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Indoor smellscape interventions and designers' intended impacts on building occupants: an exploratory review of project descriptions

Existing standards and academic research offer no guidance for intentional olfactory design. This gap is relevant because, although many indoor smells are shaped by occupants, the baseline olfactory conditions of a space can still be intentionally designed through architectural choices. This study reviews 123 project descriptions to identify olfactory design strategies and the impacts that designers expect these interventions to have on building occupants. Smellscape interventions primarily appear in residential settings (43%) and fall into six categories: scented materials, ventilation strategies, green elements, spatial connection, scented devices, and fireplaces and burning stoves. The expected impacts described in the project narratives relate to affective, perceptual, cognitive, physiological, time-related, and space-related dimensions. This study emphasises the need for a catalogue of indoor smellscape interventions and for scientific evidence linking design strategies to their actual effects on occupants. Such resources would support designers in creating spaces that are not only odour-neutral but also olfactorily pleasant and healthy.

Introduction

The relationship between humans, smells, and the built environment has attracted increasing attention in research over the past decade. Historically, the predominant approach to managing indoor environments has focused on odour nuisance control, deeming an indoor environment satisfactory if it achieves olfactory neutrality, meaning occupants do not perceive any odour.¹ This approach partly stemmed from the fact that there has long been a belief in the connection between unhealthy foul odours and pestilence or disease in cities. Furthermore, people tend to mistake any unpleasant odour for pollution.² However, it is crucial to distinguish between pollutants (chemicals in the air that can cause harm, regardless of whether they are detectable by

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their odour) and odorants that are detectable and, when non-harmful, may even enhance the indoor experiences.

In recent years, research has demonstrated that striving for complete odour neutrality might not always be the ideal solution.³ Pleasant olfactory stimuli can enhance comfort more effectively than the absence of detectable odours.⁴ Such stimuli can positively affect people's mood, well-being, health, satisfaction, and human behaviours across a variety of everyday contexts, including behaviours related to spending and eating.⁵ Olfaction is frequently overlooked, overshadowed by the dominant focus on sensory modalities like vision and hearing.⁶ Nevertheless, it plays a vital role in regulating appetite, avoiding environmental hazards, and facilitating social communication.⁷

The concept of smellscape in the built environment was first introduced by Douglas Porteous in 1985, emphasising the olfactory environment as perceived and understood by an individual in a specific place.⁸ Victoria Henshaw expanded this notion by noting that, while we can only partially detect the smellscape at any given moment, we can carry a mental image or memory of it in its entirety.⁹ That means that, although individuals perceive only fragments of the smellscape at any given moment, repeated exposure and memory allow them to construct a more complete olfactory representation of a place, which becomes part of its identity and of their experience of it.

Drawing on the indoor soundscape definition, the study by Giulia Torriani, Rossano Albatici, Francesco Babich, Massimo Vescovi, Massimiliano Zampini, and Simone Torresin developed the concept of indoor smellscape as the olfactory environment perceived and understood by a person in an indoor context, considering social, cultural, and historical aspects.¹⁰ In indoor environments, we encounter a variety of odours, to which we gradually habituate over time. Odour habituation is defined by a reduced response to smells that an individual has been continuously or repeatedly exposed to.¹¹ However, a decrease in conscious perception does not necessarily imply that the effects of an odour on occupants disappear. Olfactory stimuli may continue to influence behaviour, mood, or cognitive processes even when individuals are no longer fully aware of the scent.¹² When designing an olfactory intervention, it is therefore important to consider factors such as intensity, persistence, and duration of exposure to ensure that the intended experiential or behavioural effects are maintained over time.

In this paper, the authors adopt the term 'olfactory design' as used in the work by Victoria Henshaw, Kate McLean, Dominic Medway, Chris Perkins, and Gary Warnaby.¹³ Anna Barbara and Anthony Perliss use the term 'olfactive design' in a similar sense, describing a process of constructing invisible forms of architecture — namely, the smells that move naturally or artificially through space and change continuously — within the visible architecture fabric.¹⁴ The term 'olfactive design' was considered by the authors as more specific to the creation and experience of fragrances rather than the building design, and thus the term 'olfactory design' was adopted. Olfactory design means not leaving the olfactory experience to chance but considering it as a crucial design element in the built environment. Smells move naturally and artificially,

changing continuously over time and space.¹⁵ Designing with the sense of smell is not simply a matter of choosing a fragrance diffuser, but involves deciding which smell should trigger the experience, when to start it, and how the smell will evolve over time.¹⁶ Moreover, it demands designing in accordance with the weather, which can affect the nature and experience of an olfactory environment.¹⁷

Existing standards and protocols do not regulate olfactory design, and there is a noticeable absence of indoor smellscape considerations in traditional academic research. Despite this, designers have made attempts to incorporate the olfactory experience into their projects with the aim of triggering a series of perceptual responses.

Aim of the study

In a context where standards and protocols provide no guidance for olfactory design, there is a clear need to clarify how smellscapes are currently approached in the design practise. Even though many olfactory environments are ultimately shaped by their occupants, the baseline olfactory conditions of a space can still be intentionally designed. A systematic review of these design intentions can therefore help define the state of the art, identify how olfaction is framed within architectural discourse and precedent, and support the development of a catalogue of smellscape interventions to guide both future research and design practice, as has occurred in other areas of sensory studies.¹⁸

By reviewing four databases of architectural projects, this study addresses three research questions: (1) What methods do designers use to create a positive indoor olfactory experience? (2) What impacts on building occupants do designers expect their smellscape interventions to have? and (3) Do olfactory design choices depend on building setting?

Methods

An explorative review was conducted using online open-access architectural design databases. The aim was to identify and classify projects where the olfactory experience was intentionally considered in the design stage and therefore mentioned. This review process was informed by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines for websites.¹⁹

Search strategy

In April 2024, a search was conducted on four online open-access architectural design databases: 'ArchDaily', 'ArchitectMagazine', 'Divisare', and 'Dezeen'. These databases were selected as they are open-access and have international coverage of architectural projects. The keywords 'smell', 'odour', 'odor', 'olfactory', 'smellscape', and 'scent' were used for the research across these databases. These keywords are the same as those used in the work by Giulia Torriani, Simone Torresin, Irene Lara-Ibeas, Rossano Albatici, and Francesco Babich to conduct an investigation on perceived air quality assessment methods.²⁰ The keyword 'smellscape' yielded zero results while 'smell' pro-

duced the highest number of results ($n = 16610$), followed by 'odor' ($n = 9131$), 'scent' ($n = 2865$), 'olfactory' ($n = 2212$) and 'odour' ($n = 54$). The inclusion criteria included: (I1) completed projects by 30 April 2024; and (I2) strategies to enhance the olfactory experience in indoor spaces mentioned in the project description. This strategy made reference to the four ways of dealing with olfactory design introduced by Henshaw, namely: separating odours through planned activity or displacement; removing unpleasant odours; masking unpleasant odours with pleasant smells; and introducing 'an odour with a special quality' (i.e. the deliberate use of a distinctive, character-defining scent that contributes to the identity of a place).²¹ Based on these, the authors decided to exclude projects focused only on the elimination of unpleasant odours towards odour neutrality (E1). This is due to the primary interest in using olfactory stimulation as a design resource, going beyond olfactory neutrality, reflecting the more traditional odour control approach.²²

A total of 30872 projects were retrieved initially. After filtering for the realisation stage ($n = 5,720$), 25152 projects underwent an initial rapid (about 3 project descriptions per minute) screening of full website descriptions (about 300–1000 words). Projects that did not incorporate strategies for creating olfactory experiences were excluded ($n = 17686$), as well as projects focused solely on odour control ($n = 7352$). Consequently, a total of 123 projects were included and their full web descriptions reviewed. The screening was primarily conducted by a single reviewer. To ensure consistency, screening criteria and data extraction procedures were discussed and validated with the co-authors, and a subset of project descriptions was jointly reviewed to align inclusion decisions and variable interpretation. The selection process was informed by the PRISMA guidelines for identification of studies via websites (Fig. 1).²³

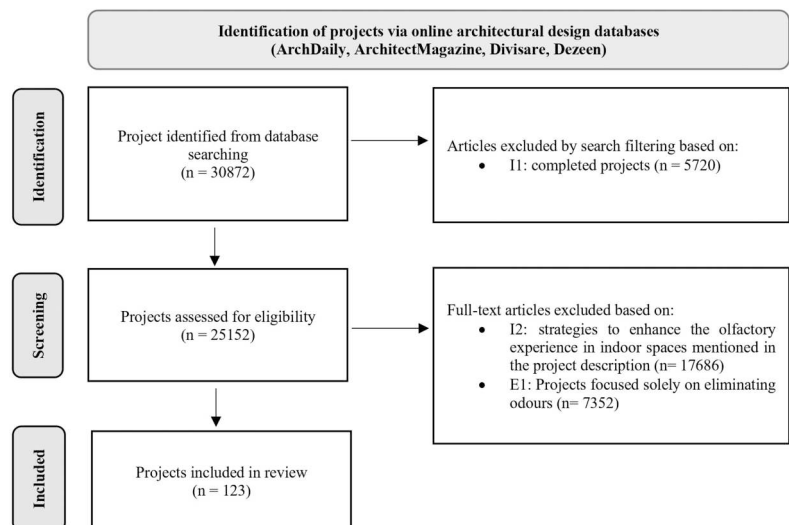


Figure 1.
Review flow diagram for the
identification of the studies via
online architectural design
websites, compiled by the authors,
2025

Table 1. Full list of articles reviewed.

Ref	Source	Project name	Architect(s)	Project year	Country (Continent)	Building type	Type of olfactory design	Subcategory	Specification	Expected impact on occupants
(Divisare 2017d)	Divisare	Pavillon Kg	Innauer-Matt Architekten	2014	Austria (Europe)	Pavilion	Use of scented materials	Wood	Spruce; Fir; Oak	Relaxing
(Tilbrook 2016)	Dezeen	Aesop Store	Snøhetta	2014	Norway (Europe)	Commercial	Use of scented materials	Wood	Oak	Warm; Inviting
(ArchDaily 2009)	ArchDaily	Therme Vals	Peter Zumthor	1996	Switzerland (Europe)	Wellness	Use of scented materials	Stone	Quartzite	Relaxing; Therapeutic
(Divisare 2016b)	Divisare	Nezu Museum	Kengo Kuma	2009	Japan (Asia)	Cultural	Use of scented materials	Wood	Bamboo	Distinctive; Connecting with nature
(Divisare 2012b)	Divisare	Serpentine Pavilion	Herzog & De Meuron; Ai Weiwei	2012	UK (Europe)	Pavilion	Use of scented materials	Cork	n/s	n/s
(Divisare 2013)	Divisare	Espacio Transmisior Del Dolmen Megalitico De Seró	Toni Gironès	2012	Spain (Europe)	Cultural	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	n/s
(Divisare 2020d)	Divisare	Nelson Mandela High School	Ledercq Associés	2014	France (Europe)	Educational	Use of scented materials	Wood	n/s	Warm
(Divisare 2020c)	Divisare	Jingdezhen Imperial Kiln Museum	Zhu-Pei	2020	China (Asia)	Cultural	Use of scented materials	Clay	n/s	Transporting the visitor into a sort of trip between past, present and nature
(Divisare 2015b)	Divisare	Ijdock	Zeinstra Van Gelderen	2013	Netherlands (Europe)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of river	Offering contact with nature
(Divisare 2016a)	Divisare	House Mextila	Edaa	2014	Mexico (America)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Natural
(Divisare 2022b)	Divisare	Jan Juc Studio	Eldridge Anderson Architects	2021	Australia (Oceania)	Residential	Use of scented materials	Wood	n/s	n/s
(Divisare 2023b)	Divisare	Bloco Arquitectos	Vila Rica House	2017	Brazil (America)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Connecting to the outdoor

(Table continued)

Table 1. Continued

Ref	Source	Project name	Architect(s)	Project year	Country (Continent)	Building type	Type of olfactory design	Subcategory	Specification	Expected impact on occupants
(Divisare 2012a)	Divisare	Rebello De Andrade, Tiago Rebello De Andrade, Manuel Cachao Tojal	House in Travessa Do Patrocinio	2012	Portugal (Europe)	Residential	Green elements integration	Vertical garden	Lavender; Rosemary; Saffron	Appropriate
(Divisare 2022c)	Divisare	Sea Lab	School for the Blind and Visually Impaired Children	2021	India (Asia)	Educational	Green elements integration	Courtyard	n/s	Helping the navigation of the building
(Divisare 2024)	Divisare	Gonzales Serrano Studio, J-AF Architecture	Una Mesa Elevada En El Paisaje	2023	Spain (Europe)	Pavilion	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Creating ties with the context; Delicate
(Divisare 2017b)	Divisare	Luciano Kruk	Mach House	2016	Argentina (America)	Residential	Use of scented materials	Concrete	n/s	Sheltering
(Divisare 2017c)	Divisare	Mucem	Rudy Ricciotti	2013	France (Europe)	Cultural	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of river	Culturally overwhelming
(Divisare 2020b)	Divisare	Mnma	Drois Tropicos	2020	Brazil (America)	Residential	Use of scented materials	Earth	Earth bricks	n/s
(Divisare 2020a)	Divisare	Capsule Hotel and Bookstore	Atelier TAO+C	2019	China (Asia)	Commercial	Use of scented materials	Wood	Bamboo	Freshness
(Divisare, 2018)	Divisare	4x6x6 House	Dua Studio	2017	Indonesia (Asia)	Residential	Spatial design	n/a	n/a	Cooking smells
(Divisare, 2023)	Divisare	La Volta Del Carmen	Piano Piano Studio	2020	Spain (Europe)	Residential	Spatial design	n/a	n/a	Cooking smells
(Divisare, 2022)	Divisare	JB3A	Cruz Atelier	2022	Spain (Europe)	Residential	Spatial design	n/a	n/a	Connecting rooms
(Divisare 2014)	Divisare	Bussum Garden Studio	Serge Schoemaker Architects	2014	Netherlands (Europe)	Pavilion	Use of scented materials	Wood	Birch	n/s
(Divisare, 2017)	Divisare	Garden of Hearts	Atelier DYIG	2012	Singapore (Asia)	Pavilion	Aroma Misting	Indoor pool	n/s	Peaceful; Pure; Lovely; Nice-smelling
(Divisare, 2015b)	Divisare	Van Gogh Exhibition	Kengo Kuma and associates	2014	Italy (Europe)	Cultural	Use of scented materials	Cloth	n/s	Tenderness; Warmth
(Divisare 2015a)	Divisare	A Garden in Chelsea	Stefano Marinaz	2014	UK (Europe)	Residential	Green elements integration	Courtyard	Quercus ilex; Sarcococca confusa; Pittosporum tobira nanum; Trachelospermum jasminoides	Vibrant

(Abdel, 2024b)	Archdaily	LIGHT UP COFFEE	Spicy Architects	2023	Japan (Asia)	Commercial	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of city	Connecting indoor and outdoor
(Abdel 2024a)	Archdaily	K. House	Kconcept, Koharchitects	2023	Vietnam (Asia)	Residential	Spatial design	n/a	n/a	Connecting spaces
(Abdel, 2024c)	Archdaily	Suluca House	Yalin Architectural Design	2023	Turkey (Asia)	Residential	Use of scented materials	Stone; Concrete; Wood	n/s	n/s
(Vial 2019)	Archdaily	Casa De Masi	Toti Semerano	2008	Italy (Europe)	Residential	Green elements integration garden	Outdoor garden	n/s	Continuously changing
(ArchDaily, 2017)	Archdaily	Hestial City Hall	Frederic Haesevoets Architecte	2016	Belgium (Europe)	Community Center	Green elements integration	Vertical garden	n/s	Continuously changing
(González 2020)	Archdaily	The Patio Office	Tal Goldsmith Fish Design Studio	2020	Israel (Asia)	Offices	Green elements integration	Conservatory garden	n/s	n/s
(Pintos, 2023)	Archdaily	House with an Eye	Studio Anna Jach	2023	Switzerland (Europe)	Residential	Use of scented materials	Wood	Pine	Pleasant; Fresh
(Abdel, 2021)	Archdaily	Pithouse in Kikuna	Atelierco	2021	Japan (Asia)	Residential	Green elements integration	Plans	n/s	n/s
(ArchDaily, 2015)	Archdaily	STOCK Share Office	OgataYoshiki+SALT / Watasekikuma +Dugout	2015	Japan (Asia)	Offices	Spatial design	n/a	n/a	Delicious; Making communication between user easier
(Abdel, 2022)	Archdaily	YD House	Iso Architects	2021	Indonesia (Asia)	Residential	Ventilation strategies	Stack ventilation	n/s	n/s
(Shuang 2019)	Archdaily	Classroom Makeover For The Blind	Creative Crews	2018	Thailand (Asia)	Educational	Aroma Misting	Scented capsules	Fire; Smoke; Gas; Leakage	n/s
(ArchDaily, 2015)	Archdaily	Vacation House	Hristina Hristova	2015	Bulgaria (Europe)	Residential	Use of scented materials	Wood	n/s	Fresh
(Pintos, 2023)	Archdaily	Rapunzel Visitor Centre	Haascookzemrich STUDIO 2050	2022	Germany (Europe)	Commercial	Spatial design	n/a	n/a	Beautiful; Connecting spaces
(ArchDaily, 2012)	Archdaily	Dancing Trees, Singing Birds	Hiroshi Nakamura & NAP	2007	Japan (Asia)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Making people feel connected to nature
(Pintos, 2021)	Archdaily	Kindergarten Peledziukas Extension	DO Architects	2021	Lithuania (Europe)	Educational	Use of scented materials	Wood	n/s	n/s
(ArchDaily 2014a)	Archdaily	Kinoya Restaurant	Jean de Lessard	2014	Canada (America)	Commercial	Use of scented materials	Wood	n/s	Cozy; Friendly
(ArchDaily, 2017)	Archdaily	International House	TZANNES	2017	Australia (Oceania)	Cultural	Use of scented materials	Wood	n/s	Natural; Warm; Reducing stress and anxiety
(ArchDaily, 2013a)	Archdaily	Hotel WIND	Team BLDG	2013	China (Asia)	Hotel	Use of scented materials	Wood	Teak	Cozy

(Table continued)

Table 1. Continued

Ref	Source	Project name	Architect(s)	Project year	Country (Continent)	Building type	Type of olfactory design	Subcategory	Specification	Expected impact on occupants
(Pintos, 2020)	Archdaily	Glass Cabin	Mjolk architekti	2020	Czech Republic (Europe)	Residential	Use of scented materials	Wood	n/s	Smell of history
(ArchDaily, 2010)	Archdaily	Lakewood House	Centerbrook Architects & Planners	2008	USA (America)	Hotel	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Making people feel connected to nature
(Abdel, 2024)	Archdaily	LADOR Seongsu Store	Indiesalón	2024	South Korea (Asia)	Commercial	Aroma Misting	Indoor pool	n/s	Entertaining
(Abdel, 2023)	Archdaily	Shindagha Historic District	X Architects	2020	United Arab Emirates (Asia)	Cultural	Aroma Misting	Scented capsules	n/s	Historic / Heritage
(Ott 2018)	Archdaily	House YM	Hideo Arao Architects Office	2018	Japan (Asia)	Residential	Use of scented materials	Wood	Cedar	n/s
(ArchDaily 2014b)	Archdaily	Mondang	AnIstudio	2012	South Korea (Asia)	Residential	Spatial design	n/a	n/a	Connecting spaces
(ArchDaily, 2013b)	Archdaily	Mod Cott	Mell Lawrence Architects	2008	USA (America)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Connecting indoor and outdoor
(Coulleri 2021)	Archdaily	Lorena House	AND-Y arquitectos	2021	Mexico (America)	Residential	Use of scented materials	Wood; Stone	n/s	Natural
(ArchDaily, 2016)	Archdaily	Caltun Shelter	ARCHAEUS	n/a	Romania (Europe)	Hotel	Use of scented materials	Wood	n/s	n/s
(Pascal 2013)	Architectmagazine	Gold 214	Pascal Arquitectos	2013	Mexico (America)	Residential	Green elements integration	Vertical garden	Orange trees	n/s
(Walker 2021)	Architectmagazine	Huinawai	Walker Wamer Architects	2019	Kailua-Kona (America)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Dramatic
(Moreira 2021)	Archdaily	Summer Auditorium CCB	Ricardo Bak Gordon	2021	Portugal (Europe)	Cultural	Use of scented materials	Cork	n/s	n/s
(Abdel Hana 2020)	Archdaily	Tara Villa	IDIN Architects	2019	Thailand (Asia)	Residential	Use of scented materials	Earth	n/s	Warm
(ArchDaily, 2012)	Archdaily	2D or Not 2D	M.I.G. Architekt	2012	Montenegro (Europe)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	n/s

(Abdel, 2024)	Archdaily	Villarici Residence	Gets Architects	2021	Indonesia (Asia)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Tropical
(Pintos 2024a)	Archdaily	Cranberry Pond House	Bryce de Reynier	2022	USA (America)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Calming; Restorative
(Florian Maria-Cristina 2023)	Archdaily	The Sphere at the Venetian Resort	Populous	2023	USA (America)	Cultural	Aroma Misting	4D machines	n/s	n/s
(Abdel, 2023)	Archdaily	The HANOK Heritage House	Listen Communication	2023	South Korea (Asia)	Residential	Use of scented materials	Wood	n/s	Subtle; Natural
(Pintos 2024b)	Archdaily	Octothorpe House	Mork-Ulmes Architects	2022	USA (America)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	n/s
(Moreira 2023)	Archdaily	House in Caxias	João Caetano Arquitetura	2023	Portugal (Europe)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Invading
(Abdel, 2022)	Archdaily	RK Residence	Seear-Budd Ross	2022	New Zealand (Oceania)	Residential	Use of scented materials	Wood	Macrocarpa	Fragrant; Spicy
(Pintos, 2023)	Archdaily	Urban Garden	Ioizou Architects + Associates	2022	Cyprus (Europe)	Residential	Green elements integration	Vertical garden	n/s	Connecting indoor and outdoor
(González 2018)	Archdaily	Cafe that Resembles Jeju Island	STARIS	2018	South Korea (Asia)	Commercial	Use of scented materials	Earth	n/s	Dirt
(Pintos 2018)	Archdaily	Andrum Spa	Johan Sundberg arkitektur	2018	Sweden (Europe)	Wellness	Use of scented materials	Stone; Wood	n/s	Soft-spoken; Beautiful
(ArchDaily, 2015)	Archdaily	Three Courtyard House	extrastudio	2015	Portugal (Europe)	Residential	Green elements integration	Courtyard	n/s	Wild; Mysterious
(Pintos, 2020)	Archdaily	A Home in Bormio	Studio wok	2020	Italy (Europe)	Residential	Use of scented materials	Wood	Pine	n/s
(ArchDaily, 2017)	Archdaily	Promised Land	Bates Masi Architects	2015	USA (America)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	n/s
(ArchDaily, 2013b)	Archdaily	I.M.A.M.	nodo17 Architects	2009	Spain (Europe)	Community Center	Green elements integration	Courtyard	Sage; Lavander; Bamboo	n/s

(Table continued)

Table 1. Continued

Ref	Source	Project name	Architect(s)	Project year	Country (Continent)	Building type	Type of olfactory design	Subcategory	Specification	Expected impact on occupants
(González 2017)	Archdaily	Lucien Cornil Student Residence	A+Architecture	2017	France (Europe)	Residential	Use of scented materials	Wood	n/s	Strong; Warm; Relaxing
(Abdel, 2021)	Archdaily	Sora No Mori Healthcare Center	Tezuka Architects	2014	Japan (Asia)	Wellness	Green elements integration	Courtyard	n/s	Calming
(ArchDaily, 2010)	Archdaily	Nursery School in Covolo	C+S Associati	2006	Italy (Europe)	Educational	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	n/s
(González 2019)	Archdaily	Black Body Mountain Shelter	Andrea Cassi, Michele Versaci	2019	Italy (Europe)	Hotel	Use of scented materials	Wood	Pine	n/s
(ArchDaily, 2011)	Archdaily	Water Museum	Juan Domingo Santos	2009	Spain (Europe)	Cultural	Green elements integration	Plans	Orange trees	Refreshing
(Abdel, 2020)	Archdaily	Woon House	Z_Lab	2018	South Korea (Asia)	Wellness	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Relaxing; Healing
(Pintos, 2021)	Archdaily	Weitblick Innovation Campus 4 Views	Sehw Architektur	2021	Germany (Europe)	Offices	Aroma Misting	HVAC system	n/s	Invigorating
(ArchDaily 2013a)	Archdaily	Rebildporten	AR Design Studio	2013	UK (Europe)	Residential	Use of scented materials	Wood	Cedar	Calm; Natural; Delicate
(ArchDaily, 2013)	Archdaily	Rebildporten	CEBRA	n/a	Denmark (Europe)	Cultural	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Natural
(González 2010)	Archdaily	Te Kaitaka	Stevens Lawson Architects	2010	New Zealand (Oceania)	Residential	Use of scented materials	Wood	Cedar	Subtle
(Coulleri 2022)	Archdaily	Ephemeral pavilion LR3 Experience	Neuronalab + Ruben Casquero	2022	Spain (Europe)	Cultural	Aroma Misting	Hazer machine	n/s	Natural; Evoking an ecclesiastical environment
(Abdel, 2021b)	Archdaily	Safezone Shelter	Shma Company Limited	2020	Thailand (Asia)	Pavilion	Ventilation strategies	Fans	Smells of plants	Natural; Providing a soothing experience
(Shuangyu 2018)	Archdaily	Richgreen Building	Keywow Architecture	2018	Taiwan (Asia)	Offices	Use of scented materials	Wood	Cypress; Cedar	Light
(ArchDaily, 2017)	Archdaily	Hotel Amarin	STUDIO UP	2016	Croatia (Europe)	Hotel	Spatial design	n/a	n/a	n/s
(ArchDaily 2011a)	Archdaily	Miele House	Kokaistudios	2010	China (Asia)	Commercial	Spatial design	n/a	n/a	n/s

(ArchDaily 2011b) (Santibañez 2018)	Archdaily	Social Incubating Center	Hyunjoon Yoo Architects	2011	South Korea (Asia)	Community Center	Spatial design	n/a	n/a	Helping to create new ideas
	Archdaily	House on the Mist	Alfonso Arango	2018	Colombia (America)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Subtle
(Abdel, 2020)	Archdaily	Isagi Restaurant	Atelier S.U.P.E.R.B. + Chen Tien Chu	2020	Taiwan (Asia)	Commercial	Use of scented materials	Wood	Cypress	n/s
(Abdel 2021a)	Archdaily	Common Air rea	Cloudfloor	2021	Thailand (Asia)	Pavilion	Green elements integration	Plans	n/s	Appealing
(Pintos, 2021)	Archdaily	Nicolai Paris Apartment	noa* network of architecture	2021	France (Europe)	Residential	Use of scented materials	Wood	n/s	Serene; Calm; Welcoming
(Abdel, 2022)	Archdaily	Care House of the Wind Chimneys	Hiroshi Nakamura & NAP	2020	Japan (Asia)	Healthcare	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Humid; Connecting people to the environment
(ArchDaily, 2016)	Archdaily	Casa Caldera	DUST	2015	USA (America)	Residential	Use of burning stoves and fireplaces	n/a	n/a	Evoking memories
(Ott 2021)	Archdaily	Luce and Pablo's House	Minimo Común Arquitectura	2021	Paraguay (America)	Residential	Use of scented materials	Clay	n/s	n/s
(Barac 2021)	Architectmagazine	HomePark Chengdu	CallisonRTKL	2021	China (Asia)	Commercial	Spatial design	n/a	n/a	n/s
(Choi 2014)	Architectmagazine	Platform 3	Rptecture Architects	2012	Australia (Oceania)	Commercial	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of city	n/s
(Johnson 2016)	Architectmagazine	Anagansett Dunes	Bates Masi + Architects	2015	USA (America)	Residential	Ventilation strategies	Cross ventilation	Lavender	Triggering memories
(Jonatan 2019)	Architectmagazine	NATÚ	Carazo Arquitectura	2018	Costa Rica (America)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Establish a link between nature and the architectural context; Stabilize heart rate; Provide emotional comfort
(M:OFA Studio 2013)	Architectmagazine	Golden Tusk Resort	n/a	2012	India (Asia)	Hotel	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	n/s
(Massie 2015)	Architectmagazine	Milan Expo 2015: Latvia	Made Ahitekti	2015	Italy (Europe)	Pavilion	Use of scented materials	Wood ventilation	n/s	n/s

(Table continued)

Table 1. Continued

Ref	Source	Project name	Architect(s)	Project year	Country (Continent)	Building type	Type of olfactory design	Subcategory	Specification	Expected impact on occupants
(Ayoubi 2017)	Architectmagazine	Kvåsossen	Rever & Drage Arkitekt	2017	Norvegia (Europe)	Community Center	Use of scented materials	Stain	n/s	Historic
(Ayoubi 2017a)	Architectmagazine	Apple Orchard Road	Foster + Partners	2017	Singapore (Asia)	Commercial	Green elements integration	Plans	Ficus Ali trees	Creating an oasis of tranquillity
(Demijian 2015)	Architectmagazine	Soft House	Kennedy & Violich Architecture	2014	Germany (Europe)	Residential	Use of scented materials	Wood	Brettstapel	Peaceful
(Thompson 2021)	Architectmagazine	Cedar Speedster	Weber Thompson	2020	USA (America)	Commercial	Use of scented materials	Wood	Cedar	Enhancing the creativity, health and wellness
(D'Angelo 2019)	Architectmagazine	Cocoon House	Nea Studio	2019	USA (America)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Connecting inhabitants with the outdoor smells
(Wang 2022)	Architectmagazine	West County Club by We Design	Current-Newswire	2021	China (Asia)	Residential	Spatial design	n/a	n/a	n/s
(D'Angelo 2021)	Architectmagazine	Hourglass Corral	DECA Architecture	2020	Greece (Europe)	Residential	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	n/s
(Ayoubi 2017b)	Architectmagazine	Verandah Walk	Wilson Architects	2017	Australia (Oceania)	Educational	Ventilation strategies	Connection to outdoor smells through natural ventilation	Smells of green nature	Supports improved levels of concentration, cognitive function and mental well-being
(AND Lab 2017)	Architectmagazine	MomentCam Headquarter	AND LAB PTE LTD	2017	China (Asia)	Offices	Spatial design	n/a	n/a	Casual
(Moreschi 2021)	Architectmagazine	Mgf House	Gianluigi Moreschi	2020	Italy (Europe)	Residential	Use of scented materials	Wood	Pine	Sublime
(Powers 2020)	Architectmagazine	Le Meridien Shenyang	Kokaistudios	2017	China (Asia)	Hotel	Use of scented materials	Wood	Oak	Serene; Cozy
(Nobel 2012)	Architectmagazine	Barclays Center, Brooklyn, N.Y	SHoP Architects	2012	USA (America)	Sport	Aroma Misting	HVAC system	Citrus	Pervading the space; Fresh-smelling
(Last 2023)	Dezeen	House of the Elements	Neil Dusheiko Architects	n/a	UK (Europe)	Residential	Green elements integration	Plans	n/s	n/s
(Eberhardt 2023)	Dezeen	KOKO Architecture + Design	permanent interactive children's play space at the Metropolitan Museum of Art	n/a	USA (America)	Community Center	Use of scented materials	Wood	n/s	n/s
(Astbury 2023)	Dezeen	Forest Sauna	Out of the Valley	n/a	UK (Europe)	Wellness	Use of scented materials	Wood	Alder	Calming

(Griffiths 2022) (Mair's 2015)	Dezeen	Cork House	Polysmiths	2020	UK (Europe)	Residential	Use of scented materials	Cork	n/s	Amazing
	Dezeen	Inflatable dome on the banks of the River Thames	Loop.pH	n/a	UK (Europe)	Wellness	Aroma Misting	Hazer machine	n/s	Allowing visitors to slip into the misty interior
(McKnight 2022)	Dezeen	Villa Petricor	CO-LAB Design Office	n/a	Mexico (America)	Residential	Use of scented materials	Earth	n/s	Evoking feeling of renewal and stillness
(Pownall 2020)	Dezeen	Hidaka Ohmu	Julia Lohmann	n/a	UK (Europe)	Pavilion	Use of scented materials	Kelp	n/s	Natural
(Griffiths 2019)	Dezeen	Residence 145	Charged Voids	n/a	India (Asia)	Residential	Green elements integration	Courtyard	n/s	Providing an enhanced connection to the outdoor planting

Table 2. Clustering of reviewed projects by category of indoor smellscape intervention and building setting.

	Indoor smellscape intervention									
	Scented materials					Burning stoves and fireplaces				
	Wood	Stone	Kelp	Cork	Concrete	Earthy materials	Cloth	Tar	Spatial connection	Green elements
Commercial	(Tilbrook 2016; Divisare 2020a; ArchDaily 2014a; Abdel 2020a; Thompson 2021)	-	-	-	-	-	-	-	(Ayoubi 2017a)	(Pintos 2023b; ArchDaily 2011a; Barac 2021)
Community Centre	(Eberhardt 2023)	-	-	-	-	-	-	(Aryoubi 2017)	(ArchDaily 2017a, 2013c)	(ArchDaily 2011b)
Cultural	(Divisare 2016b; ArchDaily 2017c)	-	(Pownall 2020)	(Moreira 2021)	-	(Divisare 2020c)	(Divisare 2015c)	-	(ArchDaily 2011c)	-
Educational	(Divisare 2020d; Pintos 2021a)	-	-	-	-	-	-	-	(Divisare 2022c)	-
Healthcare	-	-	-	-	-	-	-	-	-	-
Hotel	(ArchDaily 2013b, 2016a; González 2019; Powers 2020)	-	-	-	-	-	-	-	-	(ArchDaily 2017b)
Offices	(Shuangyu 2018)	-	-	-	-	-	-	-	(González 2020)	(ArchDaily 2010a; M:OFA Studio 2013)
Pavilion	(Divisare 2017d, 2014; Massie 2015)	-	-	(Divisare 2012b)	-	-	-	-	(Abdel 2021a)	(Divisare 2024; Abdel 2021c)
Residential	(Divisare 2022b; Abdel 2024d; Pintos 2023a; ArchDaily 2015c; Pintos 2020b; Ott 2021; Coulleri 2021; 2018; Coulleri 2021; Abdel 2023b, 2022b; Pintos 2020a; González 2017; ArchDaily 2013a; Pintos 2021b; Demirjian 2015; Moreschi 2021)	(Abdel 2024d; Coulleri 2021)	-	(Griffiths 2022)	(Abdel 2024d; Divisare 2017b)	(Divisare 2020b; Ott 2021; McKnight 2022; ArchDaily 2010a; Abdel Hana 2020)	-	-	(Divisare 2012a, 2015a; Vial 2019; Abdel 2021b; Pascal 2013; Pintos 2023c; ArchDaily 2015b; Last 2023; Griffiths 2019)	(Divisare 2015b, 2016a, 2023b; Abdel 2022d; ArchDaily 2012b, 2013d; Walker 2021; ArchDaily 2012a; Pintos 2024a, 2024b; Moreira 2023; ArchDaily 2017d; Santibañez 2018; Johnson 2016; D'Angelo 2019, 2021; Abdel 2022c)
Sport	-	-	-	-	-	-	-	-	-	(Nobel 2012)
Wellness	(Pintos 2018; Astbury 2023)	(ArchDaily 2009; Pintos 2018)	-	-	-	-	-	-	(Abdel 2021d)	(Mairs 2015) (Abdel 2020b)

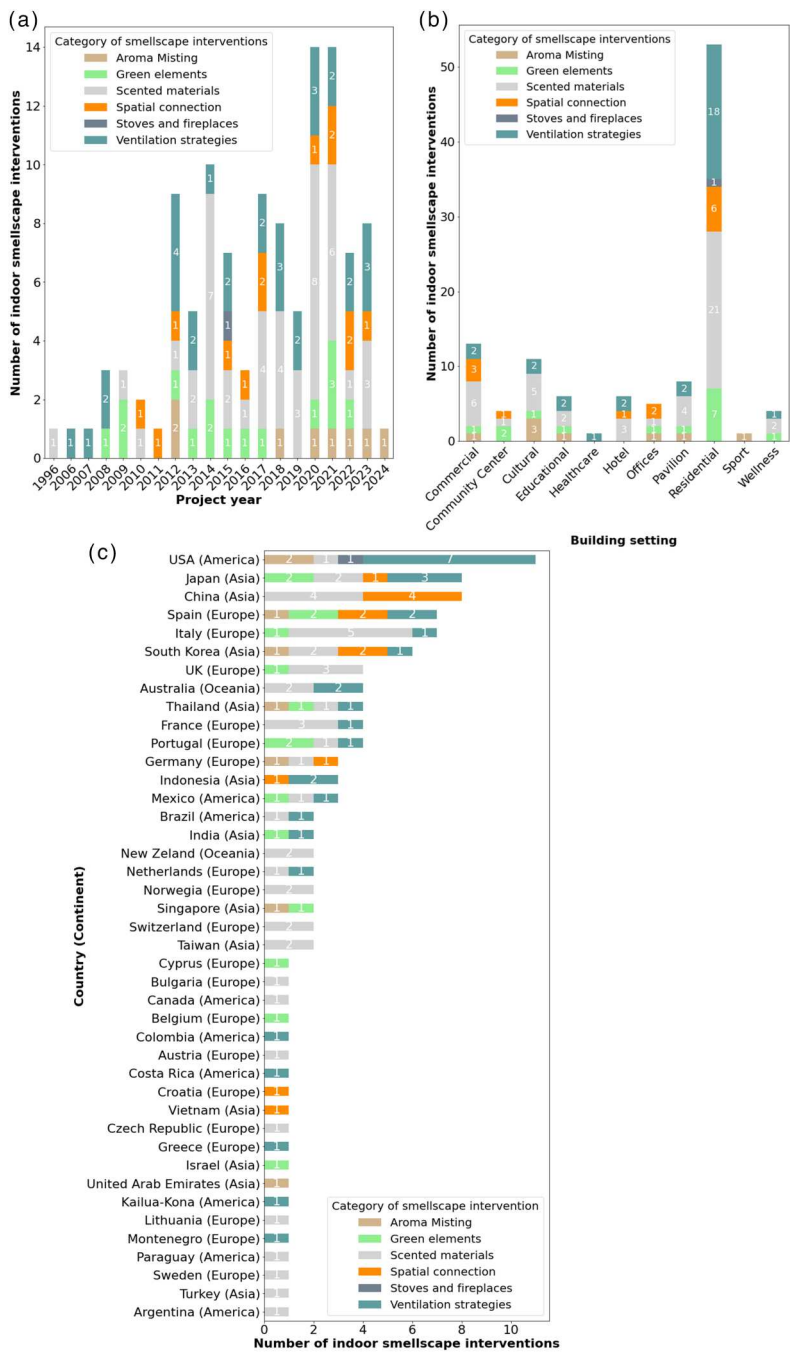
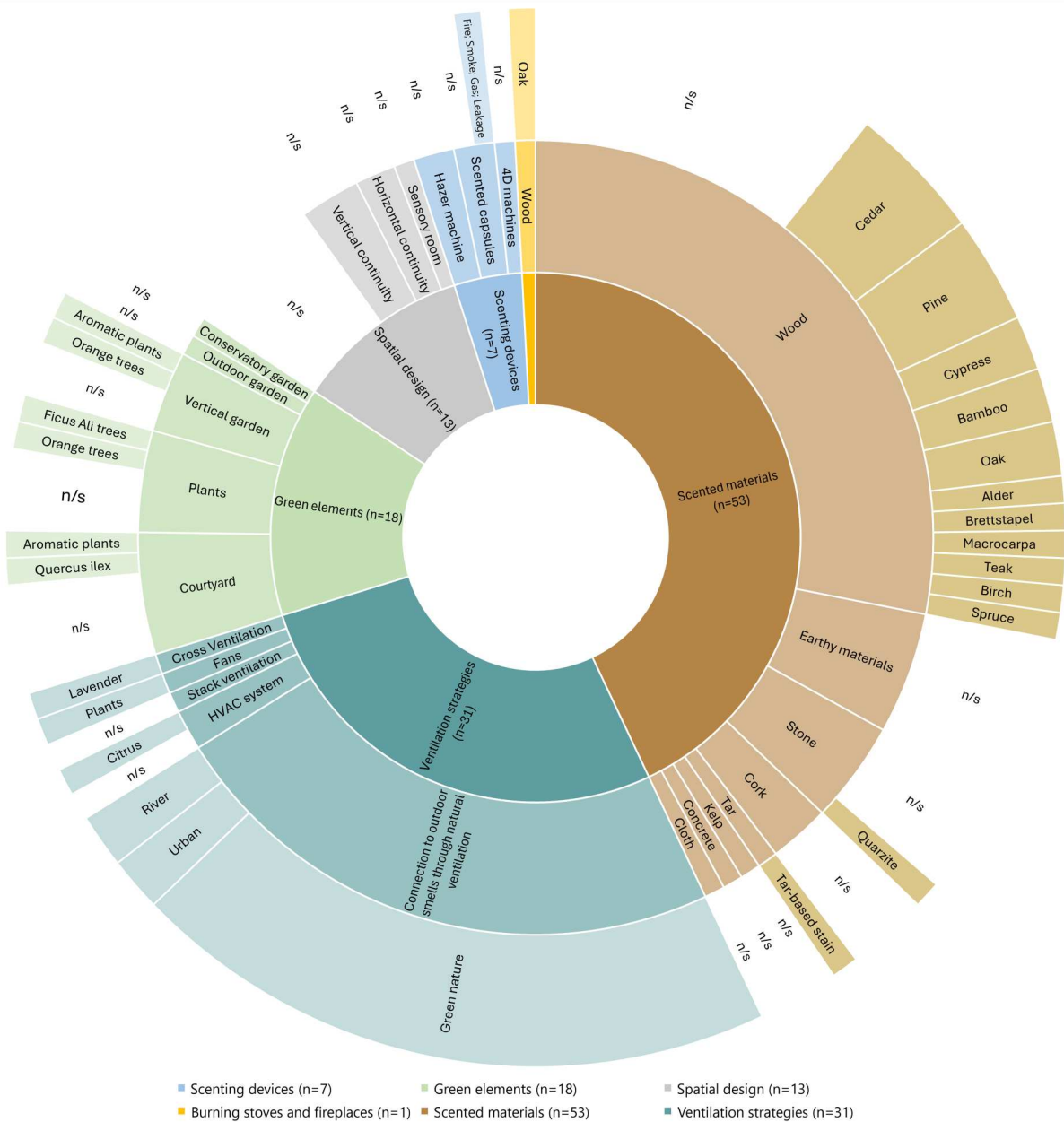


Figure 2.
Distribution of indoor smellscape
interventions per (a) project year;
(b) building setting; and (c) location
(country and continent),
categorised by category of
smellscape interventions, compiled
by the authors, 2025



Data collection and analysis

The general project information, including project title, architect(s), project year, country and continent, building setting, the type of olfactory design, and the expected impact on building occupants, were manually extracted

and indicated in the full list of reviewed articles (Table 1). The attributes used by designers to articulate the expected impacts of smellscape interventions on building occupants were clustered based on semantic similarity (Table 2). This was achieved using natural language processing (NLP) techniques.²⁴ A Python script using the Datamuse API was used to identify synonyms for each attribute, construct a graph of synonym relationships, and apply depth-first search (DFS) to find connected groups of synonyms. Datamuse was chosen for its extensive synonym database and free access. Two native English speakers were interviewed to cluster the remaining descriptors (i.e. general terms or phrases used to describe something and may include attributes as well as other descriptive language). The descriptors were then manually clustered by the authors into macro-categories.

Results

Description of the included projects

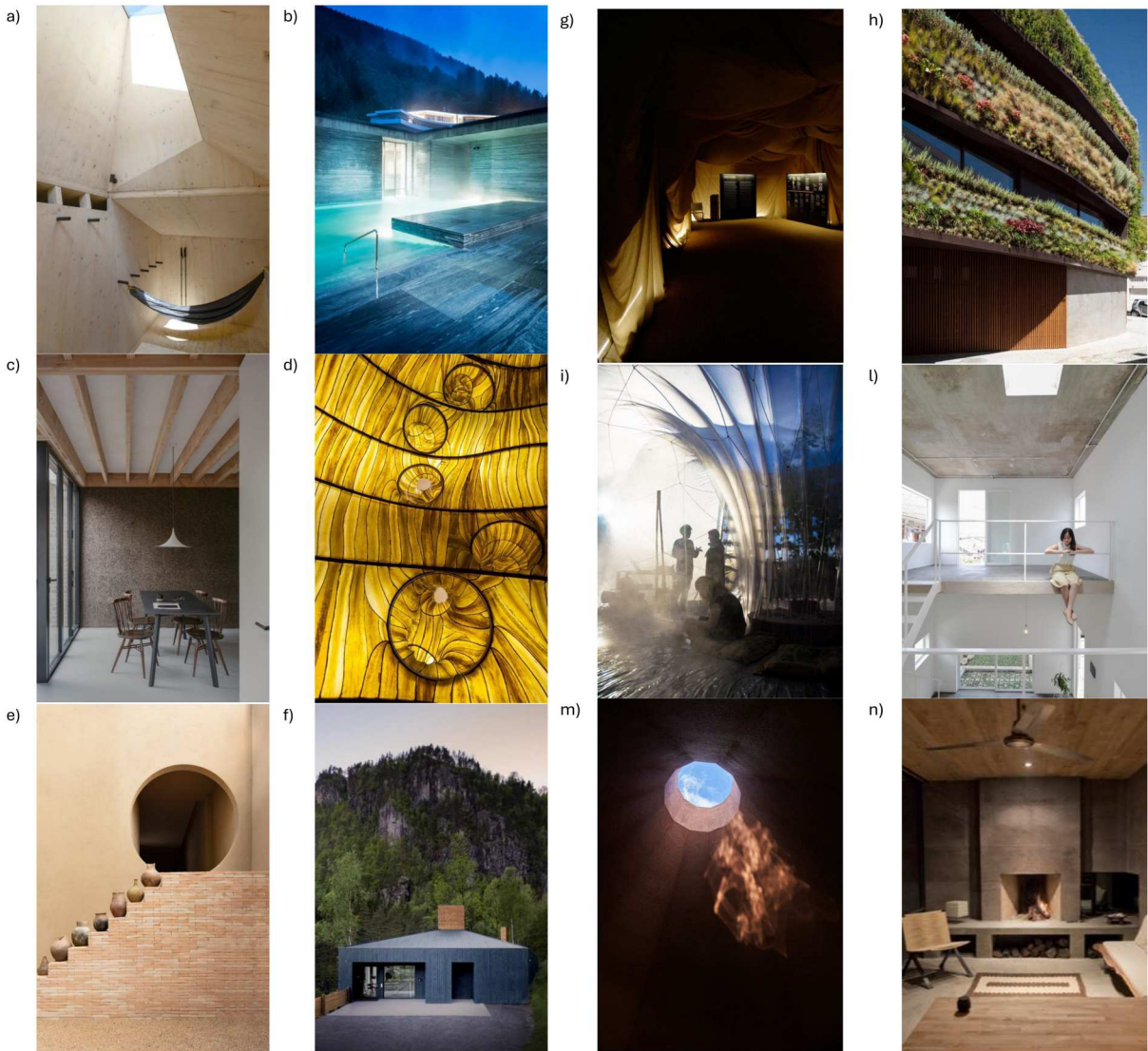
A total of 123 design projects exploring the possibility of using smells as a resource in the built environment were reviewed. Even though the websites feature projects from the twentieth and twenty-first centuries with an overall time interval of about 124 years, the reviewed interventions were mainly carried out over the last two decades, representing 0.50% of the projects completed in these years (Fig. 2a). The types of buildings included: commercial buildings (such as shops and retail spaces, restaurants, and cafés), community centres, cultural centres (including museums and auditoriums), educational buildings, healthcare facilities, hotels, offices, exhibition pavilions (not artistic installations but interior projects for everyday life), residential buildings, sport facilities, and wellness centres. They were predominantly conducted in residential settings (Fig. 2b). The most frequent locations were the US, Japan, and China (Fig. 2c).

Categories of indoor smellscape interventions

Olfactory design strategies were categorised into six groups (Fig. 3):

- use of scented materials (43%): incorporating materials where the olfactory molecules are volatile enough to be quickly perceptible;²⁵
- smells distribution through ventilation strategies (24%): using natural or mechanical ventilation systems to control and distribute smells within a space;
- composing with green elements (14%): using flowers, tree, and a variety of green spaces in order to diffuse specific odours and contribute to composing an olfactory environment;²⁶
- smell circulation through spatial connection (10%): designing the layout and use of spaces in a way that smells can circulate between them;
- use of scenting devices (8%): dispersing smells through mechanical aerosolising or passive diffusion;²⁷ and

Figure 3.
Wheel diagram illustrating the typologies of smellscape interventions identified in the reviewed projects, where the inner circle shows the six main categories of interventions, the middle ring specifies the design techniques associated with each category, and the outer ring reports the olfactory target described by the designers (n/s = not specified in the project description), compiled by the authors, 2025



- use of burning stoves and fireplaces (1%): diffusing the smells of burning wood or other materials in the indoor smellscape.

The North American designers mainly explored the technique of ventilation strategies, the Japanese ones the circulation of smells through spatial connection, and the Chinese ones the spatial connection and the use of scented materials, as shown in [figure 2c](#). The clustering of reviewed projects by category of indoor smellscape intervention and building setting is shown in

table 2. In the subsequent sections, each category will be examined in detail through an analysis of the reviewed projects.

Use of scented materials. In 43% of the reviewed projects, the use of naturally scented materials was involved to create positive indoor environments. Below is a description of the materials used, based on the descriptions provided by the designer in the reviewed databases. This aims to highlight the reasons behind the designer's choice of materials, which may not be shared by other designers or scientifically proven. The descriptors used by the designers are placed in quotation marks in the text.

Wood. Among the scented materials, wood is the most used in projects (67%). Wooden panels can serve as the final finishing surface without additional rendering, facilitating the absorption of humidity and the evaporative release of wood scents (Fig. 4a). Various types of wood are used, including cedar (14%), pine (14%), bamboo (6%), oak (9%), alder (2%), brettstapel (2%), cypress (6%), macrocarpa (2%), teak (2%), birch (2%), spruce (2%), and fir (2%). Each type of wood can offer a different sensory experience, at least in the intentions of the designers. For instance, cedar wood was chosen for its 'light scent' for both living and working spaces.²⁸ Similarly, pine wood, with its 'strong resinous aroma' and 'fresh balsamic notes', was chosen to evoke sensations of 'cleanliness' and 'natural wilderness'.²⁹ The designers have also chosen bamboo, especially in Asia, both for construction and furniture.³⁰ Oak was used in pavilions,³¹ commercial buildings,³² and hotels.³³ Meanwhile, cypress wood, with its 'light scent', was deemed well-suited for offices and commercial spaces.³⁴ Alder wood was used in sauna construction not only for its low thermal conductivity but also because it emits a 'light, sweet and relaxing fragrance' in heat and humid spaces.³⁵

Stone. While not traditionally associated with strong fragrances like wood or earth, stones with high water absorption can release subtle aromas when interacting with elements such as heat and water. Designers explored the use of stone as a scented material in both residential and wellness buildings.³⁶ The first who explored the olfactory potential of stone was the Swiss architect Peter Zumthor with the Therme Vals in 1996 (Fig. 4b).³⁷ Zumthor selected local quartzite stone for its 'sensory qualities', 'integrating the building into the landscape' and 'offering a specific scent when warmed by the spa waters'. This interaction releases a 'subtle mineral aroma', fostering a 'deep connection with nature and the surrounding mountain landscape', according to the designer's intentions. The baths are designed as a labyrinth of rooms and passages with various thermal pools, 'creating an olfactory journey that complements the visual and tactile experiences'.

Cork. Cork is a natural material with earthy, woody, and slightly sweet olfactory qualities, as well as versatility in being carved, cut, moulded, and shaped.³⁸ Its properties have made it a popular choice in various architectural

Figure 4.
Project examples for each category of smellscape interventions: (a) wood; (b) stone; (c) cork; (d) kelp; (e) earthy materials; (f) tar; (g) cloth; (h) composing with green elements; (i) use of scenting devices; (l) spatial connection; (m) ventilation strategies; (n) burning stone and fireplaces, see figure indications in the main text for project details, compiled by the authors, 2025

projects, 'enhancing both the sensory experience and the aesthetic appeal of buildings' (Fig. 4c).³⁹

Kelp. Designer Julia Lohmann showcased the olfactory potential of kelp in architecture with her Department of Seaweed pavilion at the World Economic Forum conference in Davos in 2020.⁴⁰ Called Hidaka Ohmu, the organically shaped pavilion is formed from semi-translucent panels of a large seaweed — or macroalgae — called kelp, laid over a rattan frame (Fig. 4d). The kelp pavilion aims to bring the 'salty scent of the sea' into the conference building.

Earthy materials. Earth is mainly used in residential settings, involving a multidisciplinary approach that integrates architectural engineering and traditional craftsmanship. It can be found in various forms, such as terracotta bricks (Fig. 4e),⁴¹ or rammed earth,⁴² each offering distinct aesthetic but similar olfactory properties. Earth can be applied to walls and ceilings, and it is able to 'enrich the olfactory experience', especially when it rains. Indeed, the interaction between water and earth releases the 'characteristic aroma of wet rain, known as petrichor'.⁴³

Tar. The Norwegian architects Rever & Drage used stain in their design of the community centre Kvåsfossen.⁴⁴ Rever & Drage opted to impregnate the external cladding of Kvåsfossen with tar-based stain, a decision that imbues the building with the 'evocative scent reminiscent of centuries-old building traditions'. Simultaneously, the stain's coloration provides a modern aesthetic contrast, blending tradition with contemporary design sensibilities (Fig. 4f).

Cloth. Kengo Kuma and Associates demonstrated that it is possible to use cloth as a scented material in their curation of the Van Gogh Exhibition at Palazzo Reale (Milan, Italy) in 2015.⁴⁵ Seeking to evoke the undulating earth beloved by Van Gogh, Kengo Kuma and Associates chose to install a piece of cloth in the exhibition (Fig. 4g). This earth-coloured material, with its slightly rough texture, not only visually echoed the earthy tones Van Gogh admired but also engaged visitors' senses. When visitors pressed their cheek against the cloth, it emitted a 'subtle scent of soil', 'enhancing the immersive experience' and 'deepening the connection to Van Gogh's artistic vision', according to the designer's intended effect.

Concrete. By integrating concrete into the Mach House, Argentine architect Luciano Kruk intended to use this material not only for its structural function but also as a 'defining element of architectural character and sensory experience'. According to the designer, the material qualities of concrete can affect the perception of light, air, and even smells. Its robust texture and earthy tones contribute to a 'sense of solidity and permanence' while also providing a 'neutral backdrop that complements various interior design elements'.⁴⁶

Composing with green elements. Green elements can be used to create a pleasant olfactory experience for building occupants. Plants such as Ficus Ali trees,⁴⁷ Mandarin orange trees,⁴⁸ Quercus ilex, Sarcococca confuse, Pittosporum tobira 'Nanum', Trachelospermum jasminoides,⁴⁹ Lavender, Rosemary and Sage⁵⁰ have been utilised for this purpose. Alternating various plant species ensures a 'continuously changing natural environment with different scents throughout the year', as plants bloom and perfume the air in different seasons, ensuring a 'continuous floral presence'.⁵¹ Incorporating indoor plants not only boosts visual aesthetics but also 'engages all human senses', thereby 'enriching the indoor smellscape experience'.⁵² Furthermore, these plants possess dust-retention capabilities, effectively capturing airborne particles smaller than 10 microns and helping retain other air pollutants.⁵³ Green elements can also be integrated into facades as vertical gardens.⁵⁴ The verticality of these elements allows for different scents depending on the floor, creating a 'variety of aromas suited to the type of environment that can be experienced by opening windows'. For instance, in the residential building 'House in Travessa Do Patrocinio', rosemary is used on the facade of the first floor designated for social areas, lavender is used on the second floor corresponding to the bedrooms, and crocus sativus is used near the rooftop swimming pool (Fig. 4h).⁵⁵ Green elements can also be incorporated into internal courtyards located near the areas intended to be scented.⁵⁶ Retractable doors can integrate these open-air spaces into the rooms, 'providing an enhanced connection to the scent of the outdoor plants'.⁵⁷ Lastly, conservatory gardens can be included within buildings. Without glass, occupants can touch and smell the greenery while moving from one side of the building to the other.⁵⁸

Use of scenting devices. Scents crafted for specific environments can be effectively diffused through air using dedicated scent diffusion systems such as 4D machines⁵⁹ or scented capsules.⁶⁰ The term '4D machines' is commonly used in experiential media (e.g. 4D cinemas) to indicate the integration of additional sensory stimuli such as scent, airflow, or vibration. In this context, the systems release controlled amounts of fragrance into the air to support the intended sensory experience. Scents can also be diffused as scented vapours using hazer machines or indoor pools where scented products or plants are added to the water.⁶¹ Often, this process requires collaboration between a designer and a scent specialist or medicinal herbalists capable of creating a crafted olfactory experience.⁶² An example of scent diffusion through air is the educational building for blind children designed by the Thai architects Creative Crews, where scented capsules are used to teach pupils about the smells of potential hazards such as fire, smoke, and gas leaks.⁶³ Furthermore, an example of scented vapor diffusion is the inflatable plastic dome by London's River Thames designed by the British firm Loop.pH.⁶⁴ Here the mists are dispersed through a nebuliser fog machine, typically used in agricultural warehouses. The Daily Fog Menu includes a grapefruit, lemon balm, and peppermint scent in the morning; a more invigorating bergamot, juniper berry, and

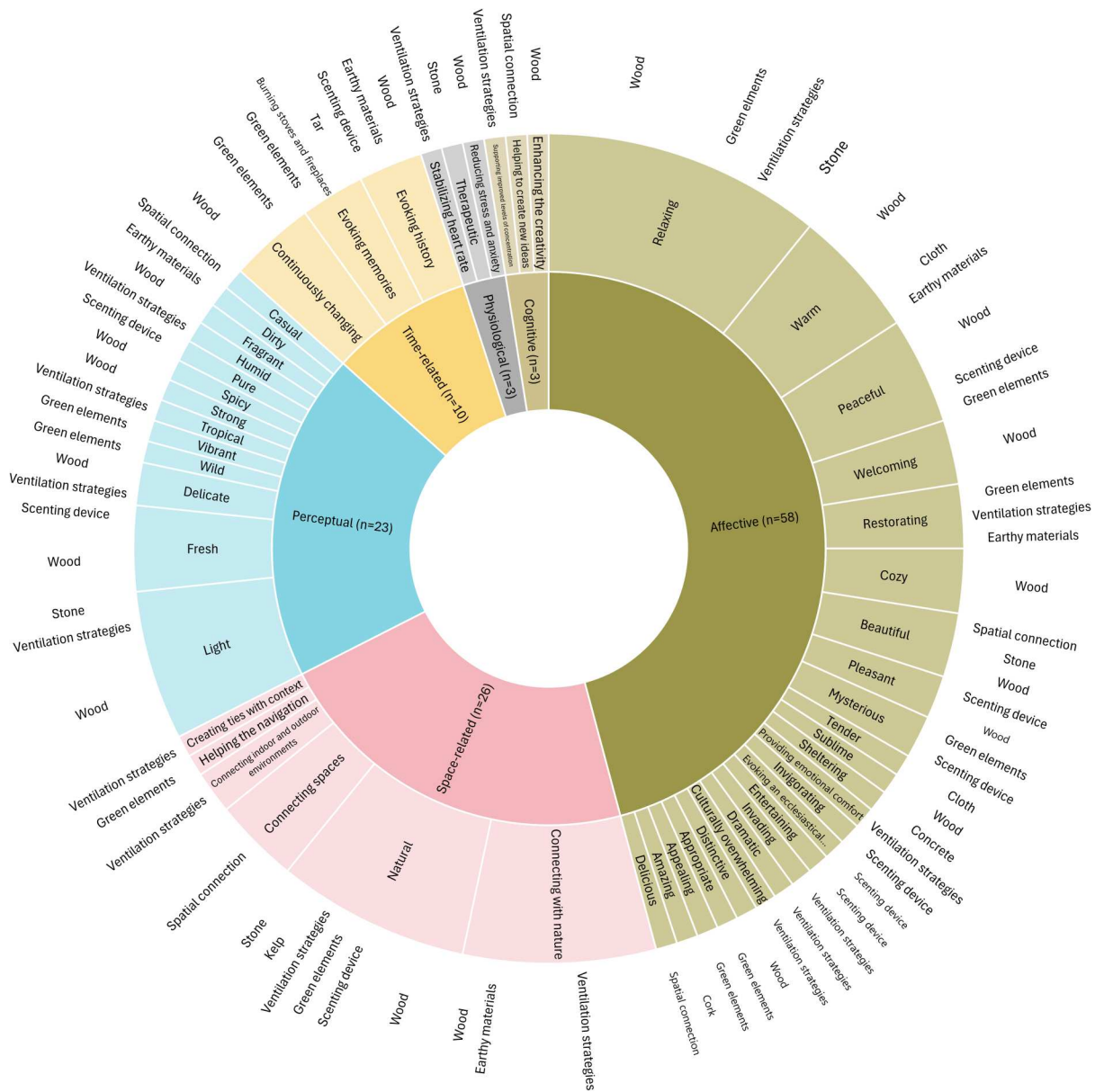
Figure 5.

A classification of expected impacts of indoor smellscape interventions on building occupants into six components: perceptual (blue); affective (khaki); cognitive (beige); physiological (grey); space-related (pink); time-related (yellow), where the inner circle represents the classification provided by the authors, the middle ring illustrates the descriptors used by designers, and the outer ring details the smellscape intervention, compiled by the authors, 2025

parsley blend for mid-afternoon; and a bedtime fragrance with chamomile, lavender, and basil oil in the evenings (Fig. 4i). Lastly, the South Korean architectural firm Indiesalon applied the technique of scent diffusion through water in the flagship store they designed for LADOR, a Korean hair product brand.⁶⁵ With the intention of encouraging customers to spend more time and money in the store, the designers introduced a display bathtub filled with the scent and bubbles of their products.

Smell circulation through spatial connection. Even when visually separated, spaces can be effectively connected through the diffusion of smells. This connection can be achieved through vertical continuity or horizontal continuity. Vertical continuity between floors can be employed in both residential⁶⁶ and commercial settings.⁶⁷ For example, mezzanines and open staircases allow smells from lower floors, such as food aromas, to permeate upper levels. This 'helps bridge physical separations and creates a shared sensory experience' (Fig. 3l). In residential settings, Kconcept Architects have explored horizontal continuity via corridors that connect front and back gardens, 'enabling the full experience of natural scents throughout the space'.⁶⁸ Furthermore, in office settings, spatial continuity was ensured by incorporating an intermediate room between two offices for use as a coffee area.⁶⁹ With the intention of creating a shared olfactory experience and fostering connections between occupants, the designers diffused positive smells throughout the space, allowing different office rooms to 'share the same olfactory experience' and 'connect people'. A crafted sensory room can also minimise visual stimuli to heighten olfactory perception, as demonstrated by Hyunjoon Yoo Architects in their South Korean community centre. Here a 'darkroom' devoid of visual distractions focuses on scent, touch, and sound, fostering a conducive environment for meditation and creative thinking.

Smells distribution through ventilation strategies. Natural ventilation stands out as the primary method to seamlessly integrate outdoor scents into indoor environments. By harnessing the wind, architects can 'design a sensory journey' where the landscape's diverse aromas, such as those of the countryside,⁷⁰ woodlands,⁷¹ wet earth,⁷² grass and flowers,⁷³ aromatic plants,⁷⁴ ocean,⁷⁵ rivers,⁷⁶ and urban environments,⁷⁷ enter through open doors and windows. Furthermore, mechanical ventilation systems can diffuse crafted scents in the environment.⁷⁸ Other ventilation strategies can alter the air to ensure good air quality, refresh the senses with cooling effects, and distribute the scent throughout the space to achieve both coverage and a consistent ambient smell level. Tall towers designed for stack ventilation, utilising the chimney effect, facilitate air circulation and the dispersion of smells throughout a building (Fig. 4m).⁷⁹ Additionally, the use of fans can create airflow that enhances the circulation of smells and provides a soothing experience as individuals move through the building.⁸⁰ Cross-ventilation strategies are also instrumental, not only for cooling purposes but also for pulling smells through different rooms.⁸¹



Use of burning stoves and fireplaces. By selecting specific types of wood that release 'delightful scents when burned', architects can create positive olfactory experiences for occupants. This approach is exemplified by the American architectural firm DUST, who designed a house that utilises the aromatic qualities of burning Arizona Emory oak. The scent of this wood, when burned, 'permeates the

home and creates lasting olfactory memories for the inhabitants', in the designers' intentions (Fig. 4n).⁸²

Expected impacts of indoor smellscape interventions on building occupants

A total of 61 different descriptors of impacts from indoor smellscape interventions on building occupants, as reported by designers, were identified. The descriptors were initially grouped into 52 categories based on semantic similarity, as detailed in the previous section. The most frequently occurring descriptor for each group has been identified (Figs. 5 and 6), also see the complete list in table 1.

The most frequently targeted impact on building occupants was the ability of smells to be 'Relaxing/Calm/Providing a soothing experience', accounting for 18% of the cases. This was followed by 'Natural', which appeared in 13% of the cases. Other descriptors included 'Warm' (4%), 'Fresh' (4%), 'Light/Subtle/Soft-spoken' (4%), and 'Serene/Peaceful/Creating an oasis of tranquillity' (4%). A classification of expected impacts of indoor smellscape interventions on building occupants into six components is proposed by the authors, as shown in figure 5, including affective (47% of cases), space-related (22%), perceptual (19%), time-related (8%), cognitive (2%), and physiological (2%) aspects. The category of affective impact concerns people's emotional responses, both positive and negative, elicited by smells (e.g. 'welcoming' or 'cozy').⁸³ Perceptual impact refers to how smells are sensed and perceived according to people's perceptual abilities, which involve bodily functions such as vision, hearing, touch, or muscle coordination (e.g. 'fragrant' or 'spicy').⁸⁴ Cognitive impact relates to how smells can affect cognitive functions such as attention, memory, and decision-making (e.g. 'helping to create new ideas' or 'enhancing productivity').⁸⁵ Physiological impact includes the automatic and without conscious awareness effects of smells on the body's biological systems (e.g. 'stabilizing heart rate' or 'reducing stress and anxiety').⁸⁶

The categories of time-related and space-related impacts refer to the ability of smells to connect us with dimensions of time (e.g. 'continuously changing' or 'evoking history') or space (e.g. 'connecting spaces' or 'creating a tie with the context'). The concept of 'space' designates a boundless, three-dimensional (length, width, and depth) extent in which objects and events occur and have relative positions and directions vis-a-vis each other.⁸⁷ The concept of 'time' does not have a single definition.⁸⁸ However, in the proposed classification context, 'time' refers both to how individuals perceive the passage of time (e.g. 'continuously changing') and to a temporal perspective oriented towards the past, present, and future (e.g. 'evoking history').

The impacts on building occupants in relation to the building setting have been shown in figure 6. In commercial environments, designers primarily seek an affective (e.g. 'welcoming') and space-related (e.g. 'connecting spaces') response. In community centres, they aim for a cognitive response (e.g. 'creating new ideas'), while in cultural settings (e.g. museums), a time-related response, especially seeking to a connection with the past (e.g. 'evoking history' or 'evoking memory'). In educational settings, a cognitive

	Commercial	Community Centre	Cultural	Educational	Healthcare	Hotel	Offices	Pavilion	Residential	Sport	Wellness
Casual							(AND Lab, 2017)				
Delicate								(Divisare, 2024)	(ArchDaily, 2013a)		
Dry									(Gonzalez, 2018)		
Fragrant									(Abdel, 2022b)		
Fresh	(Divisare, 2020a)								(ArchDaily, 2015c; Nobel, 2012; Pintos, 2023a)	(Nobel, 2012)	
Humid					(Abdel, 2022a)						
Light						(Shuangyu, 2018)			(Abdel, 2023b; Pintos, 2018; Santibañez, 2018)		(Pintos, 2018)
Pure								(Divisare, 2017a)			
Spicy									(Abdel, 2022b)		
Strong									(Gonzalez, 2017)		
Tropical											(Abdel, 2024)
Vibrant									(Divisare, 2015a)		
Wild									(ArchDaily, 2015)		
Delicious							(Divisare, 2024)				
Amazing									(Griffiths, 2022)		
Appealing								(Abdel, 2021a)			
Appropriate									(Divisare, 2012)		
Beautiful	(Pintos, 2023b)										(Pintos, 2018)
Cozy	(ArchDaily, 2014a)					(ArchDaily, 2013b; Powers, 2020)					
Distinctive			(Divisare, 2016)								
Culturally overwhelming			(Divisare, 2017c)								
Dramatic									(Walker, 2021)		
Invading									(Moreira, 2023)		
Entertaining	(Abdel, 2024)										
Evoking an ecclesiastical environment			(Coulteri, 2022)								
Restoring			(ArchDaily, 2011)						(McKnight, 2022; Pintos, 2024)		
Welcoming	(ArchDaily, 2014; Tibbrook, 2016)								(Pintos, 2021a)		
Invigorating							(Pintos, 2021b)				
Mysterious									(ArchDaily, 2015)		(Mairs, 2015)
Peaceful								(Divisare, 2017a)	(Pintos, 2023)		
Placid											(Jonatan, 2019)
Providing emotional comfort									(Abdel, 2020; ArchDaily, 2009; 2013; Gonzalez, 2017; Pintos, 2021)		(Abdel, 2021b; Artbury, 2023; Pintos, 2018)
Relaxing	(Ayoubi, 2017)					(Powers, 2020)		(Divisare, 2017a)	(Demirhan, 2015; Pintos, 2021)		
Peaceful								(Divisare, 2017a)	(Divisare, 2017b)		
Shedding									(Divisare, 2017a)		
Sublime			(Divisare, 2015)						(Moreschi, 2021)		
Tender											
Warm	(Tibbrook, 2016)		(ArchDaily, 2017; Divisare, 2015)	(Divisare, 2020)					(Abdel Hana, 2020)		
Enhancing the creativity	(Thompson, 2021)	(ArchDaily, 2011)									
Helping to create new ideas											
Supporting improved levels of concentration											
Reducing stress and anxiety			(ArchDaily, 2017)		(Ayoubi, 2017)						
Therapeutic											(ArchDaily, 2009)
Stabilizing heart rate											(Jonatan, 2019)
Connecting indoor and outdoor environment	(Abdel, 2024b)								(ArchDaily, 2013; D'Angelo, 2019; Pintos, 2023b)		
Neutral			(Divisare, 2013, 2020b; Pownall, 2020)					(Abdel, 2021)	(Abdel, 2022b, 2023b; Pintos, 2021)		
Collecting spaces	(Pintos, 2023a)					(Abdel, 2022a)	(ArchDaily, 2010)		(Abdel, 2024a; ArchDaily, 2014)		
Connecting with nature			(Divisare, 2016, 2020a)						(ArchDaily, 2012; Divisare, 2015, 2023)		
Growing ties with the context								(Divisare, 2024)			
Helping the movement of the outdoor											
Continuously changing			(ArchDaily, 2017)		(Divisare, 2022)				(Vial, 2019)		
Exciting history			(Abdel, 2023; Divisare, 2020)						(Pintos, 2020)		
Enriching memories			(Ayoubi, 2017)						(ArchDaily, 2016; Johnson, 2016)		

response is also sought, with smells that 'support improved levels of concentration'. For hotels, an affective response linked to coziness, peacefulness, and connection with nature is desired. In residential settings, space-related dimensions prevail, with particular attention to connecting with outdoor nature and linking spaces. The physiological dimension is sought almost exclusively in wellness settings, aiming for 'therapeutic' effects and 'stabilizing heart rates', as well as fostering relaxation.

Discussion

Designing positive olfactory experiences in indoor spaces

Two decades have now passed since the publication of the book, *Invisible Architecture: The Experience of Place through Smell*, by Barbara and Perliss, which originally appeared in Italian in 2006.⁸⁹ What once seemed a field of research somewhat neglected by architecture and design has over time become an increasingly promising professional practice, as highlighted by this review paper. In analogy to the soundscape domain,⁹⁰ the term 'positive' olfactory design is used in this work to refer to olfactory environments designed and perceived in such a way as to promote health, comfort, and quality of experience for individuals. Positive indoor olfactory experiences can be

Figure 6.
A classification of expected impacts of indoor smellscape interventions on building occupants into six components: perceptual (blue); affective (khaki); cognitive (beige); physiological (grey); space-related (pink); time-related (yellow), where the inner circle represents the classification provided by the authors, the middle ring illustrates the descriptors used by designers, and the outer ring details the smellscape intervention, compiled by the authors, 2025

achieved through interventions that can be classified as passive or active.⁹¹ Active indoor interventions are techniques that necessitate the use of mechanical or electrical energy to release and circulate smells. These include the use of scenting devices (e.g. 4D machines or hazer machines), ventilation strategies (e.g. natural ventilation, HVAC systems, or fans), or the use of burning stoves. Passive interventions are strategies for smell diffusion that do not require mechanical or electrical energy, relying instead on natural dispersion methods such as the use of scented materials, spatial connections, and the integration of green elements. Active interventions constitute only 7% of the 123 reviewed projects, with designers preferring smells released directly from the design elements (e.g. building materials) rather than being included as an after-thought or decorative element.⁹²

Among the indoor smellscape interventions, the one most explored by designers is related to the use of scented materials, especially wood, as shown in figure 3. Scented materials are valued mainly for their intrinsic olfactory properties, while their specific relationship with occupants is often forgotten. However, while bodies are affected by their environment, it is essential to recognise that this relationship is not one-sided. Materials not only have their own smells but also release those they have absorbed.⁹³ When designed correctly, these impregnated smells can be highly desirable to designers, who can use the inherent smell of the chosen materials and also play with their ability to absorb and diffuse foreign scents.⁹⁴ Indeed, very porous materials, such as wood, are particularly able to absorb smells and release them gradually.⁹⁵ Despite these potential benefits, the use of naturally scented materials in architecture also requires careful consideration of possible health and safety concerns. For instance, certain natural materials may emit volatile organic compounds (VOCs) that could negatively impact indoor air quality.⁹⁶

Finally, it should be recognised that the olfactory environment of indoor spaces is not determined by a single actor or design gesture, but rather emerges from a complex, multi-layered system.⁹⁷ Architectural and interior design choices such as material selection or spatial configuration form the baseline olfactory potential of a space. HVAC system designers further modulate this environment by defining ventilation effectiveness, filtration performance, air distribution, and pressure regimes. In parallel, facility-management practices introduce additional determinants of olfactory quality through cleaning protocols, maintenance products, and scenting policies. Finally, occupants' behaviours and activities contribute dynamic and often dominant sources of odorants.

Expected impacts on building occupants

The concept of smellscape encompasses the relationship between human experiences of smells, physical spaces, and the context of a place.⁹⁸ However, few studies try to understand the perceptual qualities associated with smellscape interventions. Smells are typically defined using odour quality classifications, which are often represented through odour wheels. These wheels communicate the olfactory characteristics of various products

by categorising scents into specific descriptors such as spicy, earthy, floral, or fruity.⁹⁹

Olfactory design is a discipline whose main objective is not merely to scent environments but to decide which responses to trigger in building occupants through smells.¹⁰⁰ Indeed, smells act as a spatial-emotional intermediary, connecting and giving meaning to the emotions triggered by olfaction in everyday life.¹⁰¹ The impacts on occupants presented in the Results section reflect the intended effects articulated by designers within project narratives and are not empirically validated for the analysed cases. In this section, references to the relevant available scientific literature are included solely to contextualise these intended outcomes and should not be interpreted as evidence supporting the individual projects.

The descriptors derived in this paper capture not only perceptual characteristics but also affective, cognitive, physiological, space-related, and time-related attributes, as shown in [figure 5](#). Although these descriptors refer to expected responses that have not been validated in empirical studies, the proposed classification aligns closely with the four types of smellscape pleasantness for outdoor transit spaces identified by the study by Jieling Xiao, Malcolm Tait, and Jian Kang (preference-dominated, health-dominated, memory and habit-dominated, and context-dominated), adding to this classification new dimensions of perception and cognition.¹⁰²

Furthermore, the reviewed design expectations are broadly aligned with a growing body of research in cognitive science, environmental psychology, and consumer behaviour demonstrating that olfactory stimuli can influence mood, physiological responses, and, in some contexts, decision-making. Studies in multisensory and environmental psychology show that ambient scents—especially those associated with nature or aromatherapy—can enhance mood and subjective well-being. In a study by Namni Goal and Raymund Lao, lavender increased slow-wave-sleep and subjects reported higher vigour upon awakening compared to control.¹⁰³ In the study by Kyoko Kuroda, Naohiko Inoue, Yuriko Ito, Kikue Kubota, Akio Sugimoto, Takami Kakuda, and Tohru Fushiki, jasmine tea and lavender decreased heart rate, increased positive mood, and decreased negative mood.¹⁰⁴ Further works have demonstrated that urban odours can evoke basic emotions (i.e. happiness, surprise, anger, fear, sadness, and disgust) and induce measurable autonomic responses across different age groups.¹⁰⁵ Similarly, in consumer and marketing research, there is extensive empirical evidence that ambient scents influence a wide range of consumer responses in commercial contexts.¹⁰⁶ Multiple mechanisms have been proposed—from approach or avoidance, processing fluency, to mood modulation and semantic associations with ‘signature scents’ and branding.¹⁰⁷

There is also evidence that ambient scents can affect arousal,¹⁰⁸ prosocial behaviour,¹⁰⁹ and social interaction.¹¹⁰ At the same time, however, one also needs to consider the ethical implications of ambient scenting.¹¹¹ Ultimately, though, it can be argued that future applications of olfactory design, especially in commercial settings, must be guided by transparent and ethically grounded

principles rather than functioning as covert behavioural nudges. Furthermore, it should be clarified that the present study does not endorse behaviourally manipulative uses of scents, but rather advocates for an evidence-based use of odours to improve living and working environments.

Olfactory design in different building settings

Designer choices regarding smellscape interventions and their associated expected impacts on building occupants were assessed in various building settings, as shown in figures 3 and 6. Although the sense of smell is often incorrectly associated solely with the luxury sector or with wellness and hospitality, 43% of reviewed indoor smellscape interventions pertain to residential settings, followed by commercial and cultural spaces, as shown in figure 2.¹¹²

Despite the apparent lack of a strong correlation between the building setting and the typology of smellscape intervention, see figure 3, the impacts designers aim to trigger vary depending on the building setting, see figure 6. Scientific literature indicates that fields such as marketing are highly interested in olfaction and its impact on spending patterns.¹¹³ Additionally, olfaction plays a crucial role in immersive experiences, often linked to museums and cultural contexts.¹¹⁴ Olfactory stimulation has been shown to enhance performance in productivity, learning, and concentration in environments such as schools, offices, and community centres. Research on workplaces reveals that scented environments with diffusers reduce staff absenteeism and that well-oxygenated and ventilated offices can increase productivity and cognitive functions by more than 60% compared to the average.¹¹⁵ Smells can also impact our bodies, particularly in wellness and healthcare environments. Research by the Alzheimer's Society demonstrates that patients respond to certain odours, such as cinnamon, with significant improvements in cognitive functions like visual-motor responses, working memory, and attention thresholds. Furthermore, some fragrances can evoke autobiographical memories and familiar associations, thereby helping old people reconnect with past experiences, which in turn could support emotional wellbeing and social interaction in care settings.¹¹⁶ Finally, designers of spas and hotels are well aware of the persuasive and attractive power of smells within hospitality experiences.¹¹⁷

Limitation and future research directions

Four open-access databases of architectural projects were reviewed and the information extracted relies on the descriptions provided by the designers of these projects. The impacts of smellscape interventions on building occupants are those anticipated by the designers during the design phase, but it has not been proven that these effects on people were actually achieved. Furthermore, smellscape interventions in architectural practises are often proposed based on the designers' intuitive assumptions, without explicitly linking claims to the relevant empirical evidence. Therefore, evaluation methods and field and lab campaigns are needed to test and quantify the effectiveness of these interventions. Furthermore, it will be necessary to investigate methodologies for depicting

olfactory experiences in design, translating the invisible nature of smells into vision-based design tools.

Finally, the olfactory environment should be studied in a multisensory perspective, as our perception of the objects and events that fill the world in which we live depends on the integration of the sensory inputs that simultaneously reach our numerous sensory systems (e.g. vision, audition, touch, taste, and smell).¹¹⁸ Furthermore, olfactory strategies should account for potential adverse reactions in sensitive individuals, such as those affected by Multiple Chemical Sensitivity (MCS), highlighting the need for inclusive and cautious design approaches.

This work contributed to the development of the 'Smellscape Catalogue', a digital library that explores the invisible yet powerful role of scent in design.¹¹⁹ The catalogue aims to assist designers in integrating olfactory elements into architectural practice through a growing collection of case studies on scented materials and spatial interventions that leverage the evocative potential of smell.

Conclusions

This study analysed the descriptions of 123 architectural projects that consider smellscape as a potential design resource, as provided by designers in online architectural databases. The objectives were: (1) to understand the methods designers use to create a positive indoor olfactory experience; (2) to identify the expected impacts on building occupants as intended by the designers; and (3) to determine if the building setting influences the design choices. It should be noted that the study analysed project narratives rather than empirical evidence of occupants' experiences.

Regarding the first research question, smellscape interventions can be classified into six categories. The most frequent strategy involves the use of scented materials (43%), followed by the distribution of smells through ventilation strategies (24%), the integration of green elements (14%), the facilitation of smell circulation through spatial connections (10%), the use of scenting devices (8%), and the use of fireplaces and burning stoves (1%). Wood emerged as the most commonly used scented material (e.g. cedar, pine, bamboo, and oak), although designers also rely on earthy materials, cork, stone, tar, kelp, concrete, and cloth. Within the ventilation strategies, natural ventilation is particularly prominent as a means of connecting indoor spaces with outdoor smells, whether originating from natural or urban sources. Green elements are incorporated in various forms, including aromatic plants, courtyards, vertical gardens, outdoor gardens, and indoor conservatories. Spatial connection helps smells to circulate through the building and is achieved through vertical continuity or horizontal continuity. Notably, active diffusion strategies requiring electrical or mechanical activation, such as aroma diffusion through HVAC systems, appear only in a small proportion of cases (7%).

Regarding the second research question, the study identified 52 groups of descriptors used by designers to express the expected impacts of smellscape interventions on building occupants. These expected impacts pertain to six main components: affective, perceptual, cognitive, physiological, space-related, and time-related dimensions.

Regarding the third research question, indoor smellscape interventions were found across a range of building settings, including commercial, community centre, cultural, educational, healthcare, hotel, office, pavilion, residential, sport, and wellness. The interventions are primarily conducted in residential settings (43% of cases). Although similar types of smellscape interventions can be applied across different building settings, the impacts designers aim to trigger often vary depending on the building setting (e.g. retail, healthcare, and hospitality).

Finally, this study will initiate a catalogue of smellscape interventions and calls for scientific evidence to associate the expected impacts on building occupants to different smellscape interventions.

CRedit authorship contribution statement

Giulia Torriani: Writing — review & editing, Writing — original draft, Visualisation, Methodology, Investigation, Formal analysis, Data curation, and Conceptualisation. Simone Torresin: Writing — review & editing, Supervision, Methodology, and Conceptualisation. Francesco Aletta: Writing — review & editing, Conceptualisation. Francesco Babich: Writing — review & editing, Supervision, Methodology, Conceptualisation. Jieling Xiao: Writing — review & editing, Conceptualisation. Massimiliano Zampini: Writing — review & editing, Conceptualisation. Rossano Albatichi: Writing — review & editing, Supervision, Methodology, Conceptualisation.

Disclosure statement

No potential conflict of interest was reported by the authors.

Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

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