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IDENTIFYING THE ADVERSE HEALTH IMPACTS OF CONVENTIONAL BUILDINGS FOR RESIDENTIAL OCCUPANTS

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Abstract. Numerous issues and environmental concerns are attributed to the construction and operation of conventional buildings globally. Dire among these issues are the health impacts of these buildings on their occupants. The study aims to identify the adverse health impacts of conventional buildings on occupants in South Africa based on construction professionals' perspectives. A field survey was carried out among construction professionals in the Gauteng Province of South Africa to identify the adverse health impacts of conventional buildings on occupants. The study used a simple random sampling method to select participants to avoid sampling bias. A well-structured, closed-ended questionnaire survey was developed and administered to respondents to gather data for the study. The questionnaire comprised twenty-six (26) adverse health impacts identified through an extensive literature review. The collected data from 159 respondents were then subjected to descriptive and inferential analyses using exploratory factor analysis (EFA) methods. The study's findings showed that sensitivity to odours, daytime dysfunction, and fatigue were the highest-ranked adverse health impacts on conventional buildings' occupants. The EFA returned five factors that provided a relevant understanding of the adverse health impacts of conventional buildings on occupants: respiratory symptoms, neurological and cognitive effects, general body discomfort, infectious diseases, and sensory sensitivity. In conclusion, the study emphasises the need for attention to the indoor environment and its potential impact on occupants' health and well-being with evidence that factors in conventional buildings, such as air quality, lighting, noise, temperature, and hygiene practices, play a significant role in influencing occupants' health outcomes.

Keywords: *Built environment, construction health and safety, developing countries, health impacts, sustainability.*

INTRODUCTION

The construction industry (CI) is unique compared to other sectors owing to its core and significant contribution to the socio-economic development of nations worldwide. It is common knowledge that the sector is directly responsible for providing buildings (commercial, residential, recreational, and religious) and infrastructure (roads, water, and energy), among others. The CI is regarded as the major economic stronghold of both developed and developing countries, considering its various activities and engagements culminating in an upsurge in the gross domestic product (GDP). Also, the CI is identified to be a promoter of creativity, innovation and a springboard of novel ideas as it is a sector that incorporates mechanisation and automation (Shubenkov et al., 2017; Koscheyev & Hakimov, 2019). However, to meet the needs of the growing global population on an ongoing basis, the CI utilises more resources and produces more waste than any other sector (Rose & Stagemann, 2018).

Conventional buildings refer to structures designed and constructed using standard and widely accepted building practices, materials, and technologies commonly employed in the construction industry. These buildings typically adhere to traditional building codes, regulations, and construction methods (Fargnoli et al., 2018). One significant aspect of occupant health in conventional buildings is indoor air quality. Building materials, such as paints, adhesives, and flooring materials, can emit volatile organic compounds (VOCs) that may cause short-term health effects, including eye irritation, headaches, and respiratory issues (Peter-Derex et al., 2015). Long-term exposure to indoor air pollutants has been associated with chronic health conditions like asthma, allergies, and other respiratory diseases. Building materials also play a crucial role in the thermal comfort of occupants. Insulation materials and window systems affect heat transfer and ventilation within buildings. Inadequate thermal comfort can lead to discomfort, decreased productivity, and even more severe health conditions related to temperature extremes (Nag, 2018). Moisture infiltration and the subsequent growth of mould in conventional buildings are common concerns for occupant health. Damp building materials can provide an ideal environment for mould growth, leading to respiratory issues and allergies among occupants. Furthermore, conventional building materials may contain harmful substances such as lead-based paints, asbestos, and formaldehyde (Tran et al., 2020). The presence of these substances in indoor environments poses significant health risks, particularly when disturbed during renovation or demolition activities.

Globally, the CI is tagged as a high-risk sector due to its activities and processes' various issues and negative environmental impacts (Heravi et al., 2022). Several occupational health and safety (OHS) issues are known to be associated with the industry. Construction site workers are constantly faced with hazards ranging from accidents, musculoskeletal injuries, and exposure to harmful substances (Fargnoli et al., 2018). Since the global discourse on the menace of climate change began, the CI has been identified as the major contributor. For example, in the study of Ling et al. (2011), the CI is identified as the major contributor to climate change in Singapore. Studies have shown that the CI's activities contribute to global warming and greenhouse gas (GHG) emissions (Murti & Muslim, 2023). Owing to its energy-intensive processes, such as materials manufacturing, transportation, and on-site and off-site operations, the CI consumes a sizeable amount of energy and contributes to carbon dioxide (CO_2) emissions.

However, the continued and increased negative impacts of the CI are understood to be due to the non-adoption of sustainable construction practices (SCPs). Instead of embracing the use of sustainable technologies, eco-friendly designs, and renewable construction materials, the CI still adopts conventional methods of construction, which are widely agreed to be detrimental to the human and natural environment. The study of Oguntona and Aigbavboa (2019) suggested that the material composition of conventional buildings is responsible for the negative environmental impacts of the CI. As further corroborated by Shariati et al. (2017), the properties of construction materials used in conventional buildings are not eco-friendly (high maintenance cost, high energy consumption, unsafe, and non-recyclable, among others). Studies have also shown that construction materials and the contents of new and old conventional buildings emit volatile organic compounds (VOCs) which adversely affect indoor environments (Brown et al., 1994; Claeson et al., 2007; Shah & Li, 2019; Shrubsole et al., 2019). As a result, sick-building syndrome (SBS), several building-related illnesses, and health challenges have been traced to the operation and occupation of conventional buildings (Burge, 2004). According to Stolwijk (1991), the occurrence of a significant number of subjective disorders among building occupants describes the SBS. These health issues are responsible for absenteeism and a decrease in productivity while adversely affecting the indoor experience and well-being of the occupants (Joshi, 2008; Malkova & Shoenfeld, 2022; Wang et al., 2022).

A wide range of health issues are attributed to conventional buildings globally. These include those caused by construction materials emissions, usage, or reactions that pose comfort-related or acute-health-related issues (Malkova & Shoenfeld, 2022). A few of the health issues reported by occupants of conventional buildings include fever, eye, throat, and nose irritations, cough, eye strain, dizziness, shortness of breath, itchy skin, nausea, hoarseness of voice, chest pain, sleeping and concentration difficulties, personality changes, influenza, common cold, high-stress level, headache, fatigues, sensitivity to odours, allergies, and daytime dysfunction, among others (Kongcharoen et al., 2019; Sun et al., 2019; Zainal et al., 2019; Tran et al., 2020; Awada et al., 2021; Gao et al., 2021; Akova et al., 2020). Hence, this study aims to identify the prevalent adverse health impacts of conventional buildings from the South African construction professionals' perspective. This task is imperative to raising awareness of the health implications of the continued use of conventional buildings and the non-implementation of SCPs. By exposing and identifying these health challenges, relevant stakeholders and the general populace will be encouraged to embrace the global sustainability wave.

1. RESEARCH METHODOLOGY

This research employed a quantitative research methodology to pinpoint the negative health effects of traditional buildings on their inhabitants. The study specifically concentrated on gathering input from duly registered and practising construction experts in the Gauteng province of South Africa. These experts encompassed project managers, mechanical engineers, quantity surveyors, civil engineers, architects, and electrical engineers registered and actively engaged in their respective professional organisations. The study used a simple random sampling method to select participants to avoid sampling bias and ensure all construction professionals working in Gauteng had an equal chance of being selected.

The technique was used because its adoption eliminates the possibility of clustering rather than cluster sampling, which breaks the population into different clusters and takes a simple random sample from each cluster. A carefully designed, closed-ended questionnaire was created and distributed to the participants for data collection in this study. The questionnaire consisted of two sections. The first section is aimed at collecting demographic information from the respondents. The second section included twenty-six (26) adverse health effects identified through a comprehensive literature review. The questionnaire was distributed through Google Forms, primarily using LinkedIn profiles and professional organisations.

Participants were asked to express their agreement level with the listed impacts using a five-point Likert scale. To ensure the validity of the data collection instrument, a pilot survey was conducted using 12 experts in the public health, environmental science, and built environment fields to provide insights into the selection of impact measures. Their expertise and experience played a pivotal role in guiding the study towards relevant and reliable indicators that could accurately capture the health impacts of conventional buildings on occupants. The completed questionnaires underwent a thorough review and cleaning process to ensure the accuracy and completeness of the collected data. The collected data were then subjected to descriptive and inferential analyses using exploratory factor analysis (EFA) methods. Descriptive analysis provided insights into the overall agreement levels of professionals with the identified adverse health impacts, while EFA helped identify any underlying factors or patterns within the data.

The study achieved a high Cronbach's alpha value of 0.942, indicating the data collection instrument's strong internal consistency and reliability. This value reinforces the confidence in the reliability of the questionnaire and the accuracy of the collected results.

2. FINDINGS AND DISCUSSION

The information in Table 1 provides a glimpse into the various roles of the respondents within the construction industry and their degree of involvement in green/sustainable building projects. The examination of the respondents' background information, as presented in Table 1, revealed that regarding professional qualifications, architects make up the largest proportion at 38.10 %, followed by electrical engineers and quantity surveyors, both at 18.10 %. Civil and mechanical engineers constitute 9.30 % and 9.40 %, respectively, while project managers account for 7.00 %. Regarding the educational qualifications of professionals, bachelor's and Honours degrees are equally represented, each accounting for 33.50 %.

Table 1. Respondents' Demographic Information

Factors	Variables	Percentage
Professional qualifications	Project managers	7.00 %
	Civil engineers	9.30 %
	Mechanical engineers	9.40 %
	Electrical engineers	18.10 %
	Quantity surveyors	18.10 %
	Architects	38.10 %
	Total	100.00 %
Educational qualifications	Diplomas	9.30 %
	Bachelor's degree	33.50 %
	Master's degree	16.30 %
	Honours degree	33.50 %
	Doctorates	7.40 %
	Total	100.00 %
Years of experience in the construction industry	1–5 years	23.30 %
	6–10 years	23.30 %
	11–15 years	35.10 %
	16–20 years	18.30 %
	Over 20 years	0
	Total	100.00 %
Number of current construction projects	1–2 projects	28.80 %
	3–4 projects	32.60 %
	5–6 projects	16.30 %
	7–8 projects	16.30 %
	More than 8 projects	6.00 %
	Total	100.00 %
Involvement in green/sustainable building projects	1–2 projects	44.20 %
	3–4 projects	29.50 %
	5–6 projects	16.30 %
	7–8 projects	10.00 %
	More than 8 projects	0
	Total	100.00 %

Furthermore, 16.30 % of the respondents hold master's degrees, while 7.40 % have doctorates. Respondents with diploma qualifications make up 9.30 % of the respondents. Table 1 further displays the distribution of professionals based on their years of experience in the construction industry. The majority (35.10 %) have between 11 and 15 years of experience, followed by those with between 6 to 10 years and between one and five years at 23.30 %. Professionals with between 16 and 20 years of experience account for 18.30 %, while there was no one with over 20 years of experience. Table 1 shows that the highest percentage (32.60 %) of the professionals is currently involved in three or four projects, closely followed by those involved in either one or two projects at 28.80 %.

A total of 16.30 % of professionals are involved in five to six and seven to eight projects, respectively. A smaller portion (6.00 %) of the respondents handle more than eight projects concurrently. Table 1 further presents the participation of professionals in green/sustainable building projects. The majority (44.20 %) are involved in one to two projects, followed by 29.50 % who are involved in three to four projects. Professionals engaged in five to six and seven to eight green projects constitute 16.30 % and 10.00 %, respectively. No respondents are currently involved in more than eight green/sustainable building projects. It can be inferred that the selected respondents in this study possess the necessary expertise and experience to offer professional insights on the research topic.

2.1. Descriptive Analysis: Adverse Health Impact of Conventional Buildings on Occupants

Table 2 presents data on the adverse health impact of conventional buildings on occupants in South Africa. The variables are ranked based on their mean scores, while the standard deviation values are provided to measure each variable's dispersion or variability of responses. The mean scores indicate the average level of agreement among the respondents regarding the adverse health impact of conventional buildings on occupants. The higher the mean score, the higher the rank of the variable, which indicates a more significant adverse health impact. According to the data, the top three adverse health impacts with the highest mean scores are "Sensitivity to odours", which is ranked first with a mean score of 3.33, "Daytime dysfunction", which is ranked second with a mean score of 3.28, while "Fatigue" is ranked third with a mean score of 3.26. These adverse health impacts are considered the most prominent factors affecting conventional building occupants in South Africa, as they received the highest average ratings.

The standard deviation values provide insights into each variable's spread or dispersion of responses. A higher standard deviation indicates a greater diversity of opinions or disagreement among the respondents regarding a specific barrier. Considering the standard deviation values in the table, some variables have relatively low values, indicating a higher level of agreement among the respondents. For example, "Nausea" has a low standard deviation of 0.908, suggesting that respondents had relatively consistent opinions about this adverse health impact. On the other hand, variables such as "Common cold" and "Eye irritation" have higher standard deviation values of 1.242 and 1.205, respectively, indicating greater variability in responses and a wider range of opinions among the respondents.

Table 2. Descriptive Analysis of Adverse Health Impact of Conventional Buildings on Occupants

Factors	**Mean**	**Standard deviation**	**Rank**
Sensitivity to odours	3.33	1.190	1
Daytime dysfunction	3.28	1.008	2
Fatigue	3.26	1.274	3
Visual fatigue	3.21	1.186	4
Allergies	3.19	1.160	5
Difficulty in concentration	3.14	1.187	6
Headache	3.14	1.167	6
Higher stress level	3.14	1.167	6
Eye strain	3.09	1.151	9
Common cold	3.07	1.242	10
Eye irritation	3.02	1.205	11
Cough	3.00	1.113	12
Personality changes	2.88	1.138	13
Nose irritation	2.86	1.104	14
Flu-like symptoms	2.81	1.160	15
Increased incidence of asthma attacks	2.81	1.006	15
Fever	2.81	1.075	15
Shortness of breath	2.79	1.146	18
Influenza	2.79	1.059	18
Difficulty in sleeping	2.79	0.989	18
Chest pain	2.79	1.081	19
Throat irritation	2.70	1.081	22
Dizziness	2.67	1.040	23
Dry or itchy skin	2.67	0.993	23
Hoarseness of voice	2.58	0.982	25
Nausea	2.56	0.908	26

2.2. Exploratory Factor Analysis: Adverse Health Impact of Conventional Buildings on Occupants

An Exploratory Factor Analysis (EFA) was performed after the descriptive analysis of the collected data. Table 3 displays the results of the Kaiser–Meyer–Olkin test, which yielded a measure of sampling adequacy of 0.795. This value suggests that the sample used in the analysis is sufficient for further examination.

Additionally, Bartlett's test of sphericity produced an approximate chi-square value of 1188.29 with 325 degrees of freedom and a significant p-value of 0.000. These values indicate compelling evidence that the variables considered in the analysis are not independent and exhibit meaningful interrelationships. Consequently, the data is deemed suitable for conducting additional analyses to explore the connections among these variables.

Table 3. KMO and Bartlett's Test

Kaiser–Meyer–Olkin measure of sampling adequacy		0.795
Bartlett's rest of sphericity	Approx. chi-square	1188.29
	df	325
	Sig.	0.000

Table 4 presents the communalities of adverse health impacts of conventional buildings on occupants. The initial communalities for each variable are all 1.000, indicating that the underlying factors perfectly explain the variable. However, after extraction, which involves capturing the common variance among the variables, the communalities range from 0.596 to 0.879. These values represent the proportion of variance in each variable accounted for by the underlying factors extracted from the data.

Table 4. Communalities of the Adverse Health Impact of Conventional Buildings on Occupants

Variables	Initial	Extraction
Difficulty in sleeping	1.000	0.596
Daytime dysfunction	1.000	0.730
Dry or itchy skin	1.000	0.825
Higher stress level	1.000	0.879
Nausea	1.000	0.695
Eye strain	1.000	0.803
Visual fatigue	1.000	0.846
Headache	1.000	0.826
Common cold	1.000	0.820
Fever	1.000	0.806
Cough	1.000	0.856
Fatigue	1.000	0.867
Dizziness	1.000	0.828
Influenza	1.000	0.813
Eye irritation	1.000	0.773
Nose irritation	1.000	0.729

Throat irritation	1.000	0.808
Difficulty in concentration	1.000	0.767
Sensitivity to odours	1.000	0.745
Allergies	1.000	0.852
Increased incidence of asthma attacks	1.000	0.827
Hoarseness of voice	1.000	0.879
Personality changes	1.000	0.852
Flu-like symptoms	1.000	0.824
Chest pain	1.000	0.744
Shortness of breath	1.000	0.800

A higher value indicates a stronger association between the variable and the underlying factors. Variables such as higher stress level, eye strain, cough, fatigue, allergies, and hoarseness of voice have relatively high communalities, suggesting a significant relationship with the underlying factors. On the other hand, variables such as difficulty in sleeping, daytime dysfunction, dry or itchy skin, and sensitivity to odours have lower communalities and indicate a weaker association. These results highlight the different degrees of impact that conventional buildings can have on occupants' health and provide insights into the specific health issues more strongly linked to such buildings.

The variance of the components was extracted, and it was found that the first component has the highest initial and extraction sums of squared loadings, explaining a substantial 57.596 % of the variance within the dataset, making it the most dominant component. It also boasts an eigenvalue of 14.975, indicating its strong ability to capture essential patterns and information in the data. In contrast, while still explaining a respectable 7.042 % of the variance, the second component pales in comparison to the first component. Its eigenvalue of 1.8310 suggests it captures some unique information but is notably less influential than the first component. The subsequent components, namely the third, fourth, and fifth, share a common trait. They each explain a relatively consistent and lower percentage of the variance, accompanied by eigenvalues of 1.5697, 1.2606, and 1.1530, respectively. This pattern emerges because the most significant data patterns have already been accounted for by the first two components.

Principal components analysis (PCA) prioritises components in descending order of explained variance. The first component captures the most substantial patterns, while each successive component tackles the remaining uncorrelated variance(s) in the data. As a result, finding additional unique patterns or information becomes increasingly challenging in the third, fourth, and fifth components. These later components are likely capturing less critical or orthogonal information, indicating that the primary data structures have already been identified. Thus, the scree plot depicted in Fig. 1 illustrates the extraction of five components.

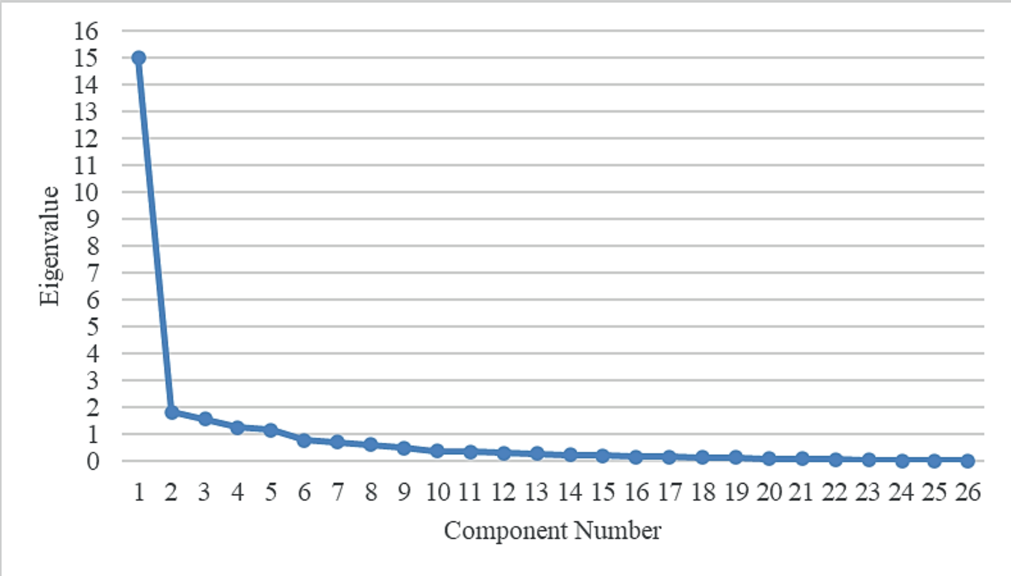

Fig. 1. Scree plot for the adverse health impact of conventional buildings on occupants.

Table 5 presents the pattern matrix resulting from a principal cluster analysis (PCA) conducted on the variables related to the adverse health impact of conventional buildings on occupants. The PCA aims to identify underlying patterns or clusters in the data by examining the correlations among variables. The correlation coefficient represents the strength and direction of the relationship between each variable and the corresponding cluster. A higher absolute correlation coefficient value indicates a stronger association between the variable and the cluster.

Table 5. Pattern Matrix for the Adverse Health Impact of Conventional Buildings on Occupants

	Components				
	1	**2**	**3**	**4**	**5**
Throat irritation	0.786				
Nose irritation	0.759				
Chest pain	0.710				
Shortness of breath	0.653				
Cough	0.620				
Increased incidence of asthma attacks	0.615				
Allergies	0.593				
Personality changes		0.914			
Dizziness		0.842			
Difficulty in sleeping		0.838			

Difficulty in concentration		0.733			
Visual fatigue		0.618			
Eye strain		0.545			
Eye irritation		0.510			
Fatigue			0.860		
Daytime dysfunction			0.845		
Nausea			0.537		
Higher stress level			0.511		
Headache			0.458		
Hoarseness of voice			0.443		
Common cold				0.755	
Fever				0.647	
Influenza				0.634	
Flu-like symptoms				0.582	
Dry or itchy skin					0.842
Sensitivity to odours					0.615

Cluster 1: The variables strongly associated with Cluster 1 include throat irritation (0.786), nose irritation (0.759), chest pain (0.710), shortness of breath (0.653), cough (0.620), increased incidence of asthma attacks (0.615), and allergies (0.593). This cluster can be named "Respiratory symptoms." The strong correlations suggest a common underlying factor related to respiratory health. These symptoms can often be attributed to exposure to poor indoor air quality or other environmental factors within the building. The respiratory symptoms observed in this cluster may arise from the presence of pollutants in the indoor environment (Nak, 2018). Dust, pollen, mould, and volatile organic compounds (VOCs) can contribute to throat and nose irritation, chest discomfort, difficulty breathing, coughing, asthma attacks, and allergies (Lu et al., 2015). Poor ventilation, inadequate filtration systems, and the accumulation of airborne contaminants within the building can exacerbate these symptoms and impact the respiratory well-being of occupants (Tran et al., 2020).

Cluster 2: The variables strongly associated with Cluster 2 include personality changes (0.914), dizziness (0.842), difficulty in sleeping (0.838), difficulty in concentration (0.733), visual fatigue (0.618), eye strain (0.545), and eye irritation (0.510). This cluster can be named "Neurological and cognitive effects". These symptoms may indicate that occupants are experiencing neurological or cognitive disruptions due to their environment. Changes in personality, dizziness, difficulty in sleeping, and difficulty in concentration may be attributed to factors like noise pollution, inadequate lighting, uncomfortable indoor temperatures, or poor air quality (Madureira et al., 2015; Peter-Derex et al., 2015). These stressors can adversely affect mental clarity, focus, and overall well-being. Visual fatigue, eye strain, and eye irritation, also observed in this cluster, may be linked to factors such as improper lighting, glare, excessive screen time, or inadequate ergonomic design of workstations (Akowuah et al., 2021). These factors can strain the eyes and contribute to discomfort and irritation, potentially affecting occupants' productivity and overall visual well-being. Identifying and addressing the factors contributing to neurological and cognitive effects is crucial for optimising occupants' comfort and performance in conventional buildings (Hamedani et al., 2019).

Cluster 3: The variables strongly associated with Cluster 3 include fatigue (0.860), daytime dysfunction (0.845), nausea (0.537), higher stress level (0.511), headache (0.458), and hoarseness of voice (0.443). This cluster can be named "General body discomfort". These symptoms are closely associated with each other, implying a common factor related to general discomfort in the body. The symptoms in this cluster may arise from exposure to various pollutants and stressors within the indoor environment (Nag, 2018). Factors such as noise pollution, temperature extremes, inadequate ventilation, and poor air quality can contribute to fatigue, sleep disruptions, increased stress levels, and physical discomfort. These stressors can manifest in symptoms such as headaches, hoarseness of voice, and feelings of overall malaise (Hamedani et al., 2019). Fatigue and daytime dysfunction can be attributed to poor sleep quality, which may result from factors such as excessive noise, uncomfortable temperatures, or suboptimal lighting. Nausea and higher stress levels can be influenced by the presence of pollutants, allergens, or unpleasant odours in the indoor environment (Lu et al., 2015). Headaches and hoarseness of voice may indicate physical strain caused by environmental factors, such as poor air quality or inadequate acoustic conditions (Nag, 2018).

Cluster 4: The variables strongly associated with Cluster 4 include common cold (0.755), fever (0.647), influenza (0.634), and flu-like symptoms (0.582). This cluster can be termed "Infectious diseases." These symptoms suggest that occupants in conventional buildings may be more likely to contract infectious diseases or viral infections. These symptoms imply that the building environment may play a role in promoting the spread of infectious diseases. Factors such as poor ventilation, inadequate hygiene practices, or insufficient cleaning protocols can contribute to the proliferation and transmission of pathogens within the indoor environment. Pathogens, including bacteria, viruses, and fungi, can spread through the air, through contact with contaminated surfaces, or by the consumption of contaminated food or water (Wang et al., 2022). Occupants in conventional buildings experiencing this cluster of symptoms may be more prone to infections owing to their exposure to pathogens within the building (Malkova & Shoenfeld, 2022). Factors such as crowded spaces, inadequate air exchange, and suboptimal sanitation practices can create an environment conducive to transmitting infectious agents.

Cluster 5: The variables strongly associated with Cluster 5 include dry or itchy skin (0.842) and sensitivity to odours (0.615). Therefore, this cluster can be named "Sensory sensitivity". These variables are strongly associated with each other, indicating that occupants experiencing dry or itchy skin may also have a heightened sensitivity to odours. The presence of dry or itchy skin and sensitivity to odours within this cluster may indicate that occupants are more susceptible to skin irritations and have an increased sensitivity to certain smells or odours present in the indoor environment (Nag, 2018). Factors such as dry air, low humidity levels, exposure to harsh cleaning chemicals, or irritants in personal care products can contribute to skin discomfort and reactions (Malkova & Shoenfeld, 2022). Additionally, the sensitivity to odours may result from exposure to strong or unpleasant scents within the building (Peter-Derex et al., 2015).

Understanding these clusters provides a comprehensive understanding of the adverse health impacts experienced by occupants in conventional buildings. By recognising the specific symptoms and their underlying causes, building designers, facility managers, and policymakers can develop strategies and interventions to improve the indoor environment and promote occupant health and well-being. The findings underscore the importance of adopting holistic approaches encompassing various aspects of building design, maintenance, and management to create healthier and more sustainable built environments.

3. CONCLUSIONS AND RECOMMENDATIONS

This study set out to identify the adverse health impacts of conventional buildings on occupants using the opinions of construction professionals. The objective was achieved through the adoption of a quantitative research method with questionnaires distributed to construction professionals in South Africa. The data that was retrieved was subjected to analysis using both descriptive and inferential analyses. The findings of this study shed light on the adverse health impacts of conventional buildings on occupants. Through the application of cluster analysis, five distinct clusters were identified, each representing a specific set of symptoms and health effects experienced by individuals within these buildings.

Cluster 1, labelled “Respiratory symptoms”, encompassed variables such as throat irritation, nose irritation, chest pain, and shortness of breath, indicating potential respiratory discomfort and health issues. Cluster 2, identified as “Neurological and cognitive effects,” highlighted symptoms such as personality changes, dizziness, and difficulty sleeping, suggesting neurological and cognitive functioning disruptions. Cluster 3, named “General body discomfort,” included symptoms such as fatigue, headache, and hoarseness of voice, indicating overall discomfort and potential stress-related effects. Cluster 4, designated “Infectious diseases,” represented symptoms such as the common cold, fever, and flu-like symptoms, signalling an increased likelihood of contracting infectious diseases. Lastly, Cluster 5, referred to as “Sensory sensitivity,” indicated symptoms related to dry or itchy skin and sensitivity to odours, suggesting heightened sensory reactions.

These findings emphasise the need for attention to the indoor environment and its potential impact on occupants’ health and well-being. It is evident that factors within conventional buildings, such as air quality, lighting, noise, temperature, and hygiene practices, significantly influence occupants’ health outcomes. Addressing these factors can contribute to creating healthier and more comfortable indoor environments for occupants.

Based on these findings, the following recommendations are made for conventional buildings:

- Improve indoor air quality: Enhance ventilation systems, remove or minimise sources of indoor pollutants, and conduct regular maintenance of HVAC systems to ensure clean and fresh air circulation within the building.
- Enhance environmental controls: Optimise lighting conditions, manage noise levels and regulate indoor temperatures and humidity to create a comfortable and conducive environment for occupants.
- Promote hygiene practices: Implement effective cleaning and disinfection protocols, encourage proper waste management, and promote good personal hygiene practices among occupants to minimise the risk of infections and the spread of diseases.
- Educate occupants: Raise awareness among occupants about the potential health impacts of the indoor environment and guide preventive measures such as hand hygiene, respiratory etiquette, and selecting suitable personal care products.
- Conduct regular building assessments: Periodically evaluate the indoor environment, including air quality, acoustics, lighting, and ergonomic factors, to identify potential areas of improvement and address any emerging issues promptly.
- Enhance collaboration: Foster collaboration among building owners, facility managers, architects, and health professionals to incorporate health-focused design principles and practices in the construction and maintenance of buildings.
- Prioritise occupants' well-being: Design buildings that prioritise occupants' well-being by considering factors such as access to natural light, comfortable workspaces, and amenities that support physical and mental health.

By implementing these recommendations, stakeholders can work towards creating healthier and more supportive indoor environments that mitigate the adverse health impacts associated with conventional buildings. Ultimately, this will contribute to the well-being, productivity, and satisfaction of occupants, making buildings more conducive to occupants' overall health and quality of life. It is worth noting that the study relied solely on the opinions of construction professionals in South Africa, which may limit the generalisability of the findings to other regions or populations. The perspectives of other stakeholders, such as building occupants or health professionals, were not included in the research, potentially missing valuable insights. The study also utilised a quantitative research method with questionnaires, which may have limitations in capturing the complexity and nuances of the adverse health impacts of conventional buildings.

Qualitative methods, such as interviews or focus groups, could have provided a more in-depth understanding of the experiences and perspectives of individuals. Finally, the study focused on identifying adverse health impacts and providing recommendations without exploring the underlying causes or mechanisms behind these impacts. Hence, further research is needed to investigate the specific factors in conventional buildings contributing to the identified negative health effects and explore potential solutions in greater detail. Also, the study was limited to construction professionals' perspectives, which might seem to be a flaw for some readers. Therefore, further studies should be carried out to compare the opinions of the occupants of these conventional buildings with those of the construction professionals.

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