

Review

# The Impact of the Aromatization of Production Environment on Workers: A Systematic Literature Review

Karol Čarnogurský <sup>1</sup>, Anna Diačiková <sup>1</sup> and Peter Madzík <sup>2,\*</sup>

<sup>1</sup> Department of Management, Catholic University in Ruzomberok, Hrabovská cesta 1A, 034 01 Ruzomberok, Slovakia; karol.carnogursky@ku.sk (K.Č.); anna.diacikova@ku.sk (A.D.)

<sup>2</sup> Department of Business Administration and Management, Technical University of Liberec, Voronezská 13, 460 09 Liberec, Czech Republic

\* Correspondence: peter.madzik@gmail.com

**Abstract:** Literature on aromatization in production environments is very limited. The literature rather describes the impact of aromachology on employees in administrative premises, but published research results on the influence of aromachology in production premises are not available. There are no scientifically based studies and research that analyze and provide at least partial evidence of the impact of fragrances on the productivity and economic performance of companies. For the study of the literature of the area of our scientific interest, we chose the globally most frequently used scientific information database Scopus. In deciding on the selection of keyword combinations and in the search, we relied primarily on our previous experience and the area of research, which is the aromatization of spaces in industrial production, and its impact on the performance of employees, respectively. We also consider the industrial applications of aromachology, and how an indoor environment is important for people's health and comfort.



**Citation:** Čarnogurský, K.; Diačiková, A.; Madzík, P. The Impact of the Aromatization of Production Environment on Workers: A Systematic Literature Review. *Appl. Sci.* **2021**, *11*, 5600. <https://doi.org/10.3390/app11125600>

Academic Editor: Jean-Luc Le Quééré

Received: 30 April 2021

Accepted: 3 June 2021

Published: 17 June 2021

**Publisher's Note:** MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



**Copyright:** © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

**Keywords:** aromachology; scents; smell; behavior; consumer psychology; aroma marketing

## 1. Introduction

Aromatization of the environment evokes effective or certain emotions. The purpose of aromatizing the internal environment is, of course, to evoke effective emotions with the defined goal of stimulating the perception of the human environment. A scientific view of human perception of flavors has been published by Small et al. [1], who from a medical point of view explain the human perception of aromas by both possible requirements, i.e., nose and mouth. Aromatic molecules contact the olfactory epithelium through the nose, which means that it is the perception of aromas from the outside environment, or through the mouth (retronasal sniffing). Then, the aroma is perceived by the mouth and associated with taste (sweet, sour, salty, spicy and hot). These situations are graphically displayed in Figure 1.

There are two basic principles for the perception of aroma through the human nose, which are named aromatherapy and aromachology. Although these concepts sound very similar, they differ in their principled focus, i.e., the quality of the aroma, its priority purpose, and use, which are summarized in Table 1. However, both support the positive effects of fragrance on a person's mood and emotions. A systematic review of these two different disciplines is published by Čarnogurský et al. [2].

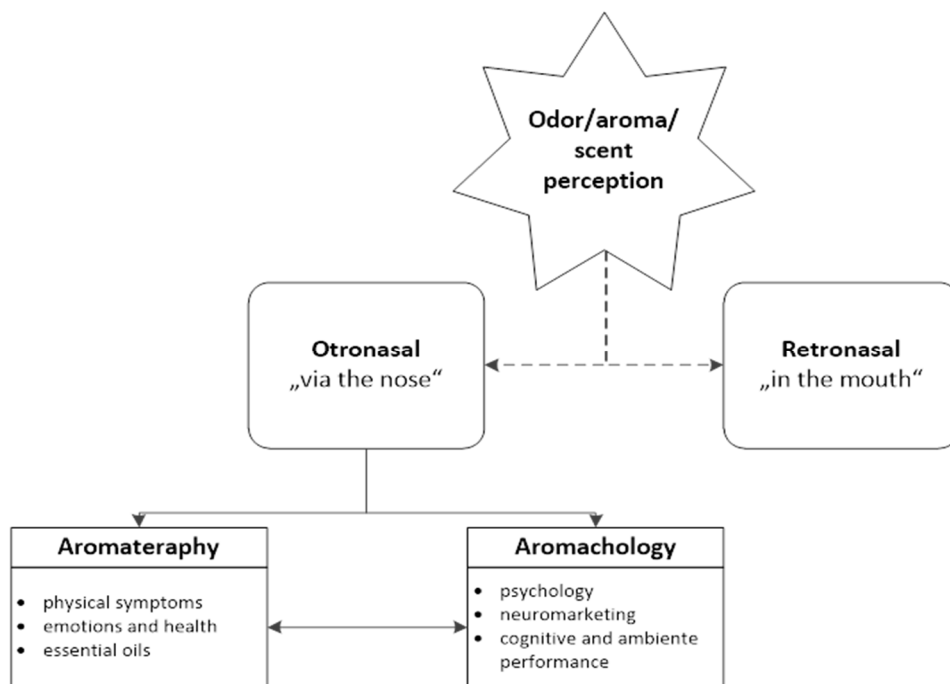


Figure 1. Human perception of aroma.

Table 1. Differences between Aromatherapy and Aromachology.

	Fragrance Quality	Solves Preferentially	Main Purpose	Main Purpose
Aromatherapy	Natural	Launching and causing a specific physiological reaction in humans	Health status of individuals	In medicine
Aromachology	Natural Synthetic	Launching and causing a psychological reaction in humans	Affecting the mood and behavior of people	For commercial purposes-retail, work environment

Aromatherapy is about the therapeutic use of natural scents and about bringing well-being [3–6]. Systematic research has also shown that aromatherapy is one of the popular complementary and alternative drugs, and the beneficial therapeutic effects of aromatherapy on employee psychological health have also been confirmed, including improving work performance and reducing workplace stress [7–10]. Aromachology is based on scientific studies, examines the psychological effects of natural and synthetic scents on humans, and is closely linked to psychology [11–15]. Table 1 shows the basic differences between aromatherapy and aromachology.

In general, the topic of research, analysis, and use of both principles of aromatization, i.e., aromatherapy and aromachology of interior spaces have a different history and depth of research. It strongly depends on the purpose of using these interior spaces.

It can be:

- Production;
- Administrative premises;
- Storage space;
- Grocery store;
- Trade in non-food products;
- Services (travel agencies, real estate agencies, consulting services, banks, financial and insurance institutions);
- Gastronomic establishments (cafes, restaurants, bars);
- Hotels;

- Medical facilities;
- Wellness services, relaxation centers and fitness; and
- Educational institutions, media spaces, households and other unspecified spaces.

Of the above-mentioned internal spaces, aromatization (in the sense of aromatherapy) is commonly used in medical facilities, relaxation centers, fitness, and other areas providing wellness services, respectively. Other services are used in households and administrative premises.

The topic of research into the aromatization (in terms of aromachology) of indoor spaces in which people use retail services, i.e., aromatization in non-food retail environments [16–19] and aromatization in food retail environments [20–22], is also published in the literature. Although ambient scents within retail stores have been shown to influence shoppers, real-world demonstrations of scent effects are infrequent and the existing theoretical explanation for observed effects is limited. Several results demonstrate how emotional processes occurring within stimulus exposure differ across individuals with varying olfactory abilities. Findings reveal an automatic suppression mechanism for an individual's sensitivity to smell.

However, the topic of research and study of aromatization (in terms of aromachology) of interior spaces, in which people work rather manually, is a new area that science is currently beginning to pay attention to [23]. Rather, the literature describes the impact of aromachology on employees in administrative premises, but published research results on the influence of aromachology in production premises are not available. There are no scientifically based studies and research that analyze and provide at least partial evidence of the impact of fragrances on the productivity and economic performance of companies. Nevertheless, the number of companies implementing aromachology is constantly growing, i.e., they flavor their premises or create olfactory traces of various brands, especially in retail, and thus indirectly positively affect the economic performance of their companies. These findings inspired us primarily to study the available scientific literature in the field of aromachology research by focusing on ambient scents of production areas and finding connections between air quality using indoor aromatics and a possible link to work performance.

The article aims to process the most relevant available scientific literature in the field of indoor aromatization with emphasis on application in the production process. However, during the process of processing the available literature, we found that the literature on aromatization in the production environment is very limited, in that it exists, but only very marginally. For this reason, we considered the relevant literature in which information about the existence of aroma/aromatization in production and industry and aroma influence on work performance expressed by a good feeling of employees.

## 2. Materials and Methods

### 2.1. Work Performance–Object of the Research

The object of research in the present study is the work environment. The working environment is defined as a set of spatial, material, physical, chemical, microclimatic, physiological, psychological, social, and other conditions in which the production and work process affect the results of production in term of work, motivation, performance, psyche, safety, and health of employees [24]. Good air quality can be defined as “air in which there are no contaminants at damaging concentrates as controlled by aware power and with which an impressive predominant part (80% or more) of the people uncovered do not express disappointment” [25]. The issue of the working environment in the interior (air quality indoor), is mainly addressed by the legislation of individual countries, or the legislation of entire regions, e.g., for the member states of the European Union, it is a set of EU directives on safety and health at work [26]. The mentioned legislation addresses not only the physical demands of work but also the conditions of the working environment in the interior, e.g., temperature, air conditioning, ambient humidity, lighting, noise, air quality, and chemical fumes, which are specific and different for each business entity and

its operations. The company is responsible for compliance with the conditions and control by the relevant control body within the competence of the country's government.

The working environment, including air quality, must meet strict standards. This also includes targeted aromatization of premises, which is known in practice and is used mainly in shops, relaxation and wellness centers, administrative premises, or even in households. Air modification in production facilities is not exactly described in the literature [23], rather, questionnaire surveys [27–29] in non-production settings are known.

Only the results of the references of the interior spaces of the objects, which were identified/extracted through the keywords industry and engineering, were included in our subject of research.

We used data from the Scopus indexed database, to obtain data for this article, as Elsevier characterizes it as the largest abstract and citation database of scientific literature and quality web resources in the world. We originally approached the creation of this article as we usually work with literature research, and we have chosen the most frequently used sources for scientific work, Web of Science, Scopus, and Google Scholar. We based this on based on:

- Our many years of experience in scientific work;
- From the experience of the last 3 years devoted to the field of research on aromatization in various environments (including neuromarketing); and
- The achieved very high number and at the same time very low relevance of the obtained links from the mentioned databases, e.g., in the Google Scholar database, when using search strings “aroma” and “industry”, “Aromatization” and “industry” we reached 276,000 and 21,600 links, respectively. We selected the largest abstract and citation database of scientific literature, Scopus.

In deciding on the selection of keyword combinations and in the search, we relied primarily on our previous experience and the area of research, which is the aromatization of spaces in industrial production, its impact on the performance of employees, respectively. We also looked at the industrial applications of aromachology. The data were searched in the database by a combination of Article title, Abstract, Keywords. Subsequently, we used frequency analysis and the obtained results were archived in an Excel spreadsheet, which is available on request for potential use.

We entered the following search string into the search engine, which were divided into 4 groups:

- “aroma” and “industry”;
- “aroma” and “work performance”;
- “aromatization” and “production”;
- “aromatization” and “industry”

The next step was to define the criteria for which of the available articles will be included in the analysis of the literal revision, and which will be excluded. We found out after reading the title of the article and the abstract, in some cases we also studied the full text, mainly the methods used, the object of research, the main findings, discussion, and implications for further investigation. The selection was made according to the following criteria:

- Articles focused on aroma in industry;
- Articles related to aroma and neuroscience;
- Articles related to work performance and production;
- Articles written in English; and
- Journal and type of scientific article.

Those articles that met our selected selection criteria underwent a detailed analysis. To obtain the required data, we subsequently specified the individual search strings according to the “Subject area”, which was “Engineering”. We then limited the data by year of publication via “Year” (from 2011 to 2020). Figure 2 (authors own processing) shows the selection process of obtaining expert articles for literature review.

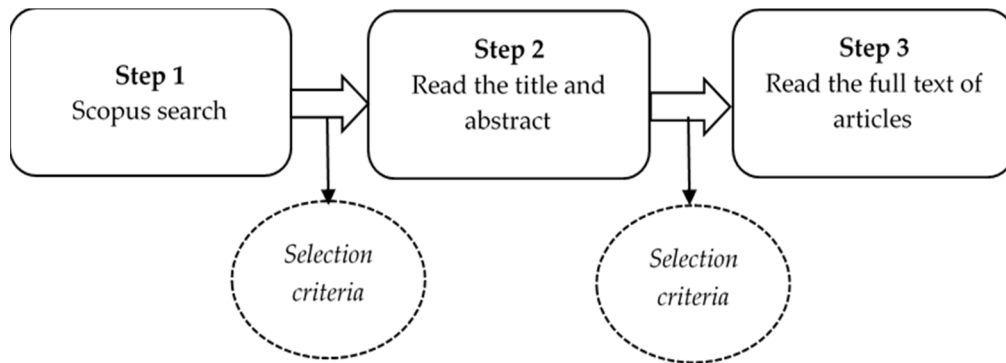


Figure 2. Article selection process.

2.2. Data Extraction

For the study of the literature of the area of our scientific interest, we chose the globally most frequently used scientific information database Scopus.

When creating an information strategy, i.e., in order to find the most relevant links, a method known from marketing research was used, namely market segmentation, where the whole market is divided into segments (market subsets) according to pre-selected criteria (geographical, demographic, psychographic, and behavioral principle of customers), creating the most homogeneous subgroups of consumers that differ as much as possible so that they can be addressed by selected marketing tools. With this approach, 4 groups (segments) of professional papers were created by a combination of keywords, the characteristics of which are in Table 2. In creating a combination of keywords, we used our previous experience in the field of neuromarketing and aromachology [2,23].

3. Results

After entering the keyword “aroma industry”, 1805 results have been displayed in the Scopus database since 2011. Figure 3 shows the main subject area and Figure 4 the document type.

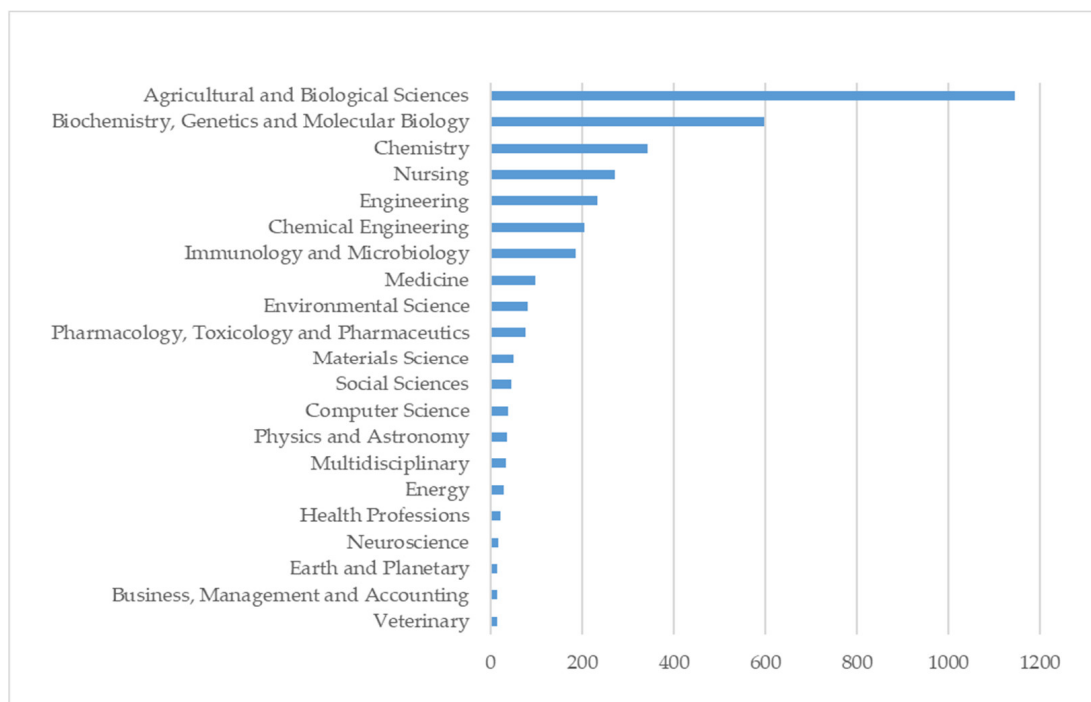


Figure 3. Subject area of the articles.

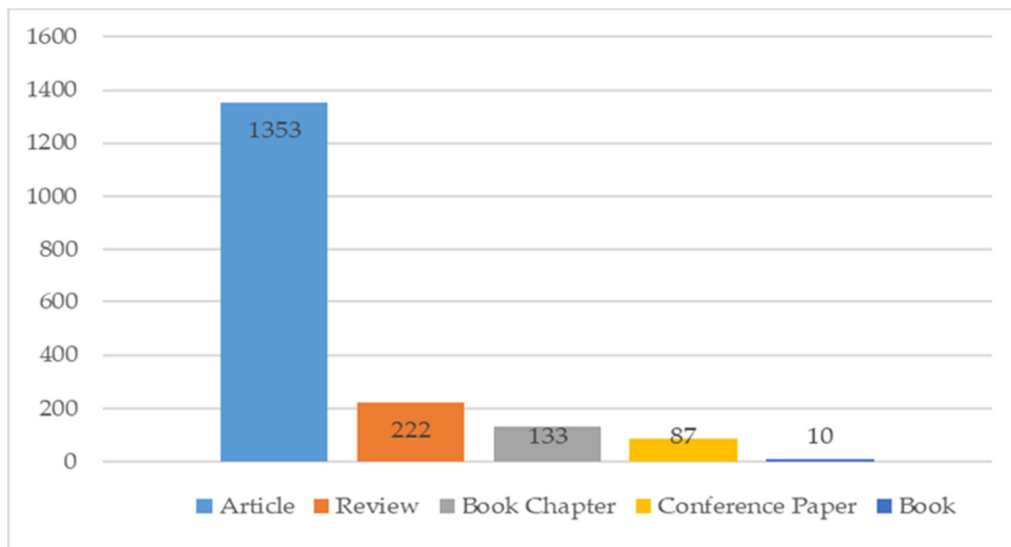


Figure 4. Type of the selected documents.

After studying a large number of scientific articles included in this literature review, we found that most are empirical and deal with the modification of the working environment in connection with cleaning and ventilation air (air quality), thermal, visual, lighting comfort, acoustic environment, building features for designing new buildings and the relationship between acceptability of each environmental parameter. At the time of the pandemic, great attention is paid to the cleaning and flow of air in existing buildings or the design of new buildings. The authors focus on office buildings only, or facilities providing services.

Figure 5 shows the number of articles sorted by year of publication and our search string. The results show in recent years an increase in professional publications in the field, which represents an opportunity to obtain relevant information and the possibility of their use in the future.

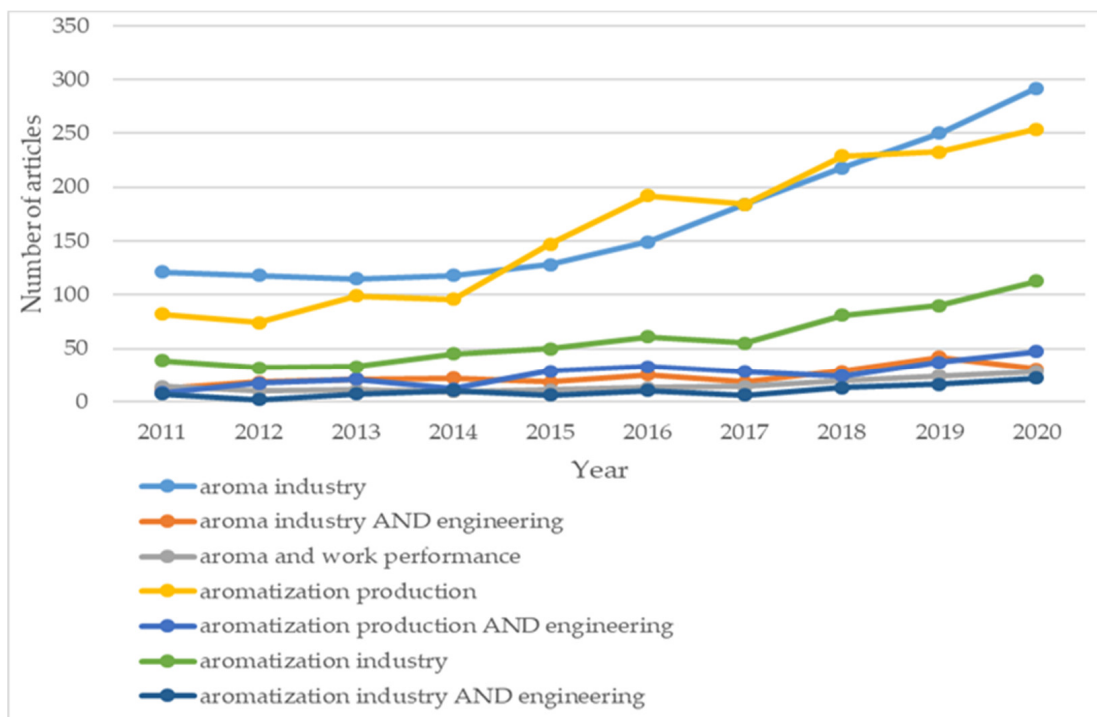


Figure 5. Number of publications per years.

The data in Figure 6 show an overview of the number of words that were relevant to our search topic. In connection with the aromatization of industry, production, respectively work performance, the word chemistry appeared the most, followed by aroma and odors, etc.

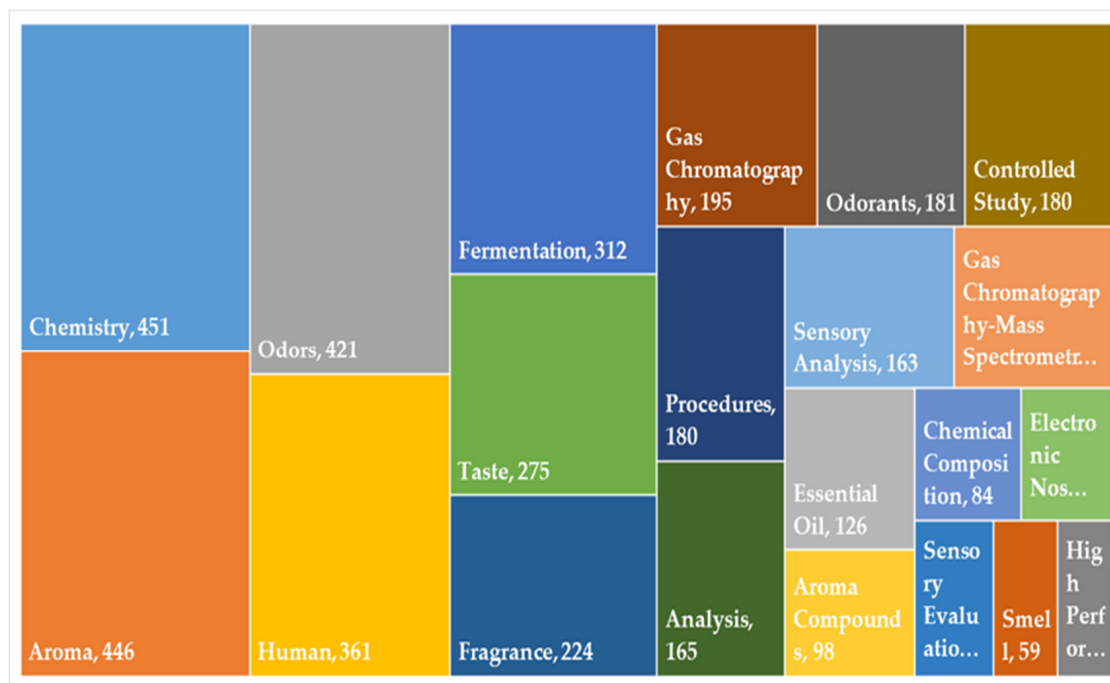


Figure 6. The number of related words.

#### 4. Discussion

- At the beginning of the discussion of the results obtained from the literature review, it is necessary to emphasize that the studied area of aromachology in industry, production environment is not exactly researched and described in contrast to research and publication in the field of neuromarketing and its implications in the retail environment, which are richly represented in indexed but also in non-indexed sources for more than two decades [18,30–43]. If there are published studies, then they are marginal, which is summarized in Table 2. From the many years of experience of the authors of the present article, working in basic and applied research and also in the international holding company of manufacturing companies, this is mainly due to the great diversity of industries;
- The size of industrial premises, the size of which is often incomparable with administrative, business premises and premises for the operation of services;
- The complexity of the aromatization of such spaces, and its control and management;
- Preferential focus of manufacturers on the quality of production, economic results and at the same time; and
- Focusing manufacturers on [24,26] the protection of the health and safety of employees, which is also related to air quality, especially clean air, ventilation, and temperature.

Table 2 is created with as many relevant publications as possible, with tens of hours of study and sorting representing several hundred publications, however, no publications were found directly related to the aromatization of production facilities.

**Table 2.** Characteristics of the most relevant information sources.

No.	Authors and Reference	Title	Year	Type of Source	Environment	Scent/or Another Factor	Research Subject/Type of Measurement	Practical Implications/Main Conclusion
1.	Wyon, D.P. [40]	Thermal effects on performance	2010	Handbook	indoor administration buildings	heating, cooling, noising; no scent	air quality	Effects on performance and productivity; noise distraction in open offices at 55 dBA has negative effects on the performance of employees.
2.	Wyon D.P. [41]	Enhancing productivity while reducing energy use in buildings	2001	Conference Proceeding	indoor administration building-call-centers	heating, cooling; no scent	air quality	Effects on performance and productivity; field intervention experiments in call-centers demonstrate that the decrement in performance can be larger in practice than it is in realistic laboratory simulation experiments.
3.	Wyon D.P. [42]	The effects of indoor air quality on performance and productivity	2004	Journal	indoor administration buildings-call-centers in northern Europe and the Tropics	Ventilation, temperature; no scent	air quality	It has been shown beyond reasonable doubt that poor indoor air quality in buildings can decrease productivity in addition to causing visitors to express dissatisfaction, the size of the effect is 6–9%.
4.	Seppanen O., Fisk W. [43]	Some Quantitative Relations between Indoor Environmental Quality and Work Performance or Health	2006	Journal	administration environment	ventilation, temperature; no scent	air quality	Quantitative relationships between ventilation rates and short-term sick leave, ventilation rates and work performance, perceived air quality and performance, temperature and performance, and temperature and sick building symptoms (SBS).
5.	Torresin S., Pernigotto G., Cappelletti F., Gasparella A. [44]	Combined effects of environmental factors on human perception and objective performance: A review of experimental laboratory works	2018	Journal (literature review)	non-industrial buildings (Neutral 56%, Office 38%, Aircraft 4%, School 2%)	acoustic, thermal, visual, combined effect; no scent	air quality	A vast literature is available on comfort studies related to the different aspects, aiming at defining quantitative correlations to predict discomfort from the environmental conditions to support design, commissioning, and operation of buildings.



Table 2. Cont.

No.	Authors and Reference	Title	Year	Type of Source	Environment	Scent/or Another Factor	Research Subject/Type of Measurement	Practical Implications/Main Conclusion
6.	Baharum F., Zainon M.R., Seng L.Y., Nawi M.N.M. [25]	Analysis of indoor environmental quality influence toward occupants' work performance in Kompleks Eureka, USM	2016	Journal	residential buildings in industrialized areas	acoustic, lighting, temperature, visual; no scent	air quality	Own research via questionnaire survey. Air quality satisfaction is lower than the thermal satisfaction in the buildings.
7.	Fisk, W., Wargocki, P., Zhang, X. [45]	Do Indoor CO <sub>2</sub> Levels Directly Affect Perceived Air Quality, Health, or Work Performance?	2019	Journal	occupied buildings	carbon dioxide; no scent	air quality	Article summarizes the findings of 10 recent studies investigating whether increased carbon dioxide (CO <sub>2</sub> ) concentrations, with other factors constant, influence perceived air quality, health, or work performance of people.
8.	Niemelä R., Rautio S., Hannula M., Reijula K. [46]	Work environment effects on labor productivity: An intervention study in a storage building.	2002	Journal	harbor storage building	thermal, contamination, lighting, ventilation; no scent	air quality.	As a result of the renovation, thermal conditions, air quality, and lighting conditions improved notably. The employees' subjective evaluations showed the significant decrease in dissatisfaction ratings.
9.	Roskams M., Haynes B. [26]	Predictive analytics in facilities management	2019	Journal	open-plan office	heating, ventilation, air-conditioning, temperature, humidity, illumination, sound pressure; no scent	air quality-own research using wireless sensors	This is the first field study to directly explore the relationship between physical environment data collected using wireless sensors and subjective ratings of environmental comfort building analytics and human analytics, towards the goal of optimizing environmental comfort in the workplace.
10.	Putnam C., Price S. [47]	High-performance facilities engineering: Preparing the team for the sustainable workplace	2004	Journal	green building	energy efficiency; no scent	facilities management department	The green building offers the potential for energy and resource efficiency, lower operating costs for owners and managers, and an indoor environment that enhances worker productivity and comfort.
11.	Barsade S.G., Gibson D.E. [48]	Why Does Affect Matter in Organizations?	2007	Journal	general working environment	no reported; no scent	emotional intelligence	Employees' moods, emotions, and dispositional affect („affect“ is another word for “emotion“ in organizational behavior studies) influence critical organizational outcomes such as job performance, decision making, creativity, turnover, prosocial behavior, teamwork, negotiation, and leadership.

There are several research studies that publish results on the air quality effects of indoor administration buildings on performance and productivity. The size of this effect may be as high as 6–9% [44,45]. On the other hand, there are only a few expert research studies that would provide information on targeted air modification (other than ventilation) in the internal environment in the production process and the interaction, e.g., that the treated air positively or negatively consciously or unconsciously affects labor productivity, respectively. Published research shows that the indoor environment is important for people's health and comfort [46–49].

Another major research area directly related to the quality of the workspace is the influence of emotions on the workplace [50,51]. The state of the literature shows that affect matters because people are not isolated 'emotional islands.' Rather, they bring all of themselves to work, including their traits, moods, and emotions, and their affective experiences and expressions, which influence others. Emotional intelligence is not a buzz word only familiar in psychology and education, but is now talked about in business circles as well.

From the studied published results of research, partial research, or studies that deal with IAQ (Indoor Air Quality), The IEQ (Indoor Environmental Quality) shows that the authors examined this issue through questionnaire surveys among employees working mostly in administrative buildings [28,39] and open space offices [26], in laboratory conditions and call centers [46], or residential buildings with air pollutants such as Radon, volatile organic compounds (VOCs) and carbonyl compounds [50].

Interesting research was conducted by Mangone et al. [52] in open space offices. They positively evaluated the effect of indoor plants on the thermal comfort of office workers within an office building. Numerous research studies have found that plants have a positive impact on people with respect to a diverse range of performance categories, for example [53–56].

Seppänen and Fisk [43] critically evaluated approximately 100 expert articles on the indoor environmental quality on human health and performance and found that there is a relationship between SBS (sick building symptoms) and work performance. The longer the internal environment is ventilated, the more illness and sickness decrease [56–64]. They also found a direct relationship between ventilation and the work output, but this performance increases only to a certain extent, up to about 30 L/s/person, then the curve acquires a saturated character. All it takes is a lower value of approx. 5 L/s and the performance increases sharply. Although the results are not statistically unambiguous, they nevertheless show that the parameters examined are related to the design of the building and the ventilation of the work areas. In this paper, they have shown that it is possible, with existing data, to estimate quantitative relationships between ventilation rate and illness-caused absence and to quantitatively estimate how work performance is related to ventilation rate, air temperature, and perceived air quality.

Similarly, a paper by S. Torresin et al. [44] looks at 110 literary sources focused on non-industrial buildings. In developed countries, people spend almost 90% of their time inside buildings, where most of their activities take place [62]. Inclusion criteria regarded (acoustic, thermal, visual, and air quality) the investigation of interaction effects between two or more environmental factors in occupant comfort perception and performance and the impact of one environmental factor on the perception of other environmental aspects (crossed effects). The effects of moderate heat stress and open-plan office noise distraction on SBS symptoms and the performance of office workers have been shown by Witterseh et al. [64]. They demonstrated that open office noise distraction, even at the realistic level of 55 dBA, increases fatigue and has many negative effects on the performance of office work, as does a moderately warm air temperature.

The complexity of research on the impact of air quality on the health or work performance of people is also evidenced by the findings by Fisk, Wargocki and Zhang [45]. The published results of the research are not clear and further research is needed to address the discrepancies among the current findings. Experts on workplace air quality assessment

have been working for a long time to develop an indoor air quality checklist (IAQ) to introduce the need for workplace air quality control [65]. Four environmental factors—defined by several physical quantities related to acoustical, thermal, visual environments, and Indoor Air Quality (included chemical composition, air velocity), respectively—have been identified as the most important to characterize indoor environments from the American Society of Heating, Refrigeration and Air-conditioning Engineers [66,67]. To control the air from production processes and to eliminate this impact on the study of the effects of flavoring as much as possible, it is possible to use a system called KOALA (Knowing Our Ambient Local Air Quality), which is a low-cost air quality monitor, which was deployed in Sydney (Australia) and was successfully used as air quality monitor data in the internal and external environment via a deep learning technique called long short-term memory (LSTM) [68]. There is also a method of measurement on pollutants and to use health effects on a six-degree scale from good to hazardous. An integrated sensing system is part of a smart building where real-time indoor air quality data are monitored round the clock using sensors and operating in the Internet-of-Things (IoT) environment [69]. It is also useful and extremely necessary to follow the IAQ (Indoor air quality) checklist when planning analyses. This is the newly developed IAQ checklist, which will be one of the key elements in identifying risk elements for the evaluation of indoor air pollutants in indoor environments and this IAQ checklist will highlight the need for IAQ assessment in workplaces [70,71]. Indoor air quality is an important factor for the company, managers and employees because it can affect people's health, comfort, overall well-being and productivity. So the question is, what do businesses have to do if they want to improve the air quality in their operations? There are several options they can realize, from using zero-emission cleaners to installing the latest and greatest air filters to improve indoor air quality. When we think about air quality and benefits for customers, we must not forget the people who spend the most time in the given environment, the employees. Air quality has a big impact on their productivity and safety. This is confirmed by several types of research from renowned institutions and specialized companies. Research is increasingly providing detailed insights into scents and human behavior and offering a range of guidelines on how to succeed in this area.

The results obtained from the study of a systematic literature review on the impact of the aromatization of the production environment on workers were already used in an experiment to examine the impact of aromatization and air quality on the unconscious and conscious perception of employee's satisfaction. The research took place for 7 months in an international company engaged in the production and sale of polypropylene fibers for a wide range of industries. The results of the research were processed and published in professional articles.

## 5. Conclusions

A large number of scientific articles are devoted to the modification of the working environment in connection with its cleaning and airflow, temperature, or noise. At the time of the pandemic, great attention is paid to the cleaning and flow of air in existing buildings or the design of new buildings. Experts focus on purely administrative buildings or facilities providing services. Attention is paid to the production area for reasons of protection, safety and health at work. There are no known scientific studies on flavoring and the scientific field of aromachology in production facilities. The reasons are discussed in Section 4. From a systematically performed literature review on the modification of the internal environment in buildings, conclusions can be drawn for basic and applied research for use in industry. Although flavoring would not directly affect performance, it is not negligible that workers feel as comfortable as possible in the course of their work. This leads to the conclusion that there is a large research gap for the implication of the scientific discipline on aromachology and subsequently for applied research in manufacturing practice.

**Author Contributions:** Conceptualization, K.Č. and A.D.; methodology, P.M.; software, K.Č.; validation, A.D., K.Č. and P.M.; formal analysis, P.M.; resources, A.D.; data curation, A.D.; writing—original draft preparation, K.Č. and A.D.; writing—review and editing, P.M.; visualization, P.M. and K.Č.; project administration, K.Č. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Acknowledgments:** This publication has been supported by the Erasmus+ KA2 Strategic Partnerships grant no. 2018-1-SK01-KA203-046324 “Implementation of Consumer Neuroscience and Smart Research Solutions in Aromachology” (NEUROSMARTOLOGY). The European Commission’s support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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

## References

1. Small, M.D.; Gerber, C.J.; Erica Mak, Y.; Hummel, T. Differential Neural Responses Evoked by Orthonasal versus Retronasal Odorant Perception in Humans. *Neuron* **2005**, *47*, 593–605. [CrossRef]
2. Čarnogurský, K.; Diačiková, A.; Madzik, P. Innovative Research Solutions in Aromachology and Aromatherapy—Literature Review. In Proceedings of the International Scientific Days 2020—“Innovative Approaches for Sustainable Agriculture and Food Systems Development”, Nitra, Slovakia, 13–15 May 2020. [CrossRef]
3. Johnson, J.R.; Rivard, R.L.; Griffin, K.H.; Kolste, A.K.; Joswiak, D.; Kinney, M.E.; Dusek, J.A. The effectiveness of nurse-delivered aromatherapy in an acute care setting. *Complement. Ther. Med.* **2016**, *25*, 164–169. [CrossRef]
4. Cooke, B.; Ernst, E. Aromatherapy: A systematic review. *Br. J. Gen. Pract.* **2000**, *50*, 493–496.
5. Price, S.; Price, L. *Aromatherapy for Health Professionals*, 4th ed.; Elsevier Churchill Livingstone: London, UK, 2012; 355p, ISBN 978-0-7020-3564-7.
6. Lis-Balchin, M. *Aromatherapy Science: A Guide for Healthcare Professionals*; Pharmaceutical Press: London, UK, 2006; 451p, ISBN 085369-578-4.
7. Damian, P.; Damian, K. *Aromatherapy: Scent and Psyche: Using Essential Oils for Physical and Emotional Well-Being*; Healing Arts Press: Rochester, VT, USA, 1995; 244p, ISBN 978-089281530-2.
8. Ornelas, S.; Kleiner, B.H. New developments in managing job related stress. *Equal. Oppor. Int.* **2003**, *22*, 64–70. [CrossRef]
9. Huang, L.; Capdevila, L. Aromatherapy Improves Work Performance Through Balancing the Autonomic Nervous System. *J. Altern. Complement. Med.* **2017**, *23*, 214–221. [CrossRef] [PubMed]
10. Andrews, S.E. *The Reduction of Stress Levels in Healthcare Workers Using Aromatherapy*; No 28322828; Brandman University: Irvine, CA, USA; ProQuest Dissertations Publishing: Irvine, CA, USA, 2021.
11. Herz, R.S. Aromatherapy Facts and Fictions: A Scientific Analysis of Olfactory Effects on Mood, Physiology and Behavior. *Int. J. Neurosci.* **2009**, *119*, 263–290. [CrossRef] [PubMed]
12. Van Toller, S.; Dodd, G.H. *Fragrance: The Psychology and Biology on Perfume*; Elsevier Science Publisher Ltd.: Amsterdam, The Netherlands, 1992; 290p, ISBN 1-85166-872-1.
13. Chu, S.; Downes, J.J. Odour-evoked autobiographical memories: Psychological investigations of proustian phenomena. *Chem. Senses* **2000**, *25*, 111–116. [CrossRef] [PubMed]
14. von Kemptski, D. The Use of Olfactory Stimulants to Improve Indoor Air Quality. *J. Hum. Environ. Syst.* **2002**, *5*, 61–68. [CrossRef]
15. Sumegi, L.; Ilona, L. *Differential Effects of Lavender and Rosemary on Arousal and Cognitive Performance*; Carleton University: Ottawa, ON, Canada, 2018; 108p, ISBN 978-0-494-79582-8.
16. Morrison, M.; Gan, S.; Dubelaar, C.; Oppewal, H. In-store music and aroma influences on shopper behavior and satisfaction. *J. Bus. Res.* **2011**, *64*, 558–564. [CrossRef]
17. Jacob, C.; Stefan, J.; Guéguen, N. Ambient scent and consumer behavior: A field study in a florist’s retail shop. *Int. Rev. Retail. Distrib. Consum. Res.* **2013**, *24*, 116–120. [CrossRef]
18. Ward, P.; Davies, B.J.; Kooijman, D. Olfaction and the retail environment: Examining the influence of ambient scent. *Serv. Bus.* **2007**, *1*, 295–316. [CrossRef]
19. Suthaphot, N.; Chulakup, S.; Chonsakorn, S.; Mongkholrattanasit, R. Application of aromatherapy on cotton fabric by microcapsules. In Proceedings of the RMUTP International Conference, Textiles & Fashion, Bangkok, Thailand, 3–4 July 2012; Available online: <http://www.repository.rmutt.ac.th/xmlui/handle/123456789/1739> (accessed on 19 April 2021).

20. Horská, E.; Horská, E.; Sedik, P.; Bercik, J.; Krasnodebski, A.; Witczak, M.; Filipiak-Florkiewicz, A. Aromachology in Food Sector—Aspects of Consumer Food Products Choice. *Nauka. Technol. Jakość* **2018**, *25*, 33–41.
21. Davies, B.J.; Kooijman, D.; Ward, P. The Sweet Smell of Success: Olfaction in Retailing. *J. Mark. Manag.* **2003**, *19*, 611–627. [[CrossRef](#)]
22. Chebat, J.C.; Michon, R. Impact of ambient odors on mall shoppers' emotions, cognition, and spending: A test of competitive causal theories. *J. Bus. Res.* **2003**, *56*, 529–539. [[CrossRef](#)]
23. Čarnogurský, K. Influence of aromatization on the conscious and unconscious perception of work environment. 2021, Under processing.
24. Sundell, J. On the history of indoor air quality and health. *Indoor Air* **2004**, *14*, 51–58. [[CrossRef](#)]
25. Zainon, M.R.; Baharum, F.; Seng, L.Y. Analysis of indoor environmental quality influence toward occupants' work performance in Kompleks Eureka, USM. *AIP Conf. Proc.* **2016**. [[CrossRef](#)]
26. Roskams, M.; Haynes, B. Predictive analytics in facilities management. *J. Facil. Manag.* **2019**, *17*, 356–370. [[CrossRef](#)]
27. Maula, H.; Hongisto, V.; Naatula, V.; Haapakangas, A.; Koskela, H. The effect of low ventilation rate with elevated bioeffluent concentration on work performance, perceived indoor air quality, and health symptoms. *Indoor Air* **2017**, *27*, 1141–1153. [[CrossRef](#)] [[PubMed](#)]
28. Mitchell, D.J.; Kahn, B.E.; Knasko, S.C. There's Something in the Air: Effects of Congruent or Incongruent Ambient Odor on Consumer Decision Making. *J. Consum. Res.* **1995**, *22*, 229–238. [[CrossRef](#)]
29. Bone, P.F.; Pam, S.E. Scents in the Marketplace: Explaining a Fraction of Olfaction. *J. Retail.* **1999**, *75*, 243–262. [[CrossRef](#)]
30. Bosmans, A. Scents and Sensibility: When Do (In) congruent Ambient Scents Influence Product Evaluations? *J. Mark.* **2006**, *70*, 32–43. [[CrossRef](#)]
31. Zurawicki, L. *Neuromarketing-Exploring the Brain of the Consumer*; Springer: New York, NY, USA, 2010; 271p, ISBN 978-3-540-77828-8.
32. Herrmann, A.; Zidansek, M.; Sprott, D.E.; Spangenberg, E.R. The Power of Simplicity: Processing Fluency and the Effects of Olfactory Cues on Retail Sales. *J. Retail.* **2013**, *89*, 30–43. [[CrossRef](#)]
33. Lemke, F.; Clark, M.; Wilson, H. Customer experience quality: An exploration in business and consumer contexts using repertory grid technique. *J. Acad. Mark. Sci.* **2011**, *39*, 846–869. [[CrossRef](#)]
34. Ariely, D.; Berns, G.S. Neuromarketing: The hope and hype of neuroimaging in business. *Nat. Rev. Neurosci.* **2010**, *11*, 284–292. [[CrossRef](#)]
35. Berčík, J.; Virágh, R.; Kádeková, Z.; Duchoňová, T. Aroma marketing as a tool to increase turnover in a chosen business entity. *Potravin. Slovak J. Food Sci.* **2020**, *14*, 1161–1175. [[CrossRef](#)]
36. Berčík, J.; Rybanská, J. Methods used in neuromarketing. *Neuromark. Food Retail.* **2017**, 83–102. [[CrossRef](#)]
37. Lwin, M.O.; Morrin, M.; Chong, C.S.T.; Goh, S.X. Odor Semantics and Visual Cues: What We Smell Impacts Where We Look, What We Remember, and What We Want to Buy. *J. Behav. Decis. Mak.* **2015**, *29*, 336–350. [[CrossRef](#)]
38. Tomi, K.; Fushiki, T.; Murakami, H.; Matsumura, Y.; Hayashi, T.; Yazawa, S. Relationships between Lavender Aroma Component and Aromachology Effect. *Acta Hort.* **2011**, 299–306. [[CrossRef](#)]
39. Lee, M.S.; Choi, J.; Posadzki, P.; Ernst, E. Aromatherapy for health care: An overview of systematic reviews. *Maturitas* **2012**, *71*, 257–260. [[CrossRef](#)] [[PubMed](#)]
40. Wyon, D.P. Thermal effects on performance. In *IAQ Handbook*; Spengler, J., Samet, J.M., McCarthy, J.F., Eds.; McGraw-Hill: New York, NY, USA, 2001; Chapter 16.
41. Wyon, D.P. Enhancing productivity while reducing energy use in buildings. In Proceedings of the Conference 'E-Vision 2000' at the Department of Energy, Washington, DC, USA, 11–13 October 2000; RAND Corporation: Washington, DC, USA, 2001.
42. Wyon, D.P. The effects of indoor air quality on performance and productivity. *Indoor Air* **2004**, *14*, 92–101. [[CrossRef](#)]
43. Seppänen, O.A.; Fisk, W. Some Quantitative Relations between Indoor Environmental Quality and Work Performance or Health. *HVAC&R Res.* **2006**, *12*, 957–973. [[CrossRef](#)]
44. Torresin, S.; Pernigotto, G.; Cappelletti, F.; Gasparella, A. Combined effects of environmental factors on human perception and objective performance: A review of experimental laboratory works. *Indoor Air* **2018**, *28*, 525–538. [[CrossRef](#)]
45. Fisk, W.; Wargoeki, P.; Zhang, X. Do Indoor CO<sub>2</sub> Levels Directly Affect Perceived Air Quality, Health, or Work Performance? *ASHRAE J.* **2019**, *61*, 70–77.
46. Niemelä, R.; Rautio, S.; Hannula, M.; Reijula, K. Work environment effects on labor productivity: An intervention study in a storage building. *Am. J. Ind. Med.* **2002**, *42*, 328–335. [[CrossRef](#)] [[PubMed](#)]
47. Putnam, C.; Price, S. High-performance facilities engineering: Preparing the team for the sustainable workplace. *J. Facil. Manag.* **2005**, *3*, 161–172. [[CrossRef](#)]
48. Barsade, S.G.; Gibson, D.E. Why Does Affect Matter in Organizations? *Acad. Manag. Perspect.* **2007**, *21*, 36–59. [[CrossRef](#)]
49. Amabile, T.M.; Barsade, S.G.; Mueller, J.S.; Staw, B.M. Affect and Creativity at Work. *Adm. Sci. Q.* **2005**, *50*, 367–403. [[CrossRef](#)]
50. Madjar, N.; Oldham, G.R.; Pratt, M.G. There's No Place like Home? The Contributions of Work and Nonwork Creativity Support to Employees' Creative Performance. *Acad. Manag. J.* **2002**, *45*, 757–767. [[CrossRef](#)]
51. Beldean-Galea, M.S.; Dicu, T.; Cucoş, A.; Burghel, B.-D.; Catalina, T.; Botoş, M.; Ţenter, A.; Szacsvai, K.; Lupulescu, A.; Pap, I.; et al. Evaluation of indoor air pollutants in 100 retrofit residential buildings from Romania during cold season. *J. Clean. Prod.* **2020**, *277*, 124098. [[CrossRef](#)]

52. Mangone, G.; Kurvers, S.; Luscuere, P. Constructing thermal comfort: Investigating the effect of vegetation on indoor thermal comfort through a four season thermal comfort quasi-experiment. *Build. Environ.* **2014**, *81*, 410–426. [[CrossRef](#)]
53. Hartig, T.; Staats, H. The need for psychological restoration as a determinant of environmental preferences. *J. Environ. Psychol.* **2006**, *26*, 215–226. [[CrossRef](#)]
54. Qin, J.; Sun, C.; Zhou, X.; Leng, H.; Lian, Z. The effect of indoor plants on human comfort. *Indoor Built Environ.* **2014**, *23*, 709–723. [[CrossRef](#)]
55. Lohr, V.I.; Pearson-Mims, C.H.; Goodwin, G.K. Interior Plants May Improve Worker Productivity and Reduce Stress in a Windowless Environment. *J. Environ. Hortic.* **1996**, *14*, 97–100. [[CrossRef](#)]
56. White, M.; Smith, A.; Humphryes, K.; Pahl, S.; Snelling, D.; Depledge, M. Blue space: The importance of water for preference, affect, and restorativeness ratings of natural and built scenes. *J. Environ. Psychol.* **2010**, *30*, 482–493. [[CrossRef](#)]
57. Fisk, W.J.; Faulkner, D.; Sullivan, D.P. *Accuracy of CO<sub>2</sub> Sensors in Commercial Buildings: A Pilotstudy*; Ernest Orlando Lawrence Berkeley National Laboratory: Berkeley, CA, USA, 2006.
58. Fisk, W.J.; Singer, B.C.; Chan, W.R. Association of residential energy efficiency retrofits with indoor environmental quality, comfort, and health: A review of empirical data. *Build. Environ.* **2020**, *180*, 107067. [[CrossRef](#)]
59. Stamatelopoulou, A.; Asimakopoulos, D.; Maggos, T. Effects of PM, TVOCs and comfort parameters on indoor air quality of residences with young children. *Build. Environ.* **2019**, *150*, 233–244. [[CrossRef](#)]
60. World Health Organization. *WHO Guidelines for Indoor Air Quality: Selected Pollutants*; WHO: Geneva, Switzerland, 2010.
61. World Health Organization. *Household Air Pollution and Health*; WHO: Geneva, Switzerland, 2016.
62. World Health Organization. *Air Pollution*; WHO: Geneva, Switzerland, 2019.
63. Klepeis, N.E.; Nelson, W.C.; Ott, W.R.; Robinson, J.P.; Tsang, A.M.; Switzer, P.; Behar, J.V.; Hern, S.C.; Engelmann, W.H. The National Human Activity Pattern Survey (NHAPS): A resource for assessing exposure to environmental pollutants. *J. Expo. Sci. Environ. Epidemiol.* **2001**, *11*, 231–252. [[CrossRef](#)] [[PubMed](#)]
64. Witterseh, T.; Wyon, D.P.; Clausen, G. The effects of moderate heat stress and open-plan office noise distraction on SBS symptoms and on the performance of office work. *Indoor Air* **2004**, *14*, 30–40. [[CrossRef](#)]
65. Syazwan, A.; Rafee, B.M.; Shaharuddin, M.; Juahir, H.; Syafiq, M.Y.A.; Ibthisham, A.M.; Nizar, A.; Hanafiah, J.M.; Azhar, M.M.; Anita, A.; et al. Development of an indoor air quality checklist for risk assessment of indoor air pollutants by semiquantitative score in nonindustrial workplaces. *Health Policy* **2012**, *5*, 17–23. [[CrossRef](#)]
66. ASHRAE. Interactions affecting the achievement of acceptable indoor environments. In *ASHRAE Guideline*, 10th ed.; ASHRAE: Peachtree Corners, GA, USA, 2011.
67. Frontczak, M.; Wargocki, P. Literature survey on how different factors influence human comfort in indoor environments. *Build. Environ.* **2011**, *46*, 922–937. [[CrossRef](#)]
68. Gottschalk, I. Consumer evaluation of ambient scent. *Int. J. Retail. Distrib. Manag.* **2018**, *46*, 530–544. [[CrossRef](#)]
69. Lin, M.-H.; Cross, S.N.; Childers, T.L. Understanding olfaction and emotions and the moderating role of individual differences. *Eur. J. Mark.* **2018**, *52*, 811–836. [[CrossRef](#)]
70. Liu, N.; Liu, X.; Jayaratne, R.; Morawska, L. A study on extending the use of air quality monitor data via deep learning techniques. *J. Clean. Prod.* **2020**, *274*, 122956. [[CrossRef](#)]
71. Ha, Q.P.; Metia, S.; Phung, M.D. Sensing Data Fusion for Enhanced Indoor Air Quality Monitoring. *IEEE Sens. J.* **2020**, *20*, 4430–4441. [[CrossRef](#)]