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A COMPREHENSIVE STUDY ON HOW ENVIRONMENTAL FACTORS INFLUENCE HUMAN WELL-BEING AT WORKPLACE IN AUTOMOTIVE INDUSTRY

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Abstract: *The workplace environment, shaped by physical factors like air quality, thermal comfort and acoustics, has a direct impact on workers' well-being, satisfaction, and productivity. The objective of this study is to investigate the correlation between indoor environmental quality and employee well-being within Hirschmann Automotive, an automotive manufacturing facility located in Mures County. The research methodology involved designing a questionnaire on workers' perceptions of their environment, comfort and performance, followed by the analysis of responses from 50 employees working in shifts under strict clothing requirements in a controlled production area. The results were analyzed to identify key trends and improvement suggestions. Environmental parameters monitored included indoor environmental quality, thermal comfort, airflow, differential pressure and carbon dioxide levels. Despite the technically regulated environment, findings reveal a notable paradox: employees reported low performance, elevated stress levels, and a greater need for breaks—particularly during high-temperature periods. A significant proportion of respondents identified poor air quality as a key factor impairing concentration and productivity, often resorting to improvised solutions such as opening doors to improve comfort. These results highlight the critical importance of maintaining optimal indoor environmental conditions in industrial settings and provide actionable recommendations for improving occupational health, workplace design, and employee performance.*
Keywords: *indoor environmental quality, survey, employee performance, workplace.*

1. INTRODUCTION

Workplace well-being has become a significant topic in the 21st century, reflecting growing concern for both human health and work-life balance [1,2]. While industries pursue efficiency through new working styles, they often overlook essential environmental and organizational factors that affect employee mood and performance, such as poor layout, risky behaviors, and high accident potential [2].

European studies comparing different occupational health and safety (OHS) systems highlight the need for robust prevention strategies and cross-level awareness [3]. Indoor air quality (IAQ) is a central component of the workplace ecosystem, influencing attendance, performance, and comfort due to factors like poor ventilation, airborne pollutants, and inappropriate environmental settings [4–6].

In the automotive sector, especially under Industry 5.0 trends, indoor environmental quality (IEQ) is becoming a strategic priority. Elements such as lighting, air quality, temperature, noise, and ergonomics directly impact employee health and well-being [7–10]. Poor air quality is associated with fatigue, respiratory diseases, and chronic conditions. Inadequate lighting and noise contribute to headaches, stress, and reduced cognitive capacity [11,12]. Poor ergonomics lead to musculoskeletal disorders and lower productivity [13].

Noise is a persistent stressor in workplaces, linked to hearing loss, stress, and poor concentration. Implementing sound control strategies like quiet zones can enhance well-being [14]. VOCs (volatile organic compounds) are particularly concerning, with links to oxidative stress and adverse health outcomes,

especially among vulnerable populations [15,16].

Indoor environmental quality is influenced by outdoor air, human activity, and surrounding materials. Pollutants can infiltrate via outdated or poorly maintained HVAC (Heating, Ventilation, Air Conditioning) systems [17,18]. Metabolic rate also shapes air quality perception, with elderly workers more sensitive to discomfort [19].

Psychosocial aspects-job demands, autonomy, relationships, and culture-interact with physical conditions to shape well-being. High stress can diminish perceived comfort even in optimized environments [20,21]. Smart buildings now use real-time IEQ monitoring powered by AI and IoT, enabling better control and predictive maintenance [22,23].

Sustainable certifications like LEED, BREEAM, and WELL emphasize IAQ, promoting healthier materials, efficient ventilation, and human-centered design. These standards are correlated with better cognitive performance and reduced absenteeism [24–26]. Human activities, including the use of office equipment and cleaning agents, can worsen IAQ, underlining the need for eco-friendly practices [27].

The COVID-19 pandemic reshaped perspectives on ventilation and IAQ, reinforcing the importance of filtration systems and outdoor air intake [28]. Cognitive performance is strongly linked to air quality, with green-certified buildings showing superior outcomes [29].

Regulatory standards such as those from EU-OSHA, NIOSH, and ISO provide limits and guidelines for pollutants like CO_2, formaldehyde, and PM2.5 (Particulate Matter with aerodynamic diameter $\leq$ 2.5 (μm)) [30]. However, occupant behavior also affects IAQ—improper ventilation habits or lack of maintenance can worsen conditions [31,32]. Occupational inequality in exposure, especially among lower-skilled workers, raises equity concerns [33]. Climate change adds complexity, with rising temperatures and pollutant loads stressing existing infrastructure [34].

Given the increasing emphasis on workplace productivity and employee health, coupled with the often-overlooked role of environmental and psychosocial factors, this study aims to investigate the relationship between indoor environmental quality (IEQ) and employee well-being within the context of an automotive manufacturing facility with focus on the following two key parameters:

- Assess on employees' subjective perceptions of key environmental parameters—such as air quality, temperature, lighting, noise, and ergonomic design—and how these affect their physical comfort, health, and performance.
- Explore the influence of psychosocial factors, including stress, interpersonal relationships, communication with supervisors, and motivation, on perceived well-being at work.

By addressing both physical and psychosocial dimensions, this research seeks to provide a holistic understanding of workplace well-being, following the next structure:

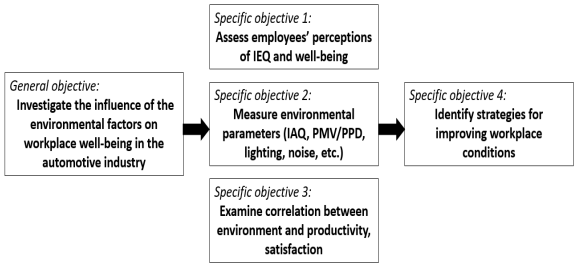

Fig. 1. Research objective scheme

The study investigates the impact of work schedules—particularly shift work and overtime—on employees' physical and mental state, as well as on their work-life balance. These scheduling aspects are often defining features of industrial environments and may contribute to long-term dissatisfaction or fatigue.

2. MATERIALS AND METHODS

2.1 Research Setting and Context

The study was carried out at an automotive components factory located in Mureș County, Romania. The factory is part of a larger international production network and operates under stringent technical and cleanliness

standards due to the sensitivity of the manufactured products. The selected department for the research involved production areas where employees are required to wear special protective clothing and work under controlled indoor conditions. The factory is equipped with HVAC systems, yet recent internal reports and employee feedback suggested potential discomforts related to air circulation, temperature fluctuations, and humidity levels. The time range of the survey was selected as being during the transition from a cold season (spring) to a warm season (summer).

2.2 Participants

A total of 50 employees (number which represents 1/7 part of the total employee structure of the chosen company) took part in the study. Participants were selected through sampling, based on availability and relevance to the research topic. The sample included individuals which have direct contact with the product manufacturing. On the opposite side the study area was not randomly chosen but with purpose to measure the results in an extreme conditions part of the plant.

The demographic profile of the sample was diverse, with participants aged between 22 and 44 years. Approximately 70% were female, and the majority had between 1 to 6 years of experience in the analyzed sector. Workers were distributed across three shifts (morning, afternoon, and night), allowing for the identification of possible variations in perceptions due to environmental conditions specific to each shift.

2.3 Questionnaire Design and Content

The main data collection instrument was a self-administered paper questionnaire consisting of 21 items grouped into three thematic sections:

- Demographic and background information (e.g., age, gender, job type, years of experience, shift schedule);
- Perceived indoor environmental quality – assessing thermal comfort (temperature, lighting, and noise levels);
- Health and well-being indicators – including motivation, concentration difficulties, and relationships between colleagues.

The questionnaire was designed as a close-ended response questionnaire, with multiple response options provided for each item, depending on the specific question. In addition, it was developed based on previous studies in the field and inspired by guidelines from the World Health Organization (WHO) and ISO 16000 and ISO 28802:2012 [35], which provide standardized approaches for evaluating indoor environmental parameters in occupational settings.

2.4 Data Collection Procedure

The survey was conducted over five consecutive working days, during the second quarter of 2025 (12.05.2025 – 16.05.2025). Participation was voluntary, and all employees were informed in advance about the purpose of the study and their right to withdraw at any time without any consequences. Prior to completing the survey, participants received a brief explanation of the research goals and a printed consent form.

To reduce bias and ensure data consistency, questionnaires were distributed and completed in the analyzed area during working hours, with the assistance of the research coordinator present to clarify any potential doubts or misunderstandings. Completed surveys were collected in an envelope and unpacked home to be analyzed and the first discussions to be carried out.

In the last step, Microsoft Excel (version 365) was used for preliminary data organization and visualization of the graphs [36].

3. RESULTS

In order to achieve the initial and defined objective the following activities were performed:

A1: Literature review on IEQ and well-being in industrial workplaces.

A2: Design and administer employee questionnaires (perceptions, comfort, satisfaction).

A3: Collect questionnaires

A4: Perform statistical analysis (correlation, comparative analysis).

A5: Interpret results and develop improvement recommendations.

3.1 Demographic and background information

The results recorded for the first thematic section, which outlines the demographic profile of the respondents, indicate that a significant majority 70% were women, while only 30% were men. This gender distribution provides insight into the composition of the surveyed population and may influence the interpretation of subsequent findings. To gain a deeper understanding of the demographic characteristics, this gender-based classification is further analyzed by age structure, as illustrated in Fig. 2.

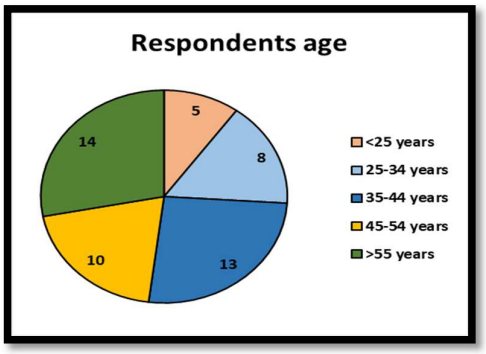

Fig. 2. Age distribution of respondents.

The aimed group of respondents had different levels of work experience in the company, this indicator also highlights how loyal the employees for the company are and which is the satisfaction level among them. The results show that the majority of the respondents have between 1-3 years in the company as shown in the Fig. 3.

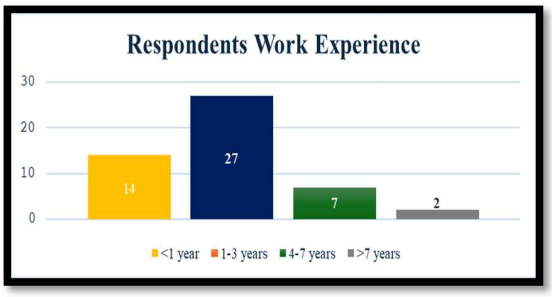

Fig. 3. Distribution of respondents by length of employment.

3.2 Perceived indoor environmental quality

In order to evaluate the perception of the indoor air quality at the workplace the respondents answered how satisfied are about the work conditions in the following order: temperature, noise level and lighting.

Most of the people said that the temperature in the production hall is acceptable with some minor deviations who are saying that is too hot. This number consists of 9 responses of the total responses, highlighting that 9 employee may be experiencing a lack of a positive organizational climate in the workplace as shown in Fig. 4, which can negatively affect their performance.

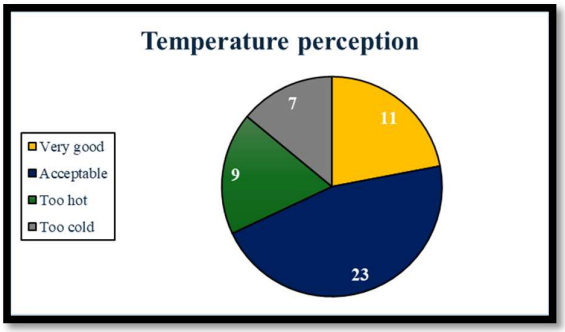

Fig. 4. Perception of thermal comfort in the workplace.

According to the respondents' perceptions represented in Fig. 5, the noise level is considered acceptable and sometimes good by more than half of the workers and does not negatively impact their health or concentration during working hours. On the other side eight people consider it bad for their own health. Issues with equipment, maintenance or facility adjustments in the production area may cause this also.

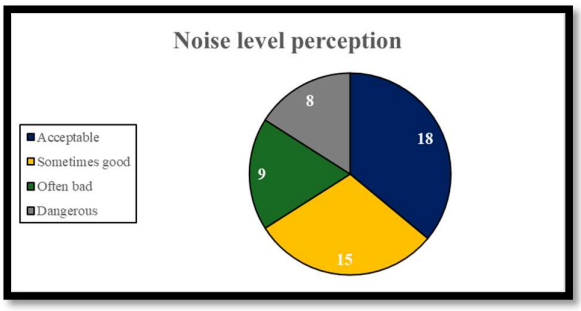

Fig. 5. Perception of noise levels in the workplace.

It is confirmed that lighting is also an acceptable factor as more than 30 of the people consider it sufficient for the current work they perform, specified in Fig. 6. Most of the time, during the validation of the production lines, each workplace is evaluated by the engineers due to the scope of the process. For processes where quality control is performed, the need of light is mandatory in order to ensure the customer requirements.

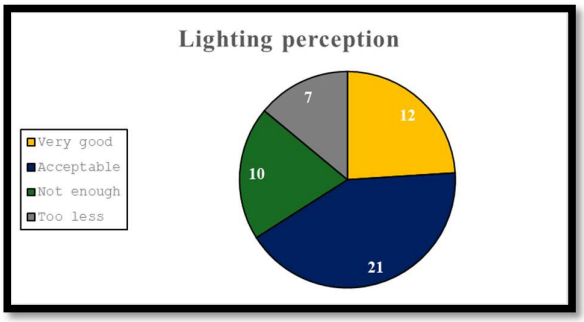

Fig. 6. Perception of lighting adequacy in the workplace.

3.3 Health and well-being indicators

Fig. 7 indicates that 18 respondents (36% of the 50 respondents) feel sometimes stressed at the workplace. This highlights a bad situation during the working time, which can lead to headaches, health issues on long term and also a not comfortable mood during the free time. In this case, the research should investigate more which is the cause for the high stress indicators and propose improvements or specific solutions in order to reduce or eliminate the root cause.

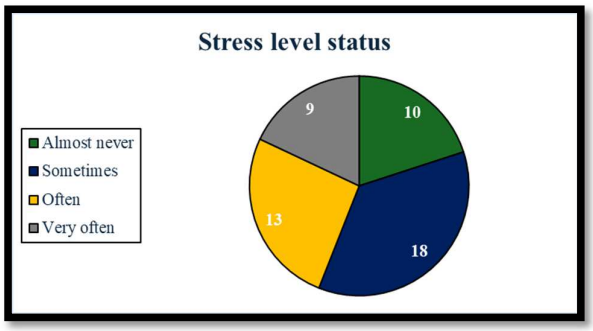

Fig. 7. Perceived levels of workplace stress among respondents.

In Fig. 8, the relationship with work colleagues was examined, and the results indicate that it does not represent a problematic factor. However, the 15 respondents, which face sometimes tense and conflictual situations, represent a question mark for further investigations.

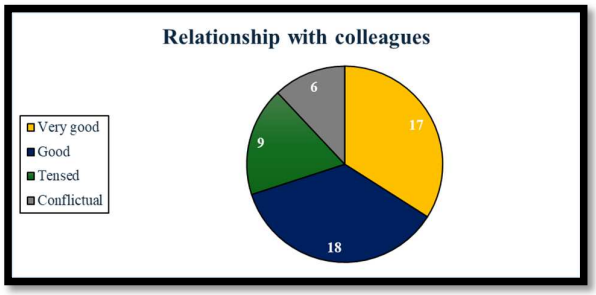

Fig. 8. Perception of interpersonal relationships among colleagues.

Most interpersonal communication is conducted under favorable conditions. Respondents also reported that during the two defined seasons, there is a generally positive organizational climate. Cognitive attitudes and external environmental factors contribute to a constructive atmosphere, often resulting in informal gatherings outside the workplace that further strengthen social cohesion and team dynamics.

The last analyzed interpersonal parameter is the motivation. There was a high desire to see the results of this specific parameter as this one defines how people come and leave the workplace during a working day.

According to Fig. 9, 34 respondents reported experiencing high levels of motivation throughout the workday.

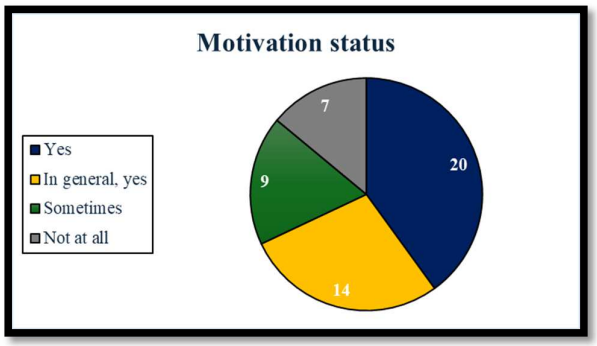

Fig.9. Self-reported motivation status among respondents.

However, to ensure sustainable well-being and performance, companies should address the remaining challenges by promoting active feedback systems, strengthening stress management programs, and implementing targeted technical solutions in areas with reported discomfort. In the Table 1. it is shown basically the summary overview of the questionnaire.

Table 1. Questionnaire summary results

Survey Item	Main Issue Identified	Summary of Responses
Is the temperature in the workspace comfortable?	Thermal discomfort	22 Yes / 28 No – majority experience temperature as inadequate
Is the noise level disturbing?	Excessive noise	Mixed results, with up to 32 respondents reporting disturbance
Is lighting sufficient at the workplace?	—	The majority reported sufficient lighting (up to 39 Yes)
Do you feel safe at work?	Perceived lack of safety	Up to 20% report not feeling consistently safe
Do you frequently work overtime?	Work overload	As many as 32 respondents indicate frequent overtime
Is the level of stress at work high?	Elevated stress	Up to 30 respondents experience high stress levels
Is the work physically exhausting?	Physical strain	Up to 35 respondents perceive the work as physically demanding
Do you feel appreciated by your direct supervisors?	Lack of recognition	Approximately 40% do not feel sufficiently appreciated
Is the work well organized in your company?	Organizational inefficiency	Up to 13 respondents rated the organization as unsatisfactory

This result reflects not an ideal environment in the organization, suggesting effective management practices are needed, a strong sense of workplace well-being during the standard eight-hour shift should be maintained, and a solid foundation for sustained employee engagement and performance should be created. There is still room for improvement to increase the motivation for the other 30% of the workers which could include discussions and feedback from their side in order to analyze and react to the determined situation.

4. DISCUSSIONS

The present study investigated how employees from one production company in Romania perceive indoor environmental quality and how these perceptions relate to their health, well-being, and motivation. The findings provide valuable insights into the current state of workplace conditions and identify key areas for potential organizational improvement.

The demographic distribution of respondents revealed a predominance of women (70%), which may reflect the gender-specific structure of the production workforce in the studied sectors. Regarding work experience, most respondents had between 1 and 3 years of tenure, suggesting a relatively young workforce with moderate company loyalty. This intermediate level of experience may influence perceptions of workplace comfort and engagement, as employees in this phase often begin to develop stronger opinions about their environment and management practices.

The assessment of indoor environmental quality focused on three primary dimensions: temperature, noise, and lighting. Most employees stated thermal conditions as acceptable, although approximately 20% expressed discomfort due to excessive heat in the production areas. This subgroup is noteworthy, as thermal discomfort has been linked in previous research to decreased

concentration and productivity, as well as negative mood states.

In our study, most respondents did not perceive noise as problematic, but noise from equipment or machinery did disturb a minority, suggesting localized acoustic challenges that require targeted interventions—aligning with "quiet computing" concepts that emphasize acoustic zoning and distraction mitigation.

Lighting was perceived positively, with over 70% of participants indicating that it was sufficient for their tasks. This aligns with the standard practice in production settings, where lighting conditions are periodically assessed by engineers during validation phases, especially for processes involving quality control. These results highlight a strength in environmental management practices within the companies studied.

Psychosocial indicators revealed mixed outcomes. Stress was reported by 45% of respondents, a figure that signals concern, especially given the potential long-term health consequences associated with occupational stress. While the source of stress was not directly identified, the result points to the need for further investigation into workload, shift scheduling, and communication patterns.

Interpersonal relationships among colleagues were generally rated as positive. The respondents emphasized a friendly work atmosphere and seasonal social interactions outside the workplace, suggesting strong informal support networks. This is an encouraging finding, as positive social dynamics are strongly correlated with employee engagement and resilience.

Motivation was another key variable, with 70% of employees reporting high levels of motivation throughout the workday. This outcome reflects positively on management strategies and suggests a generally supportive and engaging work environment. Nevertheless, the remaining 30% of respondents who reported lower motivation levels represent an opportunity for improvement. Feedback mechanisms, recognition systems, and inclusive communication strategies may help elevate motivation across the entire workforce.

The results of this study suggest that while the overall perception of the work environment is relatively positive, there are critical areas that require attention. Stress management, thermal comfort, and localized noise issues emerged as domains where targeted improvements could lead to significant gains in employee well-being and performance. Moreover, leveraging the strong interpersonal climate and enhancing motivation through employee-centered practices could further strengthen organizational culture.

This study presents several limitations that should be acknowledged. First, the research was conducted in a single production facility from the automotive sector, which limits the generalizability of the results to other industries or geographical contexts. Second, the relatively small sample size—only 50 employees—may not capture the full diversity of perceptions and experiences related to indoor environmental quality. Third, the study relied exclusively on self-reported data obtained through questionnaires, which may be influenced by subjective bias or temporary mood states.

Given these limitations, future research should consider multi-site studies across various industrial sectors to enhance external validity. Increasing the sample size and employing a mixed-methods approach, combining quantitative environmental monitoring with qualitative interviews or focus groups, could provide a more comprehensive picture of workplace well-being. Furthermore, integrating objective health indicators and long-term monitoring could help establish causal relationships between indoor air quality and employee performance, motivation, and health outcomes.

Future research should include longitudinal data to assess changes over time and incorporate qualitative methods to better understand the root causes of reported discomfort and stress. As well as consider expanding the sample across other industrial sectors and integrating objective environmental measurements to validate and deepen the current findings. Additionally, the integration of objective environmental measurements (e.g., temperature, noise level, CO_2 concentration) would provide a more

comprehensive picture of the workplace environment and its impact on human performance.

5. CONCLUSION

This study provides valuable empirical data on how employees in Romanian automotive production companies perceive the indoor environmental quality (IEQ) and how these perceptions correlate with their health, comfort, and motivational status. The results reveal a generally favorable evaluation of IEQ—particularly in terms of lighting and noise conditions—yet highlight ongoing concerns regarding thermal comfort and stress levels among certain employee groups.

Moderate stress levels and discomfort associated with temperature regulation and equipment-related noise indicate the need for targeted improvements in environmental control systems and ergonomic design. Conversely, high levels of perceived motivation and a positive social climate suggest that current organizational practices are effective in supporting employee engagement.

For industrial organizations, particularly in the context of Industry 5.0, such integrative strategies are essential not only for enhancing employee satisfaction and retention but also for sustaining productivity and operational excellence over time.

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Studiu complex privind influența factorilor de mediu asupra stării de bine a angajaților la locul de muncă în industria auto

Rezuma: *Mediul de lucru, modelat de factori fizici precum calitatea aerului, confortul termic și acustica, au un impact direct asupra stării de bine, satisfacției și productivității angajaților. Obiectivul acestui studiu este de a investiga corelația dintre calitatea mediului interior și starea de bine a angajaților în cadrul companiei Hirschmann Automotive, o unitate de producție din industria auto situată în județul Mureș. Metodologia de cercetare a implicat elaborarea unui chestionar privind percepțiile lucrătorilor asupra mediului de lucru, confortului și performanței, urmată de analiza răspunsurilor a 50 de angajați care lucrează în schimburi, sub cerințe stricte de îmbrăcăminte, într-o zonă de producție controlată. Rezultatele au fost analizate pentru a identifica tendințe esențiale și sugestii de îmbunătățire. Parametrii de mediu monitorizați au inclus calitatea aerului interior, confortul termic, viteza aerului, presiunea diferențială și nivelurile de dioxid de carbon. În ciuda unui mediu reglementat tehnic, concluziile relevă un paradox notabil: angajații au raportat performanțe scăzute, niveluri ridicate de stres și o nevoie crescută de pauze – în special în perioadele cu temperaturi ridicate. O proporție semnificativă dintre respondenți a identificat calitatea slabă a aerului ca factor cheie ce afectează concentrarea și productivitatea, recurgând adesea la soluții improvizate, precum deschiderea ușilor, pentru a îmbunătăți confortul. Aceste rezultate evidențiază importanța critică a menținerii unor condiții optime de mediu interior în spațiile industriale și oferă recomandări practice pentru îmbunătățirea sănătății ocupaționale, a designului locului de muncă și a performanței angajaților.*

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