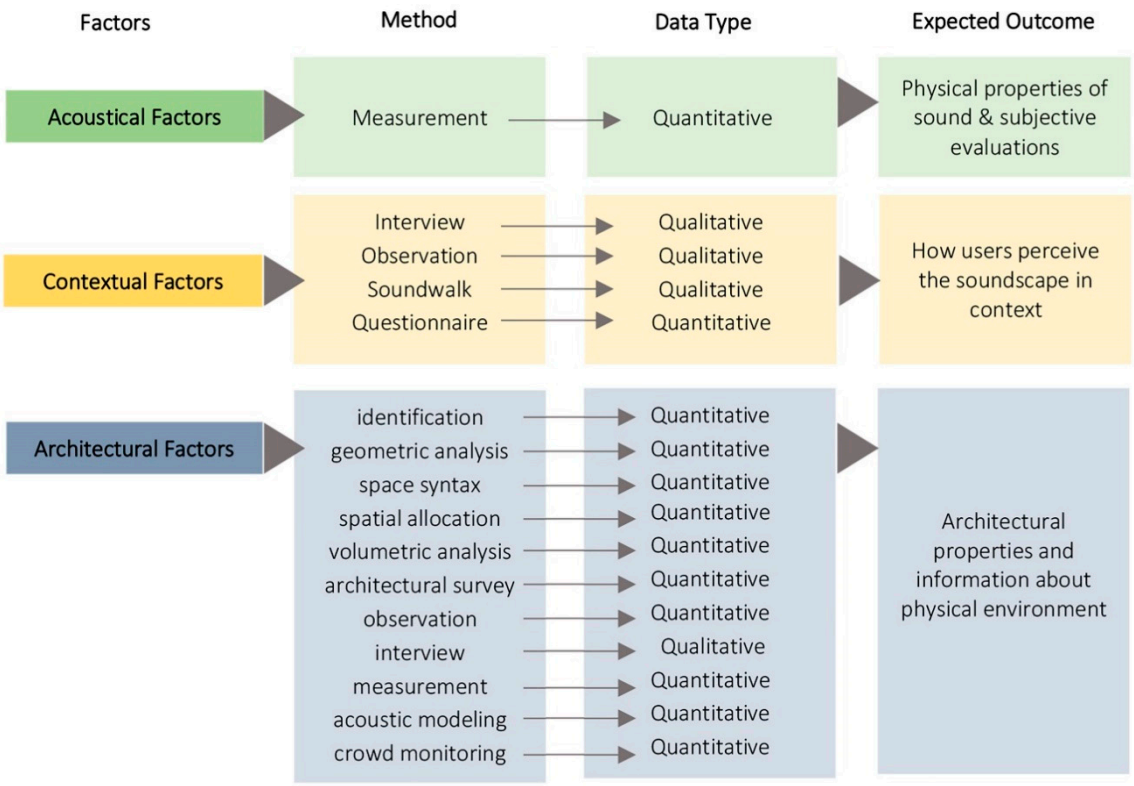

Figure 4. A proposed model on indoor soundscaping methods based on related factors [1,5,7,40,48–54].

Table 3. Methods that can be used for architectural factors of indoor soundscaping.

EVALUATION FIELD	METHODS	ARCHITECTURAL FACTORS
Functional Identity	Identification	Function
2-D Evaluation	Geometric analysis of plans and sections Space syntax Spatial allocation	Organization Form & Shape Proportion Circulation Voids Openings
3-D Evaluation	Volumetric analysis Architectural survey	Proportion Voids Overall Interior Design
Evaluation of Interior Design	Architectural survey Observation Interview	Materials & Furniture Overall Interior Design
Architectural Acoustics	Measurement Acoustic modeling	Acoustic Quality Materials & Furniture Form & Shape
Physical Environment	Measurement	Air Quality Thermal Quality Lighting Quality
Usage	Crowd monitoring	Crowd Level

Initially, functional identification needs to be substantiated since the function determines the user profile and stands in an interaction with contextual factors. After the determination of an enclosure's function, spatial evaluations need to be followed in order to analyze the physical, architectural, and visual characteristics of a space. These evaluations can be followed as the two-dimensional (2D) and three-dimensional (3D) analyses of an interior space. A geometric analysis of plans, sections,

and spatial allocations can be used to evaluate the 2D characteristics of a space as organization, form, proportion, and circulation. Space syntax can be effective to understand the relations between spaces and their organization. Moreover, volumetric analysis and architectural surveys are needed in order to analyze the volumetric proportion, which has an influence on sound formation in addition to investigating the overall interior design.

The entire acoustic quality of an interior space, which also relies on formal organization, materials and any furniture used, can be determined with acoustical measurements and acoustic modeling. The physical environmental quality, including air, thermal, and lighting quality, can be evaluated with measurements. In addition to these dimensions, crowd monitoring can be performed to determine the crowd level, which affects the quality of the physical environment, the acoustic quality and the overall space experience.

The models on indoor soundscape factors (Figure 1) and methods (Figure 4) which interact with each other are prepared as an initial proposal for the standardization of indoor soundscaping principles that should be used in architectural processes. Through further studies, they can be extended and/or evolved.

5. Indoor Soundscape Integration

In order to enhance the indoor soundscape approach, its integration into the architectural design and application process in the early stages is crucial [40]. However, the subjective attribution of indoor soundscape arouses the necessity of characterizing the factors and methods required in the design process. Certainly, a possible regulation/directive will also promote the integration of indoor soundscape principles into the design process for the implementation of the standards that would be published as well as for the existing standards [7]. During this stage, the evaluation and incorporation of present policies on noise management is highly important for the process of developing a soundscape directive. Moreover, the evaluation of existing documents (regulations/directives, guidelines, and standards) related to noise management is crucial since a possible future regulation on soundscape would include noise interventions. In other words, since the soundscape approach involves noise management, noise policies and any related published document should be a part of the procedures involving soundscape regulations and standards [7]. Therefore, governmental/official enforcements and support would be the most convenient procedure in order to integrate indoor soundscaping into architectural and design processes.

When the existing policies on noise management and soundscape are investigated so as to propose an integration model for an indoor context, a formal process has been revealed, consisting of five stages: (1) organization, (2) standardization, (3) governmental enforcements, (4) supplying information, and (5) supervision and maintenance. The five-stage process, revealed from the evaluation of existing policies and applications on noise management and the interaction between the entities, is presented in Figure 5. The direct flow of the five-stage process is identified by the bold one-way arrows and the interrelations between the five-stage process, and the architectural design and application process is identified by the dotted one-way arrows. As observed from the scheme, indoor soundscape factors and methods are directly linked with the architectural design and application process, yet the intricate relationships among these items are to be revealed as part of a future design linked with this study.

The first stage of integration was revealed as the establishment of governmental institutions and/or working groups funded by the government regarding indoor soundscaping to initiate a formal procedure of future implications. This stage was started in Europe within the context of the urban soundscape through the ISO working group (ISO/TC 43/SCI/WG 54) in addition to the actions and projects funded by the EC and/or agencies of the EC. However, in Turkey, these types of organizations are neither found in urban nor in indoor contexts of the soundscape approach.

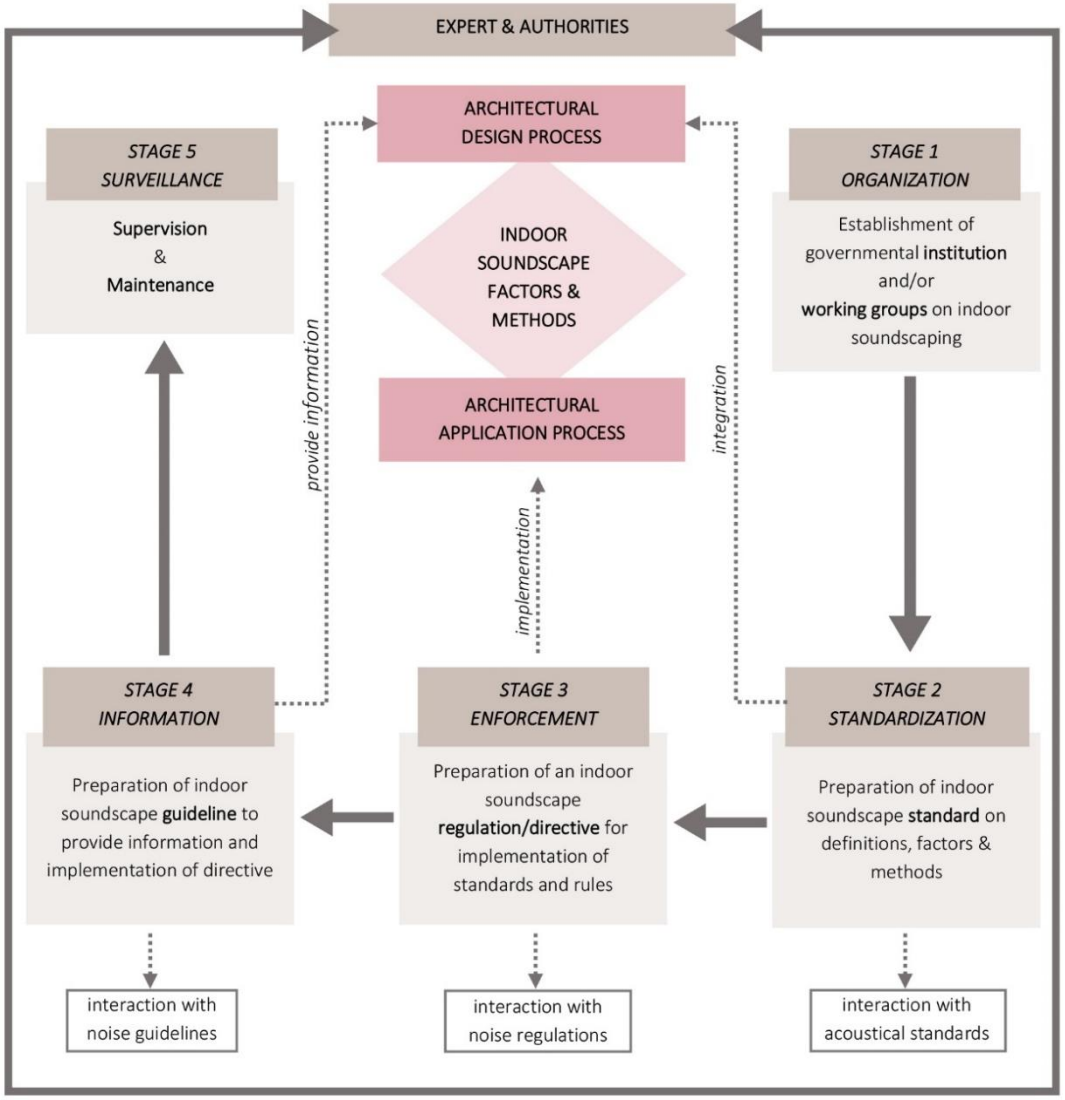

Figure 5. Integration process of indoor soundscaping into architectural design and application.

The preparations for standardization of indoor soundscaping, which would include the definitions of the concept and identification of factors and methods, represent a prominent stage for providing standardized information and procedures for the architectural design phase. The standardization of principles has major importance since the essential need for integration reveals a regulation which should refer to a standard rule, method, and process. With the evaluation of present policies, the attempts of this stage were found neither in Turkey nor in Europe.

As can be observed in noise management applications, regulations have had great effects on enforcing the observance of rules and standards during the design and construction process. Therefore, preparing a standard would be insufficient to obligate the integration of indoor soundscaping in practice. Thus, as a third stage of integration, an indoor soundscape regulation/directive would become an enforcement for architectural application processes prepared based on indoor soundscape and acoustics standards.

When the present noise management applications were investigated, it was seen that the published guidelines were also significant documents for provide information to public and related disciplines, and are also beneficial for the implementation of related regulations. Hence, the preparation of a guideline can be deemed the fourth stage in the integration process of indoor soundscaping. Finally, supervision and maintenance should be provided by experts and authorities who are assigned

by governmental institutions and/or ministries to manage the implementation process of indoor soundscaping. Without doubt, during this entire process, the support of and consultation from experts and authorities are essential.

6. Conclusions

Indoor acoustic environment quality is one of the foremost subjects for improving the welfare of people since people spend most of their time in indoor spaces. Without doubt, noise management has been of great importance, but the noise interventions in recent years have been insufficient. It has even been argued that the soundscape approach should replace noise management. Therefore, the soundscape approach, which also includes noise management, could be a better approach towards managing an entire acoustic environment as it has an extensive multifactorial scope, i.e., it is not limited to acoustical measurements but also considers human perception and the context.

In this study, the essential aim was to investigate the possibility of an indoor soundscaping model integrated with the architectural design and application process as an initial step to promote policy development regarding the indoor soundscape field and to initiate its presence in architectural practice. Therefore, as the initial stage of this study, the present and ongoing policies in Turkey and the European Union (where the soundscape policies are more advanced in comparison with Turkey) on soundscape and noise management were evaluated in a detailed and comparative manner. Governmental and institutional documents on noise management directives, guidelines, and standards were compared, and it was seen that Turkish directives have been prepared as equivalents to the European directives with the exception of the regulation on the protection of buildings against noise. Similarly, the acoustical standards of the TSE, which have been used in the regulations/directives, have been translated from ISO standards and the Turkish noise guidelines have been prepared under the scope of the EU twinning project. Hence, it was seen that the noise management policies of the EU and Turkey are compatible. However, this compatibility cannot be observed regarding the soundscape approach, i.e., a governmental operation on the soundscape approach could not be found in Turkey.

Following the above-described stage, the evaluation of extensive factors and methods of indoor soundscaping have been presented in order to understand the philosophy and advantages of the soundscape approach in comparison to noise management. In the scope of indoor soundscaping, an advanced approach regarding its integration into the design process both in Turkey and EU has not been developed. Yet, ISO 12913-1 clearly exemplifies that it is possible to standardize the indoor soundscape factors as well.

Therefore, this study aimed to present a proposal for an indoor soundscaping integration model that was produced through the evaluation of existing policies on urban soundscaping and noise management as a starting point for policy development regarding indoor soundscaping. When these policies were considered, a systematic process was observed, and this process could be demonstrated in five stages while adapting it to the indoor soundscaping integration model:

1. Establishment of an institution or working group relying on the subject;
2. Preparation of a standard including definitions, indoor soundscape factors and methods;
3. Preparation of a directive;
4. Preparation of guidelines to provide information to the public and related disciplines about the concept of indoor soundscaping and implementation of the directive; and
5. Providing maintenance and supervision by experts and authorities.

This model was presented as an initial proposal for indoor soundscaping integration with architectural design and application. Future follow-up studies are planned which involve (1) identification of the architectural design and application process phases, (2) investigation of the relations within each phase between indoor soundscaping factors and methods through case studies, and (3) derivation of conclusions to finalize the indoor soundscape integration model such that it is applicable in practice regarding architectural design and application.

In conclusion, in order to provide a healthy and pleasant sound environment, it is more advantageous if the soundscape approach is integrated into the architectural process in the early stages instead of being solely limited to noise management. The most efficient method to enhance an acoustic environment is the integration of soundscape into the design and planning process with governmental enforcements/operations. In the European region, the first attempts at this approach have been seen in recent years regarding the urban scale. In fact, indoor soundscaping should also be within the scope of soundscape integration projects in order to enhance the entire sound environment in which people live.

Author Contributions: Conceptualization, U.B.E. and P.N.D.Y.; Investigation, U.B.E. and P.N.D.Y.; Methodology, U.B.E. and P.N.D.Y.; Project administration, P.N.D.Y.; Resources, U.B.E. and P.N.D.Y.; Supervision, P.N.D.Y.; Writing—original draft, U.B.E.; Writing—review & editing, U.B.E. and P.N.D.Y.

Conflicts of Interest: The authors declare no conflict of interest.

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