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Air Quality Analysis in a Public Building in the Municipality of Olinda/PE

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***Abstract*—** *The analysis of air quality is directly related to the health preservation of individuals who attend closed environments, climatized or not, and this factor can be linked to the place (un)salubrity. Certain polluting factors are potentiated by the lack of natural ventilation; in other cases, depending on the region, the natural circulation of wind is what brings pollution to the place. Considering that all environments can be affected by a sanitary decrease promoted by low air quality, the present work aims to analyze the air contamination indices of the Forum Lourenço José Ribeiro, located in the municipality of Olinda/PE. The methodology uses exploratory research in a case study to be carried out by obtaining quantitative data on carbon dioxide (CO2) indices, internal temperature and relative air humidity that were measured between february and june/2021, in the morning shift of the aforementioned building. The present work is limited to the breadth of the data to be researched, and it should also be considered that the researched period faced the limitation of face-to-face activities motivated by the Coronavirus pandemic, which substantially reduced the amount of exposed and polluting people in the premises Results obtained indicate a good indoor air quality in the evaluated rooms, both for users, servers and occupants of sealed and artificially air-conditioned spaces, with good air renewal. Future work should be guided by the search for solutions capable of improving the natural ventilation of the researched environments, in addition to research carried out during the face-to-face working hours of the servers of the Forum Lourenço José Ribeiro.*

I. INTRODUCTION

The environment is a collective good of individual and general entertainment at the same time. In this way, the right to the environment belongs to each person, but not only to them, presenting a trans-individual dimension. For this reason, the right to a healthy environment enters the category of diffuse interest and integrates as guarantees belonging to the entire current and present generation. Among the institutes covered by Environmental Law, the air stands out in this matter (MACHADO, 2016).

The maintenance of this legal protection consists of the maintenance of this environmental asset for the maintenance of life on the planet. Considered a good for use by the people and protected by the range of diffuse rights,

whether those belonging to the current and future generations, the clean air is positive as a right provided for in the National Environmental Policy (Law n. 6.938/1981) and it must be guaranteed for all through the work of the Government and civil society (YOSHIDA; GUERRA, 2017).

Within urban scenarios with intense human activity, the properties of the air are severely compromised by the pollution factor. This finding demands greater rigor in initiatives aimed at implementing environmental guarantees of clean air. In the Judiciary context, Brazilian courts are socially relevant actors at the forefront of environmental banners and must therefore adopt sustainability policies that carry out environmental precepts, including those related to clean air, to exalt socio-environmental responsibility practices and also on behalf of preserving the health of public servants and civil society that access these public buildings.

It is well known that the various environmental emergencies aimed at the degradation and pollution of natural resources require from all of us greater rigor in the conduct of attitudes that can generate harmful results to the environment and ensure the healthy quality of life of human beings, so that the creation of a sustainable and socio-environmentally correct place is among the most relevant factors in the contemporary scenario, and the Public Power is a strategic figure in the socio-environmental agenda (TEIXEIRA; BRESSANE; NÓBREGA, 2019).

The concern with the quality of the air must be especially conducted in places of great human circulation. The greater the collectivity presence, the greater the reflection in the degradation of an environment, since every human action causes some repercussions on natural factors. Thus, preventive and restorative initiatives must go hand in hand in the search for a balance between social interests and environmental standards (CUNHA; AUGUSTIN, 2014).

That said, the case study proposed here goes back to analyzing the air quality at the Lourenço José Ribeiro Forum, located in Olinda city and an organ that makes up the structure of the Pernambuco Judiciary (CORDEIRO, 2019). As it is a public building and with intense circulation of servers, jurisdictions and other employees, the air quality in a place with these characteristics has the power to affect unspeakable people, which requires the State - represented here by the Judiciary State of Pernambuco - to act in accordance with the diffuse protection recommended by the Federal Constitution.

Among the objectives of the present work, the general objective is to analyze the air contamination rates of the Forum Lourenço José Ribeiro, located in the municipality of Olinda/PE.

II. BIBLIOGRAPHIC REVIEW

Air pollution is one of the major causes of human deaths in the world today, and the monitoring of air quality is one of the main tools to produce public policies for pollution control, in order to maintain safe levels of pollutants in the atmosphere. (TEIXEIRA *et al.*, 2019)

By protecting the health of the air, the right natural conditions for the development and maintenance of human life will automatically be guaranteed, taking into account that there have never been so many sources of pollution in progress.

Air pollution, both environmental (outdoor) and domestic (indoor), is the biggest environmental health risk, leading to responsibility for about one in nine deaths annually. (TEIXEIRA *et al.*, 2019)

Silva and Mendes (2006) advocate that, in urban areas, the typical anthropogenic polluting sources are, especially, car traffic and, when existing, industrial activity. Subsequently, Almeida *et al.* (2019) conclude that monitoring air pollution indices can be a useful tool for the safety of human health and the environment, as it ensures public planning aimed at controlling humanly healthy levels.

Garcia and Aquino (2019) assert that the social function of the State has come to the point of being urged to guide the feasibility for the development of urban policies in Brazil (CORDEIRO, 2015).

2.1 Legal Protections of the Right to Clean Air and the Sick Building Syndrome (SED)

Everyone has the right to an ecologically balanced environment, good for common use by the people and essential to a healthy life quality, imposing on the Public Power and the community the duty to protect and preserve it for present and future generations (BRAZIL, 1990).

The balanced work environment is a topic of profound importance and relevance, whose systematization and normative construction was provided by the 1988 Constitution of Brazil Federative Republic (BRAZIL, 1990), as a result of the broad and comprehensive constitutional protection given to the environment, housing all its innumerable aspects, whether of the natural environment, or of the artificial environment, including work (MARTINS; BERTOTTI, 2019).

Resolution n. 09 of the National Health Surveillance Agency (ANVISA), sought to improve the reference standards of Indoor Air Quality in artificially air-conditioned environments for public and collective use, based on the knowledge and experience acquired in the country in both first years of its validity, considering the sanitary interest in the dissemination of the subject; in

addition to the concern with the health, safety, well-being and comfort of the occupants of air-conditioned environments; the current state of knowledge of the international scientific community in the area of indoor environmental air quality, which establishes reference standards and/or guidelines for this control, among others (BRAZIL, 2003).

It should be noted that despite the legal provision referring to internal environments, external environments are also exposed to polluting factors. However, for human health purposes, the greatest risk occurs when there is no natural circulation of wind, which underlies the concern of the legislator with such spaces. In these terms, Comin (2016) highlights that air quality is directly associated with human health and environmental pollution is a fatal indicator for man. The aforementioned notion was appropriated by science from episodes of acute air pollution in European cities and the United States since the beginning of the 20th century. The author records that the most drastic example of human harm from air pollution occurred in 1952, in England, after a thermal inversion in the winter period that prevented the dispersion of particulate matter resulting from industrial activity and home fireplaces. In three days, 4,000 citizens lost their lives due to a cloud of sulfur-rich pollution parked over the city.

The same Comin (2016) teaches that, since the mid-1970s, there have been studies on indoor air quality (QAI). In this period, civil construction had already reliably adopted the verticalization of urban centers, which increased the number of sealed buildings, buildings with low capacity for air exchange between internal and external environments, which leads to an increase in concentration of chemical and microbiological pollutants inside these buildings.

The deficiency in ventilation, according to the author, caused the so-called Sick Building Syndrome (SED), a problem recognized by the World Health Organization (WHO) since the mid-1980s. The international entity shows concern with SED because the social routine demands that people spend about 50 to 70% of their day indoors, between residence, transport and work environment.

In the 1980s, a working group from the World Health Organization (WHO) sought to systematize these signs and symptoms and encompassed them in what became known as the Sick Building Syndrome (SED) or Sick Building Syndrome. This syndrome is classified as a public health problem by the WHO, and is characterized by situations of discomfort at work and/or acute health problems, reported by workers, which seems to be related to staying inside some buildings (SILVA, 2017).

Abrava (2021) details that, in sealed environments, indoor air conditioning systems aim at the concomitant control of temperature, humidity, renewal to reduce CO_2, movement and air quality of the place, as well as influencing the control of internal pressure in relation to the close environments and that cold air does not mean good quality air. Based on these data, environmental monitoring becomes a top priority action in public and private initiatives, given the concentration of people who circulate daily in these places.

It derives from this that environmental criteria are maxims to be observed by all sectors of society in the name of a common interest. Based on the growing concern with sustainability and taking into account the overcoming of the predatory model of facing the natural heritage, which warns about the depletion of nature's capacity to restore the standard of environmental balance, human societies need to adapt their demands to the leading role of the environment cause, which will never be surpassed. Framing man as an animal that needs balance in its habitat requires that new criteria and social configurations be implemented so that life on earth continues to be possible.

In this support, the Public Power has been gathering efforts in order to be an actor that leads the ecologically correct example and remodels the gears of public administration to adapt to this new standard of reverence for environmentally adequate conditions. Regarding the protection of the air, the guardianship was inaugurated with Resolution n. 05 of the National Environment Council (CONAMA, 1989), which instituted the National Air Quality Control Program (PRONAR) when taking into account the increase in atmospheric pollution, the growing use of urban spaces and of vehicles and the need to establish guidelines for the control, preservation and recovery of air quality at the national level.

The strategies adopted by CONAMA (1989) Resolution n. 05 determine the maximum emission limits of pollutants, the standardization of air quality at the national level, the prevention of air deterioration, the monitoring of air quality, the management of the polluting sources licensing and the national identification of all air polluting sources.

Once the normative and scientific bases that revolve around the matter are understood, it is worth noting that all public buildings must be operating in accordance with the aforementioned environmental rules, which allows an analysis of air quality indicators at the Lourenço José Ribeiro Forum, located in the city of Olinda/Pernambuco and a building belonging to the patrimony of the Court of Justice of Pernambuco.

As mentioned elsewhere, the public building in

question shares the structure of a sealed building, which makes possible points of pollution and environmental degradation due to the poor exchange of air. On the subject, Schirmer *et al.* (2011) draws attention to the threats of closed places, as pollutants based on carbon, ammonia, sulfur and nitrogen are substances present in buildings from construction and cleaning materials, in addition to those triggered by activities carried out on site, such as drying clothes and preparing food. People's breathing and perspiration also directly influence the creation of these air-degrading factors, such as the contagion of respiratory diseases.

According to the above comment, research on air quality is capable of identifying risks of harm to human health derived from factors never considered in everyday life and that constantly expose people to their tasks.

Some microorganisms cause allergic reactions, the symptoms of which include sneezing, watery eyes, coughing, respiratory failure, lethargy, fever and digestive problems, in addition to causing pneumonia, rhinitis and asthma. In general, the main diseases associated with biological pollutants are Legionnaires' Disease (or legionellosis, as its agent is the gram-negative bacterium of the *Legionella* genus); humidifier fever (a disease that develops from exposure to toxins from microorganisms, especially those that grow in building ventilation systems); bronchial asthma (spasms associated with inhalation of biological aerosol); allergic pneumonitis or extrinsic alveolitis; pneumonia (pulmonary infection associated with bacteria such as *Streptococcus pneumoniae*, *Mycoplasma pneumoniae*, *Staphylococcus aureus*, *Legionella* and *Haemophilus influenzae*, viruses and some types of fungi) (SCHIRMER *et al.*, 2011).

Furthermore, the non-biological contaminants mentioned by Schirmer *et al.* (2011) that tarnish air quality are carbon dioxide, carbon monoxide, nitrogen dioxide, nitrogen oxide, sulfur dioxide, particulate matter, smoke from cigarettes and volatile organic compounds.

The dangers drew the attention of the World Health Organization (WHO), which conceptualized the sick building syndrome (SED) as a situation in which the occupants or users of a specific building present symptoms without a specific origin and without the possibility of finding an etiology and is, therefore, unknown (SCHIRMER *et al*., 2011).

Sick Building Syndrome comprises several non-specific signs and symptoms that occur in the occupants of a given building. This feeling of ill health increases absenteeism at work and causes a decrease in worker productivity. This syndrome is increasingly becoming an occupational health problem, so it is of special importance to understand its cause, treatment and prevention (SILVA, 2017).

The global health entity considers the existence of SED when at least 20% of the occupants of the place present symptoms such as: mucosal irritation, neurotoxic effects, respiratory and cutaneous symptoms, and changes in the senses, for at least two weeks, and these disappear when the individual walks away from the building (SCHIRMER *et al.*, 2011).

2.2 The Q.A.I. Impact in Human Life

Complex historical factors of civilization, such as the industrial revolution, the mechanization of agriculture, the revolutions in information technology and services, oblige the modern human being to live most of the time inside buildings. With the concentration of people in cities, the salubrity conditions of the buildings interior environments began to acquire increasing importance as influencers of the health status of populations (CARVALHO, 2017).

The issue of air pollution is of great importance to Brazilian society due to its social, economic and environmental potential impacts. It gains complexity from synergies and overlaps with major contemporary challenges of Brazilian public policy, such as improving public health, sustainable economic development, reducing fires and mitigating climate change (SANT'ANNA *et al.*, 2021).

The discussion about the impacts of atmospheric pollutants in internal places of buildings, both in Brazil and in the world, is widespread and consolidated, as there is already a knowledge about their effects on human health (MATOS, 2020).

The statement that the environment is largely responsible for the state of human health is not new and goes back to the Greeks, particularly Hippocrates who, in his work Dos Ares, Águas e Lugares, defends the notion of health as a state of balance between the man and his environment. The built environment, with its artificial character, can clearly express this mutual influence because, with the increasing technological domain, it became possible to create spaces with subtle and deceiving imbalances (CARVALHO, 2017).

The impacts of air pollution on human health are linked to the incidence of premature deaths, lung and cardiovascular diseases, stroke, cancer and diabetes disposition, as well as impaired cognitive development in children and dementia in the elderly (SANT'ANNA *et al.*, 2021).

The vast majority of the population spends a large part of their time inside buildings, such as homes, schools, workplaces and other public and commercial

establishments, so these spaces must have the necessary conditions to have a positive influence on health, well-being, comfort and productivity of individuals. There are numerous factors that affect this well-being, including indoor air quality, ambient temperature, light, tobacco smoke and relationships with colleagues. Dysfunction of one of these factors is associated with several signs and symptoms, covering a wide range of clinical manifestations (SILVA, 2017).

III. METHODOLOGY

In order to carry out the present research, documentary and bibliographic data were collected, which allowed the theoretical analysis of the parameters of indoor air quality that has the power to affect the health of people who transit or work in places with low natural circulation in artificially air-conditioned environments.

In addition to the theoretical stage, the indoor air quality indices (QAI) were collected in the field, via study case, in some rooms located at the Lourenço José Ribeiro Forum, located at Avenida Pan Nordestina, s/n, Vila Popular, Olinda city, metropolitan region of Recife/PE.

In this vein, Mazucato *et al.* (2018) teaches that field research "is the process in which the researcher is directly articulated with the space (source) from which his information derives".

The qualitative-quantitative approach intends to explore the forum's air indicators in a study case supported by the legal-environmental literature and regulations produced within the Pernambuco Court of Justice, as a public actor committed to adequate socio-environmental practices.

3.1 Building Description

The Forum Lourenço José Ribeiro building (Figure 1) has 7,500.00 m² of built area, spread over four floors, with a ground floor with a parking area for magistrates and service vehicles, and three upper floors with closed rooms. The Forum also has a jury room, bank, four cells, four elevators, access for the disabled, an event room and parking for 120 vehicles in the outdoor area. See front and aerial view images:

Fig.1: Fórum Lourenço José Ribeiro front view.

Source: *Google Earth* (2018).

Intending to detect the potentially harmful factors to the traffickers at the Olinda Forum health, the Cemando rooms (Writing Center - space destined to the demands of Justice Officers who work in the Olinda district), Jury (large courtroom, with public monitoring space), Refrigeration Room and the Domestic and Family Violence Court at the Lourenço José Ribeiro Forum, located in the Olinda city, State of Pernambuco.

The first measurements took place between February 25 and March 25, 2021. The second round of measurements took place between June 10 and June 28, 2021. All measurements were carried out at 9 am and 12 pm on the current mentioned days.

It is worth noting that the 2021 forensic office went through different formats due to the Coronavirus pandemic, which imposed teleworking as the official format for performing the functions of most servers. This meant that the different months were affected by different stages of the presence return and use of measured spaces.

The rooms analyzed were:

- Refrigeration control room, measuring 12 square meters with four servers working, located on the ground floor of the Lourenço José Ribeiro Forum.
- Technical Room or Warrant Center (Cemando), measuring 66 square meters, with an average stay of two people. It is possible for up to four people to visit at the same time on some occasions.

Located on the ground floor of the building.

- Domestic and Family Violence Court Room, measuring 72 square meters, operated by 4 fixed servers. It occupies the second floor of the forum.
- Jury's Private Court Room, measuring 66 square meters, regularly used by 4 servers working on the ground floor.

3.2 Research Instrument

Data on polluting factors will be collected through the device Carbon dioxide detector Indoor environment Air quality monitor Digital gas meter Plug USA 100-240 V with storage. This tool will be able to detail the QAI (air quality index) indicators, in addition to temperature, CO_2 and humidity.

With this, it will be possible to study the statistics of air quality in environments cooled by the Modular Configuration System External Unit - Set free, electronic system of artificial refrigeration known for air control in external installations that controls several internal units simultaneously in the Forum Lawrence Jose Ribeiro. The obtained analyzes during the experiment were processed by the SPSS statistical program developed by International Business Machines (IBM) Corporation.

The chosen places to carry out the measurements are the jury room, forum reception and other environments of restricted use with similar spatial dimensions. The air assessment period will take place in the first half of 2021, between the months of February to June, during daytime hours, from 9:00 to 12:00.

Regarding the statistical method, Mazucato (2018) says that it "basically consists of quantifying data on phenomena, processes, facts, so that they can be analyzed. By using the statistical method, researchers can be able to analyze the different phenomena, processes and facts in relation to each other".

The measurements of the present research object items were integrated Input data into the statistical program (SPSS 2019). For the input data, the first line corresponds to the day, followed by the time, the internal temperature, the internal relative humidity and the CO_2 concentration. For each measurement situation performed, the data are entered into the program as illustrated. The day and time were defined as nominal data, while temperature, relative humidity and CO_2 concentration were designated as scale data.

In IBM's SPSS statistical program, data analysis begins with the configuration of input variables, where input or output variables are defined and in nominal, scale, and/or ordinal data groups. For this work, data were only divided into nominal and scale groups. The day and time were defined as nominal data, while temperature, relative humidity and CO_2 concentration were designated as scale data.

In the sequence, the definition of the input variables is carried out later. To enter the data, the numbers of digits were defined, and whether the data are ordinal such as time and day, and scale data such as temperature, relative humidity and CO_2 concentration. The important variables are internal temperature (Internal Temp), internal relative humidity (Internal Urinary) and CO_2 (carbon dioxide). Descriptive statistics provide a simple summary about the samples and about the observed data and measurements that were made. These summaries can form the basis of the initial description of the data.

Descriptive statistics for the various measurement conditions which are VVDF, Refrigeration Room, Cendo and Jury Room. For the input data of the first part, measurements were taken between February 25th and March 25th, 2021. For each day, two measurements were taken at 9 am and at noon (12:00). However, for the first part of this work, data were collected over a period of 20 days. The important variables are internal temperature (Internal Temp), internal relative humidity (Internal Hum) and CO_2 (carbon dioxide). Descriptive statistics provide a simple summary about the samples and about the observed data and measurements that were made. These summaries can form the basis of the initial data description. Descriptive statistics analyze the maximum and minimum values of the data, the mean and error of the deviation. The Tables 1, 2, 3 and 4 illustrate the average, error of deviation and standard average error for all rooms evaluated.

Table 1: VVDF Descriptive Statistics

	N.	Minimum	Maximum	Average	Deviation Error
InternalTemp	40	20,0	26,9	23,255	1,6407
InternalHum	40	48,9	68,3	58,783	4,2170
CO_2 ppm	40	437	666	518,90	50,338

Source: The author

Table 2: Refrigeration Room Descriptive Statistics

	N.	Minimum	Maximum	Average	Deviation Error
InternalTemp	40	20,3	27,1	23,812	1,6738
InternalHum	40	47,6	74,5	58,743	6,5636
CO_2 ppm	40	474	710	555,28	65,638

Source: The author

Table 3: CEMANDO Descriptive Statistics

	N.	Minimum	Maximum	Average	Deviation Error
InternalTemp	40	20,	24,7	22,803	1,2198
InternalHum	40	49,9	60,8	54,140	2,7656
CO_2 ppm	40	480	778	619,30	78,607

Source: The author

Table 4: Jury Room Descriptive Statistics

	N.	Minimum	Maximum	Average	Deviation Error
InternalTemp	40	19,7	24,9	22,710	1,4300
InternalHum	40	49,6	58,6	53,908	2,6134
CO_2 ppm	40	454	689	562,10	56,745

Source: The author

It can be seen that the average CO_2 for VVDF is 518.9 ppm, the average indoor humidity 58.8 and the average indoor temperature 23.4°C. In this condition, there was a maximum of 666 ppm of CO_2 and a minimum of 437 ppm. The analyzes were collected for VVDF, for the Refrigeration Room, for Cendo and for the Jury Room.

Employers must adopt corporate sustainability policies and practices, which must include the protection of the work environment, incorporating strategies and businesses that are economically, environmentally and socially dimensioned for the development of decent and sustainable work. Thus, future development is linked to economic and social development that is compatible with the protection of workers and the environment (MARTINS; BERTOTTI, 2019).

For the statistics of a sample, each variable (internal temperature, relative humidity and CO_2 concentration) is analyzed, where N corresponds to the number of analyzed data, remembering that there are two per day, at 9 am and at noon.

IV. RESULTS AND DISCUSSION

4.1 Measurement Results - 1st Part

One of the criteria for evaluating the balance of the work environment is the health and environment of the place, understood in an integral way, both of the workplace and its employees (MARTINS; BERTOTTI, 2019).

For the statistics of a sample, each variable (internal temperature, relative humidity and CO_2 concentration) is analyzed, where N corresponds to the number of analyzed data, noting that two analyzes were performed per day, at 9 am and at noon. The Tables 5 and 6 illustrate the means, error of deviation and standard error of the mean for VVDF and the Refrigeration Room.

Table 5: VVDF Sample Statistics

	N.	Average	Deviation Error	Standard Average Error
InternalTemp	40	23,255	1,6407	0,2594
InternalHum	40	58,782	4,2170	0,6668
CO_2 ppm	40	518,90	5,338	7,959

Source: The author

Table 6: Refrigeration Room Sample Statistics

	N.	Average	Deviation Error	Standard Average Error
InternalTemp	40	23,813	1,6738	0,2647
InternalHum	40	58,743	6,5636	1,0378
CO_2 ppm	40	555,28	65,638	10,378

Source: The author

4.2 Interaction between Temperature, Humidity and Measurement Time Analysis

For the interaction between temperature, humidity and measurement time analysis, 4 graphs were also generated according to each measurement situation of the obtained data. On the X axis is the relative humidity; the Y axis shows the time and the Z axis deals with the CO_2 concentration.

It can be observed that for the hours, the measurements performed at noon obtained the highest values of carbon dioxide concentration. The Jury Room showed the lowest CO_2 concentrations, while the Refrigeration Room and Cemando demonstrated the highest CO_2 concentrations, as illustrated in Figure 2.

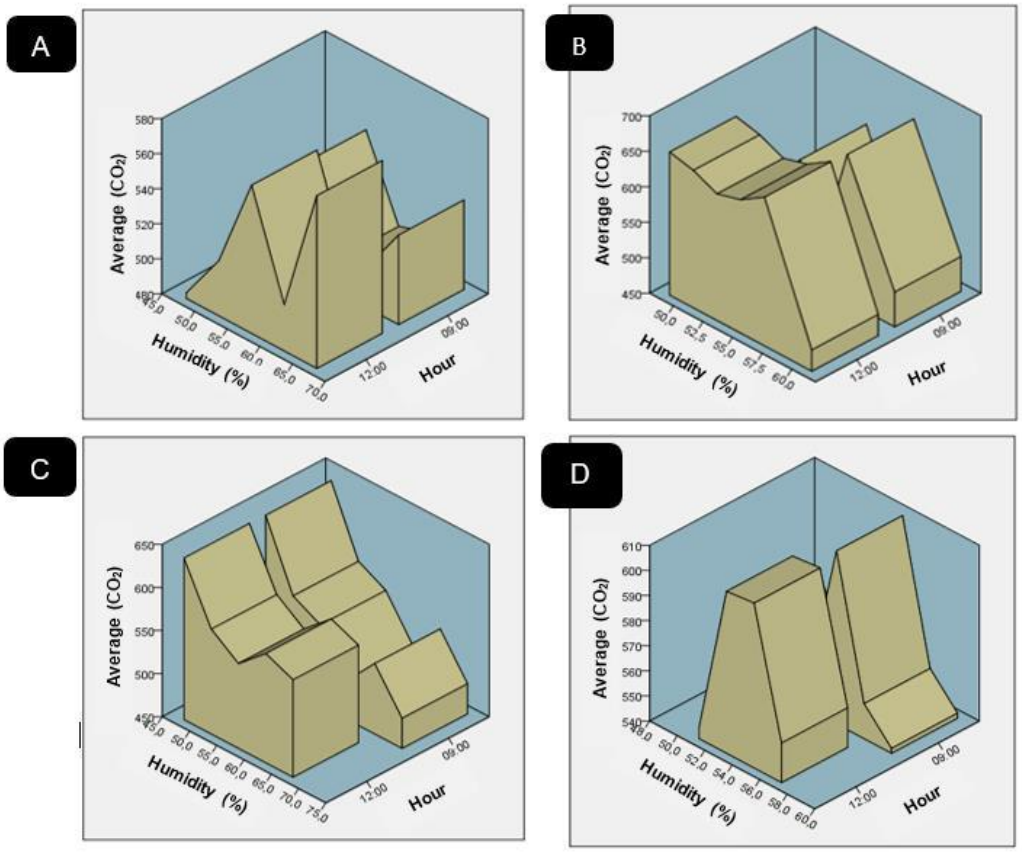


Fig.2 CO_2 Interaction, Indoor Humidity and Time on the VVDF(A), Refrigeration Room(B), Cemando(C) and Jury Room(D).

Source: The author

To verify the connection between the levels of CO_2 concentration according to the day of data collection, graphs were constructed illustrating the concentration of CO_2 on the X axis and the days of data collection on the Y axis in Figure 2. In the VVDF room (2A) and Refrigeration Room (2B), the CO_2 concentrations were relatively low, the averages were 518 and 555 ppm as illustrated in Figures 2A and 2B respectively, while the temperatures of these environments were the highest found, 23.3 and 23 .8°C respectively in VVDF and Cooling Room.

For Cemando (2C) and Sala do Juri (2D), the average concentrations of CO_2 reached 619 and 562 ppm

respectively, which are relatively higher than those found in the first two previous rooms. The maximum temperatures in these places in contrast are the lowest found, 22.7 and 22.8°C respectively. The CO_2 concentration in relation to the measurement days in the environments: VVDF, Refrigeration Room, Cendo and Jury Room can be observed in Figure 3, 4, 5 and 6 respectively.

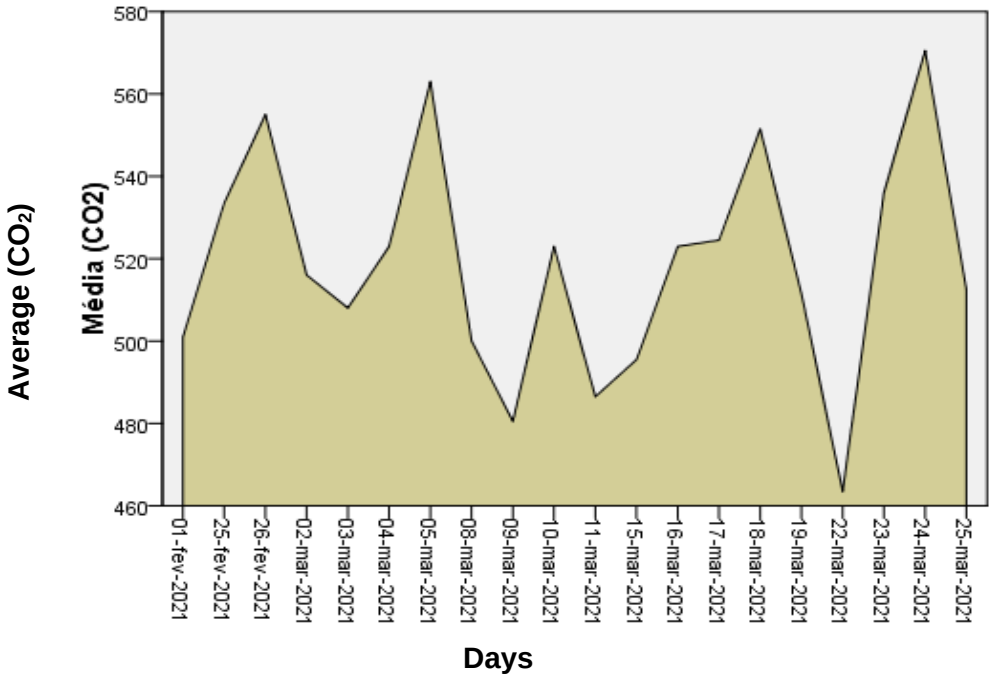


Fig.3 CO_2 in relation to VVDF measurement days

Source: The author

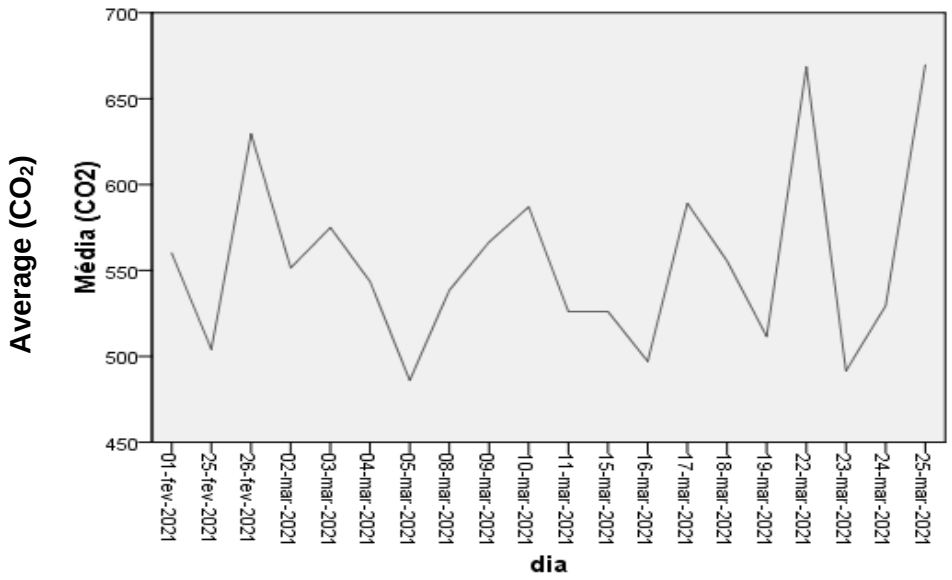
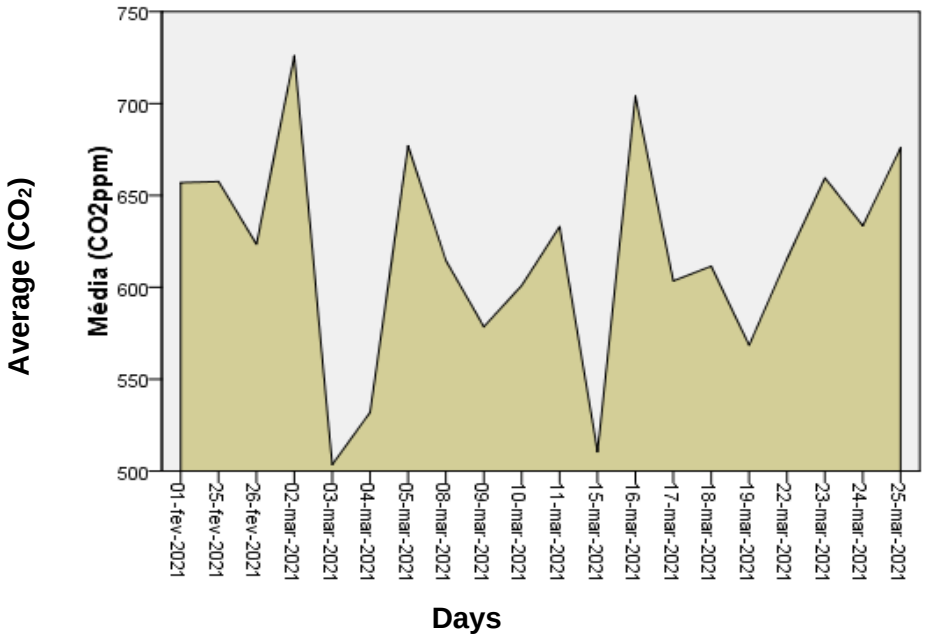


Fig.4 CO_2 in relation to Cooling Room measurement days

Source: The author



Source: The author

Fig.5 CO_2 in relation with Cemando measurement days

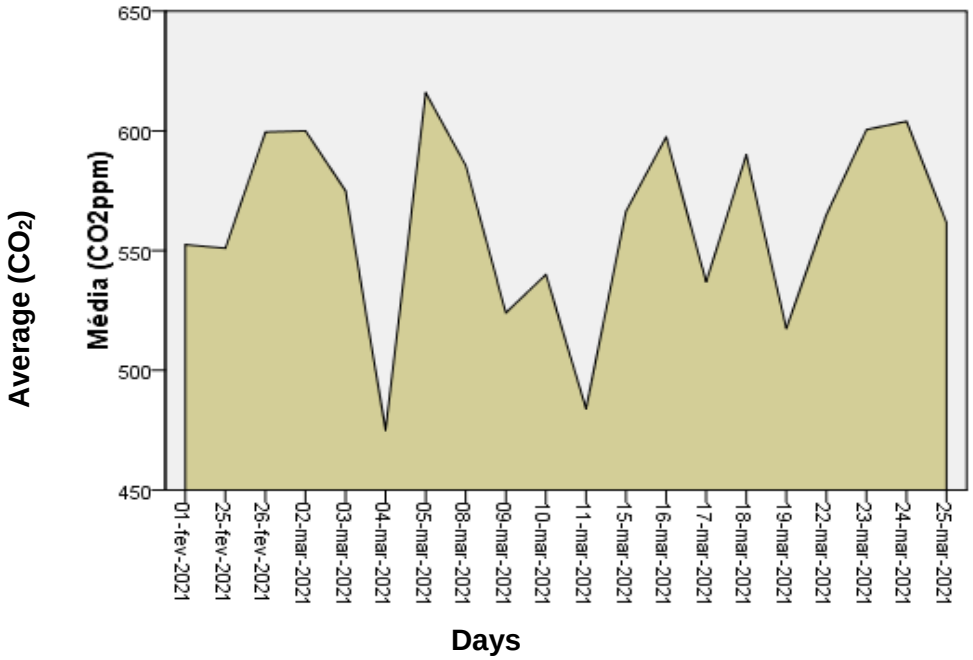


Fig.6 CO_2 in relation with Jury Room measurement days

Source: The author

4.3 Comparison of the two parts of the experiment

In comparison with the measurements carried out in the first part of the experiment, it can be observed that the average concentration of CO_2 in the first part of the work was similar to what was obtained in the second part. The highest concentrations were observed in Cendo (778 ppm) in the first part and in the second part the highest concentration was found in the Refrigeration Room (775 ppm). Regarding internal temperatures and internal relative humidity, in the first part the highest temperature was found in the Refrigeration Room with 27.1°C, in the second part of the experiment, the highest temperature was found in the Room of the Court of Domestic and Family Violence (VVDF) at 27°C. The highest indoor relative humidity was

found in the Cooling Room also for both cases, 74.5% and 68.4% respectively.

Analyzing the first four tables of the Descriptive Statistics, referring respectively to VVDF, Refrigeration Room, Cemando, Jury Room, it was found that the measurements made at the Lourenço José Ribeiro Forum indicated an adequate level of indoor air quality in the inspected environments. The maximum values of CO_2 and temperature were not exceeded, according to the standards established by ANVISA (BRAZIL, 2003). The exception was in relation to relative humidity, which in Table 2, Descriptive Statistics Refrigeration Room, was 74.5% when, according to ANVISA, the acceptable standard is 40% to 65% with a maximum value of 70 % in access areas during the summer.

Regarding the analysis of tables 7 to 13 of the Descriptive Statistics of the VVDF, Refrigeration Room, Cendo and Jury Room, it was proved that the measurements referring to the variables: temperature, relative humidity and carbon dioxide indicated, according to the standards defined by ANVISA (BRAZIL, 2003), an adequate level of indoor air quality in the studied location. According to Lyra (2015), QAI problems are related to environmental comfort and the levels and types of air pollutants. Environmental comfort involves physical variables related to the comfort or discomfort felt by the occupants, such as temperature and air temperature distribution uniformity, lighting, relative humidity and air velocity. Recent studies suggest that the ideal temperature, in terms of comfort and minimum spread of disease, is 20°C. This statement corroborates the study carried out. As a result, according to Teixeira (2019), a correct diagnosis of air quality is essential for the Government to promote improvements in the monitoring structure. It is also essential that, in addition to disseminating information and making it available in reports and electronic addresses, educational programs to raise awareness of air pollution are carried out, bringing the community information about how pollution occurs, with 77% from mobile sources, how measurement of air quality occurs and also what to do to improve these indices, which tend to increase with urban growth. The increase in the air quality monitoring network, as well as the replacement by automatic stations or even more advanced technologies, are prioritized by the public authorities, as they promote the availability of data for the academic environment and for the management itself, which will have a more accurate picture of the air quality in their region, as well as propose solutions that are more adhering to the real needs of cities.

The statement by Schirmer (2011) also reinforces the study, which reports that the concern with Indoor Air Quality (QAI) arose mainly with the tendency to build sealed buildings for aesthetic reasons, noise control and even air conditioning, which ended up causing an increase in cases of problems related to air quality in such environments. The interest in QAI studies arose after the discovery that the decrease in air exchange rates in these environments was largely responsible for the increase in the concentration of biological and non-biological pollutants in indoor air. This concern is justified since most people (around 80-90%) spend most of their time inside these buildings and, consequently, are exposed to pollutants in these environments.

Also according to Schirmer (2011), it is known that ventilation systems, when poorly operated and without adequate maintenance, become potential sources of pollutants, mainly particulate materials and microorganisms (due to the accumulation of moisture in these systems). Therefore, in order to have a healthy building, good indoor air quality must be achieved, through the use of adequate ventilation rates, building automation systems and, mainly, continuous monitoring of these facilities.

V. CONCLUSION

The initial objectives were met with the analysis of the Olinda Forum air quality carried out. For this, the indoor air quality was verified, the indicators were investigated and through statistical interference, the temperature, humidity and carbon dioxide in the building were analyzed and discussed.

The results obtained in this study show that the measurements made at the Lourenço José Ribeiro Forum indicated an adequate level of indoor air quality in most of the inspected environments. It is worth mentioning that the year 2021 was crossed by different stages of return of the servers, employees and users of the Judiciary to the physical office. The months of pandemic that followed prevented the verification of a traditional routine of access to public buildings.

In this sense, it is recommended for the future that more work on the carbon dioxide (CO_2), temperature, and relative air humidity measurement be carried out so that it can be possible to monitor the return to the forum's face-to-face working hours in its normal transit capacity of people and particles in the air that could be harmful to human health and the environment.

Observing these determinations, the Quality of Life at Work (QVT) has been gaining ground in terms of organizational well-being. In this way, more than the relationship between man and architecture, it is worth emphasizing the importance that the built space establishes for the individual in working conditions.

Problems related to the work environment are not recent, so much so that in 1982, the Technical Committee of the World Health Organization defined sick building syndrome (SED) as the set of the following symptoms: headache; fatigue; lethargy; itchy and burning eyes, nose and throat irritation; skin abnormalities and lack of concentration in office workers.

The objective is to guarantee user productivity, a fundamental part of this process. Therefore, based on the premise that air quality interferes with the worker's health status, and consequently in their activities, through architecture it is possible to provide the safety and well-being of users, preventing the development of pathologies associated with the permanence indoors, especially with artificial air conditioning.

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