

AN EXAMINATION OF THE CHALLENGES ASSOCIATED WITH OLFACTORY STIMULI IN MUSEUM SERVICES: A SYSTEMATIC REVIEW OF VISITOR-CENTRIC STRATEGIES

DOMEN MALC, NIKA RAKUŠA, BORUT MILFELNER,
ALEKSANDRA PISNIK²

University of Maribor, Faculty of Economics and Business, Maribor, Slovenia
domen.malc@um.si, nika.rakusa2@um.si, borut.milfelner@um.si,
aleksandra.pisnik@um.si

This systematic review examines the impact of olfactory stimuli in museums, revealing a gap in the literature on how scents enhance visitor experiences. Utilising the PRISMA methodology, we analysed 237 records from various academic databases. Findings illustrate that scents are often thematically aligned with exhibits, such as historical scents, to deepen visitor engagement. Art galleries also utilise scents to enhance emotional and cognitive responses, evoking memories and enhancing immersion. Both pleasant and unpleasant scents impact visitors: pleasant scents improve mood and engagement, while unpleasant scents can intensify emotional reactions and immersion. Nevertheless, challenges like olfactory fatigue and technical limitations in scent delivery can hinder effectiveness. Overuse or weak diffusion may detract from the intended experience. Multisensory approaches that combine scent with other stimuli are especially beneficial for inclusivity, particularly for visually impaired visitors. Yet the review also identifies methodological limitations in current research, including small sample sizes, limited demographic diversity, and laboratory-based settings. The absence of standardised guidelines makes consistent integration difficult. Overall, this review highlights the potential of olfactory elements to enrich museum experiences and encourages further exploration and innovation in integrating olfactory stimuli into cultural experiences, including via a customer-centric lens.

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1 Introduction

Museums in the 21st century stand as cornerstones of cultural and intellectual knowledge, experience and heritage. And while many of their primary functions remain unchanged (collecting, caring for, and displaying works of art and artefacts), contemporary challenges have shifted the way museums are managed and the goals they pursue.

Museums aspire to become more visitor-focused (Roederer & Filser, 2018). Their evolution has led them from being primarily collections-based to more education-focused places (McGinnis, 2014) or, as Weil (2002, 28) put it, “from being about something to being for somebody.” This new way of thinking has pushed them toward delivering sociable, recreational, and participatory experiences (Kotler, 2001), which extend beyond traditional visual-centric museum displays to multisensory exhibits.

Most of the world-famous museums, and a plethora of smaller ones, have adopted exhibits that encourage visitors to experience the displays not only by seeing, but also through audio, tactile, proprioceptive, and olfactory stimuli, with some success. Several studies have demonstrated the positive effects of multisensory exhibitions on visitors’ engagement, stimulation (Jung et al., 2019), recall (Aggleton & Waskett, 1999), and general experience (Keller, 2014).

However, olfactory stimuli are often overlooked in a museum context (Drobnick, 2004; Stevenson, 2014). While there are some exceptions, museums tend to provide a rather clinical environment where smells and odours are generally unwelcome (Verbeek et al., 2022), as these stimuli are hard to define, distribute, control, and recreate (Spence, 2020). Verbeek et al. (2022) also noted a notable lack of both descriptive and evaluative research on the topic. They have advocated for “more research-oriented approaches, capturing the development and impact of sensory approaches within the heritage contexts” (Verbeek et al., 2022, 317).

The limited number of studies from the museology of smell, as well as from other fields (e.g. marketing), show that scents positively impact museum visitors, by raising engagement, memorability, increasing the time spent viewing displays, lowering museum fatigue, enhancing the affective impact, and understanding of the art

(Aggleton & Waskett, 1999; Keller, 2014; Mitchell et al., 1995; Spence, 2020; Vega-Gómez et al., 2020; Verbeek et al., 2022; Vi et al., 2017).

In general, there are two main propositions on how olfactory stimuli may influence our mood, physiology, and behaviour: pharmacological and psychological hypotheses. The pharmacological hypothesis states that aromas' effects are due to their direct ability to interact with and affect the nervous and endocrine systems. On the other hand, the psychological hypothesis promotes an indirect effect, stating that "responses to odours are learned through association with emotional experiences, and that odours consequently take on the properties of the associated emotions and exert the concordant emotional, cognitive, behavioural and physiological effects themselves" (Herz, 2009, 276). Spence et al. (2014) note two additional characteristics of olfactory stimuli. Firstly, the authors note that responses to olfactory cues are more likely to be hedonically charged than responses to other stimuli. Such positive or negative evaluations can induce approach or avoidance behaviours, respectively. Furthermore, the authors emphasise that scent memory is considered the strongest of the senses (Goldman & Seamon, 1992), which can inadvertently enhance the memorability of exhibitions in museums.

Despite general agreement on the benefits of "scented museums", the available literature indicates a lack of research on the use of odour in the museum context. Works that address the multisensory exhibits in museums and galleries mention olfactory stimuli briefly, as a potential sense to address in the future (e.g. Candlin, 2003; Carulli & Bordegoni, 2019; Falvo, 2012; Harada et al., 2018) or (un)intentionally ignore them altogether (e.g. Djoussouf et al., 2023; Eardley et al., 2016; Smith, 2020). Again, some exceptions should be noted. The seminal paper by Spence (2020) reviews some of the challenges of using ambient scent in art galleries and museums, while Verbeek and colleagues (2022) provide an insightful report on the development of scented guided tours at the Rijksmuseum (Amsterdam). They emphasise that "conducting scented tours and curating scented displays can certainly benefit from more experiments, from better documentation and a more robust system for impact evaluation" (Verbeek et al., 2022, 336).

Our study aims to address this proposition by conducting a systematic review of published articles, gathering insights from past research through a thematic analysis, and developing guidelines for both museum staff on the development and

positioning of olfactory displays and for researchers investigating the impact of odour in the museum context. Finally, given the overall shift toward customer-centricity in museums (Kotler et al., 2008), we also propose a more customer-centric approach to visitor research. To our knowledge, there are no systematic reviews that focus solely on olfactory stimuli in museum contexts. Accordingly, this work may advance interdisciplinary research and enable new practical applications in the field.

Thus, this study contributes to the literature in three ways. First, it provides a systematic synthesis of research on olfactory stimuli in museum and gallery contexts. Second, it organises the fragmented evidence into key themes concerning visitor engagement, memory, congruence, accessibility, implementation challenges, and methodological limitations. Finally, it extends the discussion by proposing a customer-centred research agenda that connects olfactory museum experiences with perceived quality, perceived value, and visitor satisfaction.

2 Materials and Methods

The literature review followed the PRISMA method to develop a systematic review. This ensured transparent and comprehensive reporting of the topics surveyed. The review focused on a randomised search exploring the use of scent to enhance the museum experience, aiming to provide relevant data on its implementation, use, and evaluation. The inclusion criteria are specified in Table 1, while the exclusion criteria are outlined in Table 2.

Table 1: Inclusion criteria

Inclusion criteria	Description
Inclusion criterion 1	The paper has one of the following terms in the title, abstract, or keywords: 'scent', 'odour', 'olfactory', 'smell' or 'multisensory'; along with one of the terms: 'museum' or 'gallery'; and with one of the terms: 'visitor', 'consumer', 'participant' or 'tourist'; And with one of the terms: 'perception', 'experience' or 'attitude'
Inclusion criterion 2	The paper is written in English or Slovenian.
Inclusion criterion 3	We have access to the full text of the paper.

To conduct a comprehensive survey on the specified topics, two search stages were employed: an online search and an analysis of the records obtained from the initial search.

For the first stage, literature was identified through extensive searches of well-known databases, including Web of Science, Elsevier Scopus, and EBSCO. The search was initiated in July 2024 and used the logical expression: Title/Keywords/Abstract containing ('scent' OR 'odour' OR 'olfactory' OR 'smell' OR 'multisensory') AND ('museum' OR 'gallery') AND ('visitor' OR 'consumer' OR 'participant' OR 'tourist') AND ('perception' OR 'experience' OR 'attitude').

During the second stage of the search process, which involves reviewing full-text articles (refer to Fig. 1 for a detailed overview of the steps outlined in the PRISMA method), a search was conducted to determine eligibility for analysis. This was necessary because certain articles lacked sufficient information for either qualitative or quantitative analysis.

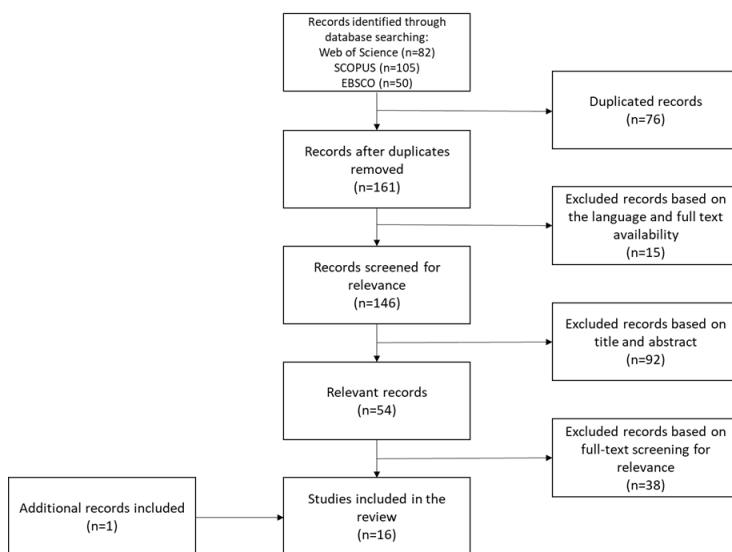


Figure 1: Detailed overview of the steps according to the PRISMA method

Source: own.

2.1 Study Selection

A total of 161 records were obtained and reviewed by two reviewers to determine their eligibility based on language and full-text availability, in line with the exclusion criteria. During this process, 6 records were discarded due to language restrictions, and 9 records were excluded because full texts could not be obtained. After reviewing the titles and abstracts of each study and applying the exclusion criteria, 92 records were excluded, leaving 54 full-text papers for eligibility assessment.

Table 2: Exclusion criteria

Exclusion criteria	Description
Exclusion criterion 1	Full-text paper is not available.
Exclusion criterion 2	The paper is written in a language other than English or Slovene.
Exclusion criterion 3	The paper does not consider the use of scent.
Exclusion criterion 4	The scent described in the paper is not applied in a museum context.

The eligibility assessment was conducted on 54 full-text papers to gather all necessary data for the current systematic review. During this process, 38 articles were excluded based on the established criteria, and the remaining articles were included from the second stage of the search. Seventeen papers were ultimately selected for full-text assessment. The variables considered included the stimuli used in the study, sample size, country, study objectives, research methods, key findings, suggestions for future research, and identified limitations.

3 Results

The search of the identified databases resulted in a total of 237 records. 76 duplicates were removed, leaving 161 unique records to be screened. The language, full-text availability, title, and abstract of these unique records were analysed against the eligibility criteria. 107 records did not meet the criteria and were excluded. This left 54 records eligible for full-text analysis. Of these, 38 records were excluded based on our predefined criteria. Subsequently, an updated search revealed 1 additional article, bringing the total number of records for qualitative synthesis to 17. Table 3 provides an overview of the key features of the included studies, including author, year, country, research design, sample characteristics, methods used, and whether and how scent was incorporated.

Table 3: Summaries of Analysed Studies

Author	Year	Type of paper	n	Methods	Smell	Device
Aggleton & Waskett	1999	Experimental	45	Questionnaire	Yes	Scents were dispersed throughout the exhibition.
Cirriuncione et al.	2014	Empirical	86	Between-participant experiment	Yes	The scents were diffused during the experiment via professional diffusers.
Chu et al.	2016	Case study	13	Semi-structured interview	Multisensory	Applied to wooden disks placed inside the prototype.
Miotto	2016	Case study	-	-	Yes	Olfactory delivery device, releasing the scent on demand.
Huang et al.	2018	Empirical	32	Questionnaire, user observation and video analysis	Multisensory	2018
Carulli & Bor-degoni	2019	Case study	-	-	Multisensory	Olfactory display device that delivers odours, enabled by AR.
Wilson et al.	2020	Empirical	21	Semi-structured interviews and observations	Multisensory	-
Wang	2020	Empirical	S1 2152 S2 148	In-depth interviews, observation, questionnaires	Multisensory	Odor generator
Vega-Gómez et al.	2020	Empirical	234	Experiment, questionnaires, interviews	Yes	Device dispersing 30 s of scent every 180 s.

Author	Year	Type of paper	n	Methods	Smell	Device
Spence	2020	Review	-	-	Yes	-
Cho	2021	Review	-	-	Multisensory	-
Marto et al.	2022	Review	-	-	Multisensory	-
Vaz et al.	2017	Empirical	25	Questionnaires, observations and semi-structured interviews	Multisensory	Bowls containing spices and incense.
Verbeek et al.	2022	Empirical	S1 148 S2 60 S3 4	Questionnaires, interviews, observation	Yes	Scent-containing vases with a pump, Aroma-Jockey, ultrasonic scent diffusers, blotters, headspace (dry diffusion) techniques, whispies.
Blundell	2023	Case study	3	Interview	Smell and taste	Motion-activated diffusers, scent-dispensing foot pump and AirParfum.
Zhang et al.	2023	Empirical	12	Experiment, post-study interviews, questionnaires	Yes	Olfactory display – controlled odour release.
Luo et al.	2024	Review	-	-	Multisensory	-

3.1. Overview of Analysed Studies

Our review includes 17 articles: 4 case studies, 4 review articles, and 9 empirical studies. The studies varied considerably in their research design, empirical setting, and treatment of olfactory stimuli. 9 articles focus on multisensory techniques, while 7 concentrate solely on the sense of smell. Additionally, one article examines the interaction between smell and taste. Four articles investigate how multisensory applications can enhance accessibility for visually impaired visitors, while 7 articles

discuss the use of relevant technologies, including augmented reality (AR) and virtual reality (VR).

A first group of studies used experimental or quasi-experimental designs to examine the effects of scent on visitors' perceptions, memory, evaluations, or interpretations. Aggleton and Waskett (1999) investigated whether certain scents in a museum enhance visitors' recall of exhibit information at the Jorvik Viking Centre. Participants completed memory tests under different scent conditions, allowing the authors to examine whether exposure to the same scents encountered during the original museum visit improved recall. Cirrincione (2014) studied the effects of ambient scents on how people perceive and remember art, emphasising factors such as perceived pleasantness, arousal, and recall of artwork. Participants were presented with talcum or citrus that varied in pleasantness while evaluating artworks created by two contrasting artists, Arcimboldo and Rothko, and the study examined perceived pleasantness, arousal, scent-artwork congruence, and memory. Vega-Gomez et al. (2020) extended this line of inquiry into a real museum setting by testing the influence of exhibition-congruent scents on visitors' perceptions and behaviours in González Santana Museum. Their study examined how olfactory marketing affected visitors' perceptions, evaluations, and behaviour. Zhang et al. (2023), on the other hand, focused on the role of olfactory stimuli within virtual museum environments. Their study used an olfactory display to investigate whether scent could help non-experts understand stylistic characteristics of Western landscape paintings, such as tone, mood, and genre.

A second group of empirical studies examined scent as part of broader multisensory museum experiences, often using mixed methods such as questionnaires, observations, interviews, and video analysis. Huang et al. (2018) designed and evaluated the effectiveness of mixed reality technologies in enhancing the visitor experience within museums and cultural heritage settings, focusing on engagement, discussion, and reflection. One of their exhibits, "Batu Boh," used sensor-based interaction to simulate food preparation and released fragrance as part of the experience. Wang (2020) explored the use of multisensory elements in historical exhibitions at the Taizhou Museum, including an odour generator that produced a fishy smell in the "People at the Seashore" section to evoke the atmosphere of a fishing village. Vaz et al. (2017) presented the "Mysteries of the Art of Healing" exhibition, designed to be accessible to blind and partially sighted visitors. They

included an olfactory experience in which visitors could engage with eight original pharmacy bottles from the collection, each containing pharmacological substances with distinctive odours. Verbeek et al. (2022) examined historically informed scented tours at the Rijksmuseum in Amsterdam, documenting different scent-delivery methods and the evaluation methodology for these initiatives. Wilson et al. (2020) focused on the needs of blind and partially sighted visitors in interpreting museum objects, with attention to how sensory properties, including scent, contribute to understanding museum objects.

A third group of studies consisted of case studies and design-oriented contributions that documented the development, implementation, and practical challenges of olfactory or multisensory museum applications. Chu et al. (2016) introduced sensory prototypes designed to evoke the historical and experiential elements of 16th-century prayer nuts through narrative design and sensory interactions. Their “Scents of Power” prototype used conceptual scents to convey historical meanings that could not be easily conveyed through text alone. Miotto (2016) introduced an olfactory delivery device designed for exhibitions related to Singapore’s culinary heritage. The device was designed to address challenges in odour diffusion, containment, ergonomic design, and maintenance, and was applied in several exhibition contexts. Carulli and Bordegoni (2019) discussed AR applications that integrated olfactory experiences into cultural heritage applications. In their examples, scents were released in response to visitors’ interactions with religious symbols, enriching the cultural and emotional impact of the experience. Blundell (2023) analysed three exhibitions that used smell and taste to enhance the museum experience, resulting in visitors who were more engaged and present. The main difference in this study was that it included cases in which scent served as a supporting sensory layer and those in which smell was the central focus of the exhibition.

The fourth group consisted of review articles that positioned olfactory and multisensory museum experiences within broader theoretical, technological, and accessibility-related discussions. Spence (2020) reviewed the use of ambient scent in art galleries and museums, with particular attention to how scents affect the visual perception of artwork. Cho’s (2021) review examined multisensory approaches to presenting visual art to individuals with visual impairments, including patterns, temperature, scent, music, and vibrations. Marto et al. (2022) conducted a systematic

review of multisensory virtual and AR applications in cultural heritage to explore how different stimuli can enrich multisensory experiences (immersion, realism, and engagement). Luo et al. (2024) provided an integrative review of multisensory museum experiences, focusing on the theoretical basis of multisensory experiences in museums, their features, and the impact of technology on sensory practices within museum contexts.

Across the analysed studies, several patterns emerge. First, olfactory stimuli were rarely used in isolation. In most studies, scent was combined with visual, tactile, auditory, gustatory, spatial, digital, or narrative elements. Second, the purpose of scent varied across contexts. In some studies, scent was used to improve memory or recognition; in others, to support emotional engagement, historical imagination, accessibility, immersion, or interpretation. Third, scent delivery methods differed substantially, ranging from bowls containing spices and incense, scented disks, pumps, blotters, and diffusers to odour generators, motion-activated devices, AR-supported olfactory displays, and controlled olfactory systems in virtual environments. Fourth, the visitor groups and evaluation methods also varied, with some studies focusing on general museum visitors, others on children, non-experts, visually impaired visitors, or participants in experimental settings. This diversity makes direct comparison difficult, but it also illustrates the scope of possible olfactory applications in a museum context.

3.2. Key Findings of Analysed Studies

The sense of smell is becoming increasingly important in museums and art galleries, which can adopt various approaches to incorporate scent. In museums, scents typically align with the exhibits' themes and meaning. In contrast, art galleries may use scents related to the artwork being viewed but not necessarily directly connected to it (Spence, 2020). Table 4 summarises the key findings discussed below.

Table 4: Key findings

Theme	Main findings	Research gap
Engagement and immersion	Scent can deepen engagement, memory, emotional responses, and interpretation, but effects are not uniformly positive.	More real-museum experiments needed.

Theme	Main findings	Research gap
Congruence and meaning	Scent works best when aligned with the exhibit narrative and supported by interpretation.	Test semantic congruence systematically.
Accessibility	Scent can support inclusive interpretation, especially for visually impaired visitors.	More studies with diverse visitor groups.
Technical implementation	Diffusion, fatigue, overlap, contamination, maintenance, and device noise are recurring problems.	Need for implementation standards.
Perceived value and satisfaction	Consumer-centred outcomes such as perceived value, perceived quality, and satisfaction are underdeveloped in the literature.	Future quantitative model testing.

The role of Scents in Creating More Personal and Engaged Visits

Several studies have shown that incorporating scents and other sensory elements, such as sound, touch, and taste, can enhance the visitor's experiences in museum exhibitions. For example, a case study from the USA explored prototypes featuring tactile elements and scents to increase interaction with the exhibit and enhance the experience. Participants reported that the sensory features led to a more personal and authentic experience (Chu et al., 2016). Similarly, Wang (2020) found that the multisensory exhibits effectively engage visitors. Increased visitors' engagement in the scented tour group was also observed in Verbeek et al.'s (2022) study. An interactive multi-sensory application focused on olfactory stimuli was also developed in Italy to enhance visitor experience and interaction (Carulli & Bordegoni, 2019). Blundell (2023) discussed how the sense of smell makes museum experiences more engaging, helping visitors interact with art, especially abstract pieces, in new ways. The results confirmed the effectiveness of this approach in encouraging diverse perspectives on and understanding of art. Vaz et al.'s (2017) study also confirmed that multisensory experiences are perceived as entertaining, pleasant, and satisfying. Verbeek et al. (2022) concluded that the sense of smell can enhance cultural heritage experience. It helps create a direct connection to the past, stimulates imagination, improves understanding of artworks' specific qualities, and enhances emotional responses to heritage.

A systematic review by Marto et al. (2022) examined technological multisensory applications in cultural heritage, focusing on how different stimuli impact multisensory experiences. They found that visitors exposed to experiences with and without scent reported that adding scent positively influenced their sense of spatial

presence and perceived realism compared with visual-only experiences. Additionally, Vega-Gomez et al. (2020) found that scent in a museum led to higher evaluations and more positive ratings than visits without scent. Verbeek et al. (2022) reached a similar conclusion, noting that the average rating for the scented tour was slightly higher than that for the non-scented tour. The visitors also found the experience highly immersive and received greater context. Marto et al. (2022) analysed various studies and found that multisensory experiences positively impacted users in 78,6% of cases, while only 21,4% were inconclusive, with no studies indicating a negative impact. They suggested numerous positive effects of multisensory experiences, including greater user involvement, stronger emotional responses, improved information interpretation, enhanced learning and communication, new ways of thinking, and greater immersion. Wang (2020) highlighted additional benefits of sensory experiences: increased satisfaction, enhanced overall museum experiences, the acquisition of cognitive knowledge, emotional connections, greater exhibition attractiveness, and longer visit durations. Verbeek et al. (2022) observed that smell influences visitors' talkativeness, as they shared scent-related observations and memories. This made them engaged with artworks for longer periods and with greater attentiveness.

However, Cho (2021) noted that adding scents to art does not always enhance the experience as expected. Spence (2020) noted that ambient scents could hinder art evaluation and lead to negative visitor ratings, regardless of whether the scents are perceived as pleasant or unpleasant. A study by Vega-Gomez et al. (2020) evaluated how scent impacts behaviour and assessment of museum visits, finding that scent does not directly influence spending behaviour or the perceived quality of the museum. Additionally, it does not affect the visitors' choices between museums with the same theme and category. The findings also confirm that the scent does not change the perceived space or the number of people present. However, further analysis is needed to determine whether the scent's effect is direct or indirect through improvements in other variables, and whether the lack of influence on museum selection is due to the specific nature of the examined scent or to other overriding factors. Finally, Zhang et al. (2023) confirmed that olfactory experiences in virtual museums can enhance understanding of stylistic elements in Western landscape paintings; however, olfactory interventions improved only the accuracy of genre recognition and perception of style information, but not the recognition of the artist's mood. Furthermore, the olfactory aids specifically increased the capture of

style information for Romantic and Impressionist painting but negatively impacted the perception of realism.

The importance of Alignment and Meaningful Use of Scents

A case study from the USA suggests that providing clear guidance on sensory interactions can enhance participation, rather than confusing visitors or causing disengagement (Chu et al., 2016). Wang (2020) also found that the best results are achieved by combining multisensory elements with other presentation methods. Additionally, Zhang et al. (2023) noted that only two participants accurately identified all the scents used, underscoring the need for textual or other aids to help visitors recognise the smells. Verbeek et al. (2022) highlighted that the combination of the tour guide's input and the smell enhances the overall experience.

Blundell (2023) warned that overwhelming visitors with excessive sensory input could divert their attention from the art and its message. Spence (2020) further noted that a mismatch between scent and visual displays could distract visitors. One visitor of the scented tour commented that the fragrance distracted them from the artwork. Therefore, scents must be semantically aligned with the artworks to evoke positive responses from visitors. This alignment has been shown to increase visitors' willingness to return to a museum, as confirmed by Cho (2021) and Vega-Gomez et al. (2020). Zhang et al. (2023) also observed that mismatched scents, overly strong odours, and personal associations with certain smells could lead visitors to feel disconnected from the artwork, potentially diminishing their immersion in the museum experience. They also confirmed that matching odours to participants' expectations led to a more immersive experience. However, Cirrincione et al. (2014) found that participants rated paintings more arousing when paired with incongruent scents. This phenomenon can be understood as the additional effort required to comprehend the incongruence. This extra effort heightens attention and increases the level of perceived arousal of the specific painting.

The impact of Scents on Diverse Audiences

In studies exploring multisensory approaches, researchers have found that visitors perceive and respond to scents differently. While multisensory stimuli can effectively engage visitors, their impact varies across individuals due to differences in sensory

perception and personal experiences (Wang, 2020). Zhang et al. (2023) highlighted the importance of tailoring flavour choices to the preferences of different audiences, indicating the need to adapt sensory experiences according to the target audience's sensory preferences. According to a study by Spence (2020), ambient scent might affect women more than men. Vega-Gomez et al. (2020) also concluded that the effects of scent can vary based on the visitor's gender. Luo et al. (2024) emphasise that sensory possibilities play a crucial role in exhibition design, especially for children, as they offer new ways to experience artworks, access information, and perceive various phenomena. Blundell (2023) suggests involving potential visitors in the planning of multisensory experiences, as this is crucial for ensuring their success. Additionally, Wilson et al. (2020) highlighted the importance of olfactory properties in how blind and partially sighted visitors perceive and understand objects. Visually impaired participants in the study by Verbeek et al. (2022) emphasised that smell stirred their imagination, helped them feel more connected to artworks, highlighted the function of objects, and enhanced their memories, as they could describe smells in detail.

These approaches allow individuals with different sensory abilities to understand better exhibited items and artworks. In her review, Cho (2021) discussed methods for transforming visual art elements through sensory experiences, including scent. This approach aims to provide a fresh perspective on art appreciation while enhancing cultural enjoyment and accessibility for the visually impaired, as confirmed by Verbeek et al. (2022).

Different Scents and Their Impact on Visual Art Perception

Researchers have examined various pleasant and unpleasant ambient smells and concluded that while pleasant scents may improve mood and encourage engagement with exhibits, unpleasant scents can significantly enhance immersion in an experience (Spence, 2020). Similarly, participants in the study by Zhang et al. (2023) preferred more objective odours that reflected artists' biographies, including unpleasant ones. Spence (2020) also discusses the concept of sensation transference, which suggests that people's feelings toward a scent can affect their evaluation of visual art. Interestingly, negatively valenced smells seem to have a greater impact on people's ratings than positive ones.

The Relationship Between Scents, Colours, and Other Sensory Elements

Research indicates that scents are most effective when combined with other sensory elements such as colours, sounds, and temperature. For instance, a Korean study found that linking scents to shapes, colours, temperatures, or sounds can create a richer, more engaging experience for users (Cho, 2021). Cho (2021) concludes that scents should complement, rather than replace, other modalities to enhance meaning and improve the overall visitor experience. Participants in a study by Zhang et al. (2023) also suggested incorporating additional sensory elements to enrich the olfactory experience. Researchers underscore the influence of scents associated with specific colours in attracting attention to areas of a scene that feature similar colours (Spence, 2020). Verbeek et al. (2022) observed that smell can direct visitors' eyes to previously overlooked details and shift their attention to the overall atmosphere of the depicted scene. They recommend using eye-tracking devices to measure time spent on each artwork, both with and without scent, to confirm this observation. However, Cho (2021) acknowledges that the sense of smell has limitations when expressing colours. Cirrincione et al. (2014) provide recommendations for future research to explore interactions among senses and their combined effects on the perception of art. In Portugal, research has shown that combining scents with other senses, such as touch and sound, creates more holistic and inclusive experiences. This approach benefits not only visually impaired visitors but also the broader public (Cho, 2021; Vaz et al., 2017).

Challenges and Limitations in the Use of Scents

Although scents can enhance experiences, research indicates that improper use can lead to olfactory fatigue, in which the olfactory system becomes overwhelmed and temporarily unresponsive (Miotto, 2016; Verbeek et al., 2022; Wang, 2020). However, if the odour concentration is too low, the scent may fail to produce the desired impact (Miotto, 2016). Verbeek et al. (2022) therefore suggest different strategies for neutralising the nose and organising scents, from least intensive to most intensive at the end of the tour. Since the sense of smell is highly subjective, different individuals often have diverse opinions and reactions to specific scents, which can complicate a shared olfactory experience among museum visitors (Wang, 2020). Wang (2020) also highlights the challenge of accurately evaluating the impacts of multisensory exhibits on individuals with varying sensory abilities.

Moreover, several studies highlighted the technical difficulties, particularly the challenge of evenly distributing scents without them overlapping (Cho, 2021). Combining various scents within the same museum area can lead to the “garbage effect”, resulting in an unpleasant odour (Miotto, 2016). Wang (2020) discusses the challenges of controlling the amount of scent released and achieving completely odourless museum spaces, as factors such as temperature, air circulation, and humidity influence the existing scents.

Zhang et al. (2023) highlight another challenge related to the odour release mechanism's noise, which distracted visitors from fully immersing in the experience. A case study from the USA emphasised the importance of ensuring that scents can be easily housed and replaced without direct contact with visitors' skin (Chu et al., 2016). This indicates a need for improved technology that enables precise, sustainable scent delivery, as well as effective methods for maintaining scent freshness over time. Since odorants are inherently consumable and often degradable, the odour diffusion method must also account for the need to replenish and maintain these scents, especially in the context of permanent exhibitions intended to last several years (Miotto, 2016). Marto et al. (2022) emphasised the uncertainty regarding the most effective methods for incorporating smell into cultural heritage experiences, noting that some studies utilised perfumes or oils, while others employed olfactory displays or a basic version of Computational Fluid Dynamics (CFD).

Wilson et al. (2020) discuss the challenges of replicating olfactory characteristics without additional processing or scent additives, as some materials have inherent smells that may interfere with how objects are perceived. Furthermore, it was observed that people tend to prefer synthetic smells over authentic ones, since historical scents may not resonate with modern visitors in the same way they did for those who encountered them regularly in the past (Spence, 2020). In contrast, Verbeek et al. (2022) found that historically informed scents are more appreciated than more synesthetic creations. Blundell (2023) also emphasises the tendency to favour synthetic scents instead of using natural scents, as they could potentially affect the artworks' materials. It is important to control odours to prevent artefacts from unwanted contaminations (Miotto, 2016; Verbeek et al., 2022).

Several studies have indicated that visitors often do not actively engage with olfactory experiences or struggle to recognise them. While an olfactory delivery device featured in Singapore's culinary heritage exhibit was well received by visitors, who expressed enthusiasm for experiencing different scents (Miotto, 2016), which was also observed among participants in Verbeek et al. (2022) study, a case study from the USA points out that visitors' engagement with the scents tends to be brief (Chu et al., 2016). For example, research conducted in Malaysia revealed that while children noticed and commented on scents, they did not connect them to the exhibition content. This indicates a need for better guidance in using scents to enhance engagement and reflection (Huang et al., 2018). Verbeek et al. (2022) emphasise the need for staff to learn to work with smells. For this purpose, they created a smell manual that includes essential guidelines for working with scents. These guidelines recommend practices such as smelling in silence first, avoiding requests for participants to label a scent, and encouraging discussions about connections to the artwork. Evaluating, differentiating and reflecting on the scents would probably also require repeated or more profound inhalations (Chu et al., 2016). Additionally, a study from the United Kingdom concluded that the sense of smell was the least utilised, even among blind and partially sighted individuals (Wilson et al., 2020). Marto et al. (2022) also reported that scent is often regarded as less significant compared to taste, visual, and auditory stimuli. Cho (2021) found that blind and visually impaired visitors tend to use scents more as a complement to their other senses, while scent plays a lesser role for those who primarily rely on sight and hearing.

The Impact of Scents on Memory and Learning

Aggleton and Waskett (1999) found that exposure to the same scents experienced during a previous museum visit significantly enhances visitors' ability to remember the exhibits, supporting the principle of encoding specificity. This principle suggests that elements of the environment in which learning takes place, such as a museum, can enhance memory when those elements are present later. Their study is notable for being the only one to utilise a real-world setting to measure memory recall over an extended period, providing strong evidence for the effectiveness of scents in aiding memory. However, it did not formally test whether scents evoke emotional reactions that could enhance memory retention. Cirrincione et al. (2014) later observed that the effect of scent on memory was direct rather than mediated by its

emotional valence. Miotto's (2016) case study on an olfactory delivery device emphasises the importance of smell in evoking personal memories and shaping visitors' emotional experiences. Carulli and Bordegoni (2019) also discuss the potential of interactive multisensory applications to improve long-term memory retention of exhibition information. Verbeek et al. (2022) also recognise the role of smell in increasing the memorability of a museum visit. Marto et al. (2022) and Cho (2021) recognise the role of smell in recalling personal memories and eliciting emotions. Vaz et al. (2017) study participants also mentioned that the sense of smell contributed to their learning about the pharmacological substances available at the portable pharmacy. Conversely, Spence (2020) highlights how ambient scents can hinder memory retention. Cirrincione et al. (2014) also suggest that the pleasant ambient scent can decrease evaluations and hinder memory of art in a virtual exhibition. Verbeek et al. (2022) highlight the need for more detailed background information about the scents to enhance visitors' knowledge.

Innovative Ways of Using Scents and Technology

Some studies have investigated the use of advanced technologies, such as scent delivery devices and virtual reality (VR), to create more immersive experiences. For instance, an Italian study employed interactive AR applications that incorporated scents, creating deeper emotional connections and more lasting memories of exhibitions (Carulli & Bordegoni, 2019). This innovative approach demonstrates promising potential for enhancing cultural experiences through technology. Marto et al. (2022) examined various multisensory technological applications in cultural heritage, while Luo et al. (2024) highlighted the crucial roles of sensory cues and technology in exhibition design. Additionally, Huang et al. (2018) focused on creating and evaluating the effectiveness of mixed-reality technologies in enhancing the visitor experience in museums. Blundell (2023) also focuses on the creative use of technology, such as the AirParfum machine, which allows smelling multiple fragrances without saturating the senses while also communicating with external devices.

Research Approaches, Methods, and Limitations of Analysed Studies

Carulli and Bordegoni (2019) discuss the relatively uncommon use of olfactory stimuli and multisensory approaches in cultural heritage exhibitions. Similarly, Marto et al. (2022) note that scent, compared to other senses, has been under-researched and underused in museums. They also highlight that most studies analysing scent experiences involve at least one other stimulus. As outcomes vary with the specific stimuli used, further research is needed to understand better how sensory stimuli affect visitors' experiences. In Portugal, a systematic review has highlighted the lack of standardisation in the implementation of multisensory experiences. This inconsistency makes it difficult to compare methods and establish common guidelines for effective sensory approaches (Marto et al., 2022).

Spence (2020) identifies a significant limitation in many of the reviewed studies: they lack validity because they were conducted in laboratory settings, where participants viewed art reproductions for only brief periods. This limits the general applicability of findings to real museum settings. Such artificial setups can lead to unnatural reactions; participants may not exhibit the same feelings and behaviours as they would in an actual museum environment. Cirrincione et al. (2014) suggest testing whether their findings apply to real art galleries and museums to ensure broader relevance. Blundell (2023) emphasises the importance of collecting visitor feedback, as it can yield more accurate and valuable information. Huang et al.'s (2018) study is further limited by the absence of a control group to compare learning outcomes with and without technology augmentation. The study by Verbeek et al. (2022) also lacks a control group. Many studies have focused on the short-term effects of scents on visitors, while few have examined their long-term effects. More research is needed to understand the sustainability of sensory interventions over time (Aggleton & Waskett, 1999).

Miotto (2016) highlights that there is no formal collection of feedback on these olfactory experiences. Marto et al. (2022) also noted the lack of unanimous data regarding visitors' opinions or feelings about scent experiences, as this was not the primary focus of the analysed studies. On the other hand, Spence (2020) highlights a significant limitation in the studies reviewed, which primarily focus on small, specific participant samples, such as students or visitors from certain demographic groups (e.g. WEIRD – Western, Educated, Industrialised, Rich, and Democratic).

These groups do not adequately represent the diverse museum visitor population. This is particularly crucial in studies examining how scents influence artistic evaluation, as the results may be biased and reflect only particular cultural or social norms. Additionally, most studies did not provide participants with a reason to associate the smell with the visual display, which may have affected their ratings, underscoring the importance of a guided sensory experience (Spence, 2020).

Cirrincone et al. (2014) tested only two scents and two artists, suggesting that further studies should expand on this. A study from China also recommended incorporating a wider variety of painting categories to strengthen the study's findings, as the limited types of painting used in their experiment can hinder generalisations about art appreciation (Zhang et al., 2023). Additionally, the research by Vega-Gomez et al. (2020) underscores the necessity for further research using larger sample sizes and multiple museums to validate their findings. Zhang et al. (2023) also emphasise the importance of broader participant recruitment in future studies.

Meanwhile, Cho (2021) developed a multisensory expression and delivery tool that acts as an educational tool, improving the accessibility and usability of products and artworks through multimodal interaction. Additionally, Luo et al. (2024) identified six key response qualities in visitor-exhibition interactions: experience dimensionality, duration, attention, sensory intensity, emotional valence, and engagement level. However, further exploration is needed to understand how these qualities influence interactions.

4 Discussion

This systematic review set out to synthesise published research on olfactory stimuli in museum and gallery contexts, identify what is currently known about their effects on visitors, and derive implications for museum practice and future research. Overall, the reviewed literature suggests that smell can enrich museum experiences, but not in a simple or universally positive manner. Rather than functioning as an inherently beneficial add-on, olfactory stimulation appears to operate as a context-dependent amplifier whose effects depend on how well it is integrated into the exhibition narrative, how it is technically delivered, and how it is interpreted by different visitor groups. This is an important conclusion because it moves the discussion from the question of whether olfactory stimuli “work” in this

environment, toward the deeper questions of when, how, and for whom they improve the museum experience.

4.1 The effects of olfactory stimuli are ambiguous

A first major insight from the review is that olfactory cues can deepen engagement, stimulate imagination, support memory, and make encounters with heritage and artworks feel more vivid and personal (Aggleton & Waskett, 1999; Blundell, 2023; Chu et al., 2016; Verbeek et al., 2022). Across the included studies, scent was associated with stronger immersion, richer interpretation, increased talkativeness and socialisation, stronger affective reactions, and, in some cases, improved recall and learning (Aggleton & Waskett, 1999; Marto et al., 2022; Vaz et al., 2017; Verbeek et al., 2022; Wang, 2020). At the same time, the evidence does not support a uniformly positive effect. Some studies reported null effects (e.g. Vega-Gómez et al., 2020), while others suggested that scent can hinder evaluation, distract from artworks, or impair certain aspects of memory or realism judgments (Blundell, 2023; Cirrincione et al., 2014; Spence, 2020; Zhang et al., 2023). Taken together, the literature suggests that scent should not be conceptualised as a universally positive atmospheric building piece, but as a stimulus that can intensify experience in both desirable and undesirable directions. In that sense, smell seems less like a direct driver of positive outcomes and more like a mechanism that heightens attention, affects, and interpretive processing.

4.2 Olfactory stimuli require congruence and interpretive support

A second major insight concerns congruence and meaningful use of olfactory stimuli. The review consistently indicates that olfactory stimuli are most effective when visitors can make sense of them in relation to the object, artwork, space, or the story being presented. Historically informed scents, semantically aligned odours, and combinations of smell with narrative guidance or interpretive framing appear especially promising (Chu et al., 2016; Spence, 2020; Verbeek et al., 2022; Zhang et al., 2023). By contrast, mismatched or insufficiently explained odours and scents can confuse visitors, break immersion, or shift attention away from the exhibition's intended meaning (Huang et al., 2018; Spence, 2020; Verbeek et al., 2022; Zhang et al., 2023). Importantly, congruence is not only a technical design issue but also a curatorial and communicative one (Chu et al., 2016; Huang et al., 2018; Spence, 2020;

Verbeek et al., 2022; Zhang et al., 2023). Visitors may fail to recognise the intended scent, may interpret it through personal memories, or may simply not understand why it is present. This means that scent should rarely be treated as a self-explanatory device. In many settings, its value seems to depend on accompanying cues such as verbal interpretation, textual explanation, guided tours, or integration with other sensory and visual elements.

4.3 Opportunities and constraints of olfactory stimuli implementation

Third, the review shows that smell is especially promising when understood as part of a multisensory system rather than as an isolated intervention. Several studies (e.g. Carulli & Bordegoni, 2019; Cho, 2021; Huang et al., 2018; Marto et al., 2022; Vaz et al., 2017; Zhang et al., 2023) propose that olfactory cues work best when combined with touch, sound, spatial design, or digital technologies such as AR and VR. This is particularly relevant in museum environments, where visitors do not experience exhibitions through a single sensory channel. The contribution of scent may therefore lie less in replacing visual interpretation and more in enriching it, redirecting attention, increasing realism, evoking associations, and supporting embodied meaning-making. This also helps explain why scent appears particularly valuable in accessibility-oriented settings. For visually impaired visitors, for instance, olfactory cues may strengthen imagination, object understanding, emotional connection, and memory (Cho, 2021; Vaz et al., 2017; Verbeek et al., 2022; Wilson et al., 2020); for other visitors, they can broaden the exhibition's experiential repertoire (Blundell, 2023; Marto et al., 2022). Thus, the review supports the view that olfactory design should be embedded within broader multisensory experience design and inclusive museum practice.

At the same time, the literature makes clear that implementation is far from straightforward. The reviewed studies repeatedly highlight problems such as olfactory fatigue, weak diffusion, excessive intensity, scent overlap, contamination risks, maintenance demands, device noise, and the difficulty of sustaining scent quality over time (Cho, 2021; Chu et al., 2016; Miotto, 2016; Verbeek et al., 2022; Wang, 2020; Zhang et al., 2023). In addition, the highly subjective nature of smell complicates standardisation: visitors differ in sensitivity, preferences, memories, expectations, and even willingness to engage actively with olfactory cues (Miotto, 2016; Wang, 2020; Zhang et al., 2023). These findings are important because they

show that the success of scented exhibitions or exhibits cannot be reduced to curatorial creativity alone. It also depends on operational capabilities, staff training, environmental control, and clear protocols for scent delivery (Marto et al., 2022; Miotto, 2016; Verbeek et al., 2022; Wang, 2020). This review highlights several practical principles for using scents in exhibitions. It suggests that scents should be used selectively rather than decoratively and should be closely aligned with the exhibition's theme and narrative. Additionally, it's important to help visitors interpret these scents while carefully managing their intensity and sequencing. Considerations for accessibility, maintenance, and preventing sensory overload are also crucial. These rather broad guidelines further emphasise the fact that the field still lacks comprehensive, practical standards for designing, sequencing, explaining, and evaluating olfactory experiences in museums.

4.4 Apparent need for more rigorous and visitor-centred research

A fourth key conclusion concerns the state of the evidence base itself. The reviewed literature is still fragmented. The body of work includes case studies, reviews, and a limited number of empirical studies, often with small samples, narrow visitor groups, artificial settings, insufficient control conditions, and inconsistent outcome measures. Many studies focus on short-term reactions rather than lasting learning, memory, satisfaction, or revisit behaviour. Smell is also often embedded in broader multisensory interventions, making it difficult to isolate its specific contribution. As a result, the field currently provides suggestive rather than cumulative evidence. The strongest overall conclusion is therefore not that museums should simply diffuse more scents, but that olfactory design deserves more rigorous and visitor-centred investigation.

There is one additional implication of this review: the need for a more explicit service and marketing perspective in future research on olfactory museum experiences. While the reviewed studies provide valuable evidence on engagement, immersion, memory, interpretation, accessibility, and implementation challenges, they pay far less systematic attention to how olfactory stimuli affect broader evaluative dimensions of the museum service encounter. In particular, the literature remains fragmented regarding perceived quality, perceived value, and overall visitor satisfaction, even though these constructs are central to understanding museum

experiences from a customer-centric perspective introduced at the beginning of this study.

This gap is particularly relevant given the patterns identified in the reviewed studies. If scent can increase immersion, enrich emotional and cognitive responses, stimulate personal memories, guide attention, and shape the meaningfulness of the visit, then it is reasonable to ask whether these effects also translate into higher perceived service quality, greater perceived value, and stronger overall satisfaction – also under different moderating conditions. From this perspective, the perceived value framework outlined below can be understood not as a direct conclusion of the existing evidence, but as a structured response to the gap revealed in this review.

4.5 Future research framework: olfactory stimuli, perceived value, and satisfaction

Perceived quality, perceived value, and customer satisfaction play a central role in evaluating marketing activities from the customer perspective and significantly impact museum performance. Therefore, further in-depth study of these aspects in relation to smell is needed to understand their overall impact on the customer experience in the museum environment.

Perceived value is a fundamental construct in consumer behaviour, influencing decision-making and satisfaction with products and services. It refers to the balance between the benefits consumers receive and the costs they incur (Zeithaml, 1988). It is essential to recognise that both benefits and costs can take various forms. For instance, Sheth et al. (1991) highlighted five benefits: functional, social, emotional, epistemic, and conditional. Conversely, costs can be categorised into monetary and non-monetary, including time and effort, as well as perceived risks associated with the purchase and/or use of a product or service.

Perceived value is thus treated as a multidimensional construct, applied across various domains, including cultural institutions, where both tangible and intangible aspects of value are pivotal for the customer experience (Armbrecht, 2014). Understanding perceived value is also significant for museums. The concept transcends immediate benefits, encompassing emotional, social, and cultural dimensions essential for engaging visitor experiences.

A review of museum management literature also reveals a lack of attention to the perceived value of museum services and their measurement, except for a few academic contributions. Hume (2011) emphasised that museum strategy should focus on the holistic visitor experience. Museums should consider the heterogeneity of visitor expectations and design strategies tailored to customers' needs and desires. Accounting for all service quality dimensions is crucial for enhancing perceived value and long-term museum success. The author also notes that perceived value in the museum context is often multifaceted, as museums combine educational, cultural, and pragmatic aspects. Therefore, museums aiming to attract and retain visitors must consider these dimensions in creating a comprehensive experience, as the decision to revisit is influenced by the value delivered to individual visitors.

In the service sector, a widely accepted conceptualisation of perceived value was developed by Petrick (2002) with the SERV-PERVAL model, defining five dimensions: (1) Quality, (2) Emotional response, (3) Monetary price, (4) Behavioural price, and (5) Reputation. These components are critical in-service environments, including museums, where non-monetary sacrifices significantly influence the perceived value of the service. Non-monetary costs may include time spent visiting the museum, effort required to explore exhibits, or cognitive load needed to process extensive information. While service quality is paramount in this context, emotional responses also profoundly impact the customer experience. This model was previously adapted to measure perceived value in organisations representing various fields, from hospitality to insurance and banking. The available literature and collaboration with museum professionals could be used to evaluate the role of scent in relation to museums' perceived service value.

Further studies should therefore investigate how scent contributes to the complex perception of value in museum settings. Additionally, research should explore how scent enhances the visitor experience and overall satisfaction, and how these factors interact. According to this literature review, illustrated in Figure 2, the effects of perceived quality, emotional responses, perceived monetary and non-monetary value, and social value on overall satisfaction should be further examined when scent is integrated into museum services. Based on what has been elaborated, the following propositions can be applied:

P1: Including scent in a museum exhibition increases visitors' perceived quality compared to exhibitions that do not incorporate scent.

P2: Including scent in a museum exhibition increases visitors' emotional response compared to exhibitions that do not incorporate scent.

P3: Including scent in a museum exhibition decreases visitors' perceived monetary and non-monetary costs compared to exhibitions that do not incorporate scent.

P4: Including scent in a museum exhibition increases visitors' social value compared to exhibitions that do not incorporate scent.

P5: Including scent in a museum exhibition increases visitors' overall perceived value compared to exhibitions that do not incorporate scent.

P6: Including scent in a museum exhibition increases visitors' overall satisfaction compared to exhibitions that do not incorporate scent.

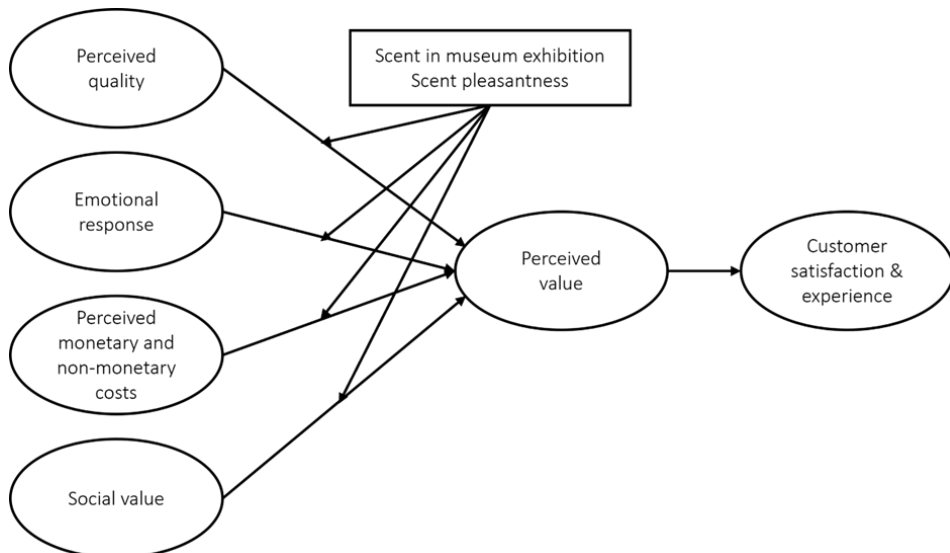


Figure 2: Proposed conceptual model of perceived service value for museums

Source: own

These propositions are not presented as empirically confirmed conclusions of the present review. Rather, they are offered as a future research framework derived from the identified gap in the literature, namely the limited integration of olfactory museum research with service quality, perceived value, and satisfaction constructs.

This review further shows a lack of research studies with an experimental design that includes a control group not exposed to scent alongside the experimental group. Such studies are crucial for understanding the moderating impact of scent on cause-and-effect relationships and for reducing bias in interpreting results. The subjective nature of scent perception also poses an important challenge. The pleasantness or unpleasantness of smell, which emerges as a central theme in the literature, remains under-researched in its role in improving or degrading museum service quality, perceived value, and visitor satisfaction. In the future, special attention will be needed to develop models of the perceived value of museum services that capture users' cognitive, emotional, and behavioural responses to olfactory stimuli. Based on the above, we propose further studies to test the basic concepts of the perceived value of museum services in two groups of visitors: those exposed to olfactory stimuli and those not.

According to that, we propose:

P7: Including scent in a museum exhibition moderates the relationships between visitors' perceived quality, emotional response, perceived monetary and non-monetary costs, social value, and visitors' overall perceived value.

Such a conceptual framework could be applied in measuring the contribution of sensory elements in museum exhibits. The introduction of sensory elements, such as scent, can enhance emotional and social engagement among visitors. Scents can evoke historical connections and nostalgic feelings, enriching the emotional experience and potentially increasing the authenticity of exhibits and displays. Measuring emotional responses (e.g., using the PAD model – pleasure, arousal, dominance) would also be appropriate in this context, as scents are closely linked to emotional experiences (Russel & Mehrabian, 1974).

4.6 Managerial implications

The findings of this review have important implications for museum management and exhibition design. Most importantly, olfactory stimuli should not be treated as merely decorative atmospheric elements, but as intentional part of the visitor experience. The reviewed studies suggest scents can boost engagement, immersion, emotions, memory, interpretation, and accessibility, but effects are not automatic or always positive. Museums must approach scent design purposefully and systematically, guided by the exhibition's interpretive goals. Scents are most effective when connected to displayed objects or themes, with contextual cues helping visitors understand their relevance. Olfactory stimuli should be integrated with other senses to enhance immersion, historical imagination, embodied learning, or accessibility, avoiding excessive stimulation that distracts visitors. Implementation requires careful planning of scent intensity, duration, diffusion, ventilation, and maintenance, with pilot testing recommended. Evaluation should go beyond noticing or liking scent, assessing its impact on understanding, engagement, perceived quality, satisfaction, accessibility, and revisit willingness. The key challenge is designing meaningful, inclusive olfactory experiences aligned with museum goals.

5 Conclusion

This review shows that olfactory stimuli can enrich museum experiences by deepening engagement, supporting memory, stimulating imagination, and enhancing interpretation, but their effects are neither simple nor uniformly positive. Their success depends on congruence, interpretive support, multisensory integration, and careful implementation. At the same time, the evidence base remains methodologically fragmented, limiting the ability to draw strong cumulative conclusions. Overall, the review suggests that scents and odours should be treated not as a decorative addition, but as a potentially powerful yet demanding component of museum experience design. For museum practice, this implies selective, meaningful, and well-supported implementation. For future research, it implies the need for more rigorous and visitor-centred studies, including work that examines how olfactory stimuli may shape broader evaluative outcomes such as perceived quality, perceived value, and satisfaction.

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