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Automated building for coworking services

Edíficio automatizado destinado a serviços de coworking

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ABSTRACT

The integration of automation with architecture is increasingly present in entrepreneurial and commercial environments. The search for practicality, cost savings and efficiency made technologies an essential asset in these scenarios. The presence of devices involving automation is increasingly frequent in our daily lives, especially in concepts of smart homes, automated industrial production and global agriculture. Commercial architecture follows this constant evolution, offering intelligent systems that help reduce energy consumption, control climate control, provide automated lighting, refined security systems and facilitated access control, among other methods of automation in the commercial aspect. In the current scenario, the concept of shared work Coworking is a great business alternative, collaborating with the development of new professionals and boosting the growth of entrepreneurs and freelancers from the same region. These buildings provide features such as climate controls, lighting, outdoor seating, safe and easy access to the building, and reservation capabilities for meeting rooms, workspaces, and the dining area. The development of this work is based on the execution of the electrical design of a 04-story building, containing the electrical, automation and communication design of most of the enclosures, taking into account the relevant technical standards.

Keywords: Automation, Electrical sizing, Coworking, Intelligent Architecture.

1 INTRODUCTION

Buildings Coworking as well as automation, prioritize safety, economy and comfort (LIMA, P.V.G, 2018), aiming at the best experience of its users. Automation systems allow centralized control of lighting, air conditioning, security, audio and video, elevators and energy management, providing efficiency and saving resources. Commercial architecture follows this evolution constant (ROCKENBACH, 2004), offering intelligent systems that help reduce energy consumption, control air conditioning, provide intelligent lighting, refined security systems and facilitated access control, among other methods of automation (SEBASTIAN, 2017). With this, automation emerges as an indispensable need in corporate offices with coworking performance, meeting the needs of micro and macro entrepreneurs, offering an accessible workplace for freelancers, students and content creators in general. Architecture must keep up with automation technologies to maximize their benefits and meet market demands.

With automation, it is possible to monitor and control the energy consumption of a given environment in real time, identifying usage patterns and opportunities to reduce spending. This can include controlling lighting, climate control and other electrical and electronic systems. In addition, automation can help reduce energy waste by turning off equipment and systems when they are not in use or when the building is empty. This can result in significant energy and cost savings, which is especially important at a time when sustainability and environmental responsibility are increasingly valued by businesses and consumers (CAVALCANTE,2007).

2 METHODOLOGIES

2.1 SWOT ANALYSIS

The SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis methodology, also known as SWOT (Strengths, Opportunities, Weaknesses and Threats) analysis, is a tool used to assess the strategic position of a company, product, project or even a person in relation to its internal and external environment.

3 OBJECTIVES

This work aims to present the importance of integrating the control and automation area together with architecture in the commercial sphere, more specifically in a large Coworking space, highlighting how these technologies can contribute to cost reduction, increased energy efficiency and improved user experience.

- Demonstrate how automation is increasingly present in our lives and how coworking spaces have become a great alternative for the growth of companies and freelancers in the labor and economic sphere;
- Present the main automation technologies used in commercial spaces .
- Highlight how integrating architecture with these technologies can maximize their benefits and meet market demands;
- Show how automation can be seen as an indispensable need in corporate offices with coworking performance, meeting the needs of micro and macro entrepreneurs;
- Emphasize the importance of aesthetics and design in integrating automation with the architecture of commercial spaces.

4 JUSTIFICATION OF THE TOPIC

Due to the post-pandemic scenario and the country's economic issues, entrepreneurship and the growth of micro-enterprises have been a major challenge in current times. Coworking spaces have become a great alternative for the growth of companies and freelancers in the labor and economic sphere, especially for this type of demanding public.

The Covid-19 pandemic has brought new concepts of productivity, alternatives and quality of work. New specialties began to gain ground in the labor scenario worldwide, such as working from home (home office), for example. The Coworking shared office model is seen as mo ideal for people who work with their workstations, as it is interactive, functional, productive and especially economical.

Economy is paramount in current times, and Brazilian society is learning to manage and put into practice financial education. Corporate offices are a priority category when it comes to economy, since setting up or opening an office today in our country has become increasingly risky and complex.

Automation is increasingly present in our lives, and its growth is remarkable. Technology must be seen as an ally to meet the demands on aspects of economy, efficiency and embrace the technological advances that are increasingly part of our lives. Automation emerges as an indispensable need in corporate offices with coworking performance, meeting the needs of micro and macro entrepreneurs in the city of Foz do Iguaçu, in addition to offering an accessible workplace for freelancers, students and content creators in general.

Architecture must keep pace with automation technologies to maximize their benefits and meet market demands. Commercial buildings can have an optimal improvement in energy performance, safety and user experience. The complementary aspects of integrating the technological equipment and cabling with the aesthetic design, both inside and outside the building, are extremely important.

5 THEORETICAL FRAMEWORK

In order to gather fundamentals with principles and qualified sources to support the study, it was considered essential to search for authors who deal with separate concepts in Coworking spaces, Smart building and equipment to work automation.

5.1 SPACES FOR COWORKING SERVICES

According to Leforestier (2009), coworking facilities 451paces are physical spaces that bring together professionals who work outside the conventional office, who are usually independent entrepreneurs, *freelancers*, entrepreneurs and self-employed professionals who seek some kind of human interaction, since in the *home-office* usually the work ends up being isolated. In the specific case of our region, according to data accumulated in the last three years of the general price index - IGP-M Market, the percentage of rent rose approximately 46.37%, making it difficult and often risky to open a company and rent a room for its operation.

The *home-office* work modality is characterized by the insertion in a space, without defined size or properties, destined only for professional activities and located in the worker's residence, being optional the use of information technologies to carry out the activities (Ellison, 1999; Lim & Teo, 2000). In Brazil, approximately one in four people could work remotely, according to the Institute for Applied Economic Research (IPEA, 2018). This is equivalent to 20.4 million people, which represents 24.1% of the total employed population in the country.

Freelancer is the English term used to refer to the self-employed professional who works with different companies and captures their clients independently.

Living with pets at work brings numerous benefits to the human being in the workplace. According to data from Abinpet, Brazil has the second largest population of dogs, cats and songbirds and ornamental birds in the world and is the third largest country in total pet population. There are 54.2 million dogs, 23.9 million cats, 19.1 million fish, 39.8 million birds and another 2.3 million other animals. With that in mind, *pet friendly* spaces become a great project differential.

According to RIBEIRO (2017) when declaring itself pet-friendly, the establishment is informing that it is pet-friendly. That is, that the pet will be well-received in that place. He will not only be able to enter the establishment, but can also stay with the customer.

With all this proposed technology context, the need arises for the existence of the integration of biophilia in the final project presented. Biophilic architecture according to Kester Nunes seeks to connect spaces with nature, promoting well-being and comfort for its occupants. According to KELLERT & CALABRESE (2018), pioneers in the field, biophilic architecture seeks much more than integrating nature into architectural plants. It seeks to create a good living and working environment for people, from spaces that help promote well-being and mental and physical health.

5.1.2 Intelligent Building (Commercial Automation)

Intelligent buildings, also known as Smart Buildings, are buildings that use technology for their best functioning.

According to Muratori (2011) Automation is the set of services provided by integrated technological systems as the best way to meet the basic needs of security, communication, energy management and comfort of a building. Thus, the smart building proposed in the project seeks to integrate technology in the space of workstations and leisure of the building, thus providing greater practicality and agility in the *Coworking* environment.

According to Liu et al. (2017), commercial automation in smart buildings aims to integrate technologies to improve people's quality of life and reduce operating costs. This requires the use of sensors, actuators and electronic devices connected in a network, which allows automated management of systems.

According to Wang et al. (2019), commercial automation also allows for greater flexibility in the use of building spaces, adapting to users' needs in real time. For example, meeting rooms can be easily reconfigured to different sizes and configurations, ensuring greater utilization of available space.

The idea is to integrate commercial architecture with general automation, and small fragments of domotics, which according to Aiello and Dustdar (2008), Domotics is the term that incorporates the management of all housing resources of a residence (AIELLO; DUSTDAR, 2008), making simultaneous use of electricity, electronics, mechanics, telecommunications and information technologies, offering a variety of integrated applications in the areas of security, communication and energy management, providing for residents and users, comfort, safety, leisure and communication. (ROQUE, 2008). For Barbosa and Silva (2010, p. 33, 34), all these elements must be controlled by a single central control unit, making it possible for people living in this place to interact easily and efficiently with the equipment and appliances installed in their residence. That said, the need arises to choose two control systems, being the arduino system, and the PLC (Programmable Logic Controller).

Smart office is an intelligent work environment that uses advanced technologies to optimize productivity, improve energy efficiency and provide a more comfortable and personalized experience for employees " - Simon Dudley, CEO of Logitech. The idea of smart building comes from this concept, but not only thinking about the office sectors, but all environments, and all possible aspects of the building.

According to Muratori (2011), Smart Buildings are buildings that use integrated technology solutions such as sensors, systems and interfaces that interact through the Internet of Things (IoT) and/or Artificial Intelligence (AI). The case study addresses exactly this principle, where a smart building.

In addition, commercial automation contributes to the environmental sustainability of smart buildings by enabling the monitoring of energy and water consumption and the control of lighting and HVAC systems more efficiently. According to Al-Ma 'aitah et al. (2021), commercial automation can reduce energy consumption by up to 30% in commercial buildings.

5.2 EQUIPMENT FOR BUILDING CONTROL AND AUTOMATION

5.2.1 Router

For general connection of the building, the *Mesh* router system is presented, a device that extends the range of Wi-Fi and distributes the signal power in the environments easily and quickly. This technology connects devices to the internet without losing quality. To put it simply, the *Mesh* router creates an intelligent network because it connects the device to the best Wi-Fi signal point automatically.

5.2.2 Sensors

Are devices used to detect and monitor different variables, such as temperature, humidity, presence, among others. They allow automation systems to make decisions in real time, adapting to the needs of users and environmental conditions.

5.2.3 Actuators

Are devices responsible for transforming an electrical signal into a mechanical movement, allowing the control of different equipment and systems. For example, an actuator can be used to open and close a door or window, or to regulate the intensity of light in an environment.

5.2.4 User interfaces

These are devices used to allow users to interact with automation systems, making necessary settings and adjustments. Touch screen displays, keyboards, buttons, among others, can be used.

5.2.5 Communication systems

These are devices used to enable communication between different devices and automation systems, allowing information to be transmitted and processed in real time. Different communication protocols can be used, such as BACnet, Modbus, LonWorks, among others.

5.3 ROTOCOLS FOR BUILDING CONNECTION, CONTROL AND AUTOMATION

5.3.1 IoT:

The Internet of Things is a concept that is outside the scope of technologies, as it does not derive from them, but uses them to fulfill a series of functionalities. The technologies associated with the "concept" are many, and just to name a few, we have those that refer to the physical connection of objects, or basic infrastructure, such as wired connections and wireless connections (FACCIONI FILHO, 2016b). IOT is what defines all the logistics of the project presented, with a concept of management and functionality that makes automation happen efficiently.

5.3.2 ZigBee

For Xinrong Li, the *ZigBee* protocol is a low power, low data rate and short range wireless network technology designed to support simple wireless communication and low data rate applications. This system would be the one adopted if the building worked a wireless automation system, thus decreasing the amount of duct shafts passed, but in return increasing the chances of worse instability and problems in communication between equipment and controllers.

5.3.3 Cable

According to NEOCONTROL (2018), in wired solutions, a control center, or integrator, is required. This central works as the data interpreter and user interface, in which all devices are connected via cable, whether they are actuators or sensors. The central is responsible for executing any user command, as well as reading information from all connected sensors and performing pre-programmed tasks. This technology is usually cheaper than the wireless home automation system, in addition to being more reliable and more robust. Because this technology requires modifications to the electrical network infrastructure, it becomes more viable for homes that are under construction or renovation.

In Brazil, the standard NBR 16264 (ABNT, 2014) stipulates a model for residential structured cabling. This is the first Brazilian standard for residential structured cabling. With this, the home automation market now has a national reference for projects and installations. Before this regulation, national companies used foreign standards, such as those developed by the American Institute of Standards and Standards (ROCKENBACH, 2005).

5.3.4 LoRaWAN

According to the IEEE publisher (2017), LoRaWAN (Low Power WAN Protocol for Internet of Things), has a data link layer with long range, low power consumption and low bit rate, has emerged as a promising solution for IoT in which end devices use LoRa to communicate with gateways through a single hop. LoRaWAN is utilized in an extended range of IoT applications such as smart infrastructure monitoring and management, precision agriculture, smart cities, asset tracking, waste management, alarm systems and many other use cases where efficient and long-range wireless communication is required .

6 AUTOMATION + ARCHITECTURE IN THE COMMERCIAL ENVIRONMENT

Technology is very present in our time, we can see those smart homes (domotics) and also in the world industrialization. In the commercial sphere, automation in the operation of a commercial building is still little present, so it can be much more explored to prioritize aspects of safety, comfort and especially economy in a commercial building. In Brazil, there is a great waste of energy, where many people do not use it responsibly, which contributes to a perspective of future energy crisis.

This integration of Architecture with automation goes far beyond practicality and comfort, becoming nowadays a necessity to follow the technology and the functioning of the labor market that is increasingly competitive and effective. Thus, the need arises to reinvent and reconcile automation technologies in buildings intended for entrepreneurship, commercial services, and in this more specific case, buildings intended for *Coworking* services. According to the Brazilian Association of Residential and Building Automation (AURESIDE), the building and residential automation market in Brazil grew by about 20% in 2020, compared to the previous year, even during the pandemic. In addition, the expectation is that this market will continue to grow by an average of 20% per year in the coming years, driven mainly by the search for greater energy efficiency and comfort in environments. Also according to AURESIDE, the building automation segment represents about 70% of the total automation market in the country

The idea of the case study is basically to present design of a smart commercial building with advanced automation technologies to manage its systems and services, with the aim of increasing efficiency, reducing operating costs and providing a safer and more comfortable environment for its users. The operation of an automated smart building involves a series of interconnected components such as sensors, control devices, communication networks and management software.

One of the key components of a smart building is the building management system (BMS), which is responsible for controlling and monitoring the building's electrical, air conditioning, lighting, security and other systems. The BMS collects data from sensors installed in the building and uses algorithms to make automatic decisions based on this data in order to optimize the use of the building's resources.

Integrated systems that can be found in smart buildings include:

- Security systems, which use cameras, motion sensors and alarms to monitor and protect the building and its occupants.
- Access systems, which control access to areas of the building using access cards, fingerprint readers or facial recognition.
- Energy management systems, which monitor and control the use of electricity and other renewable energy sources in order to reduce the building's consumption and carbon emissions.
- Refuse systems, which use sensors to monitor the amount of waste generated by the building and can automate the process of collecting and sorting recyclable materials.

Overall, an automated smart building uses advanced technologies to collect and analyze building data, and uses this data to make automated decisions that optimize the use of building resources, ensure the safety of users, and provide a more comfortable and efficient environment.

7 CHOICE OF MANUFACTURER

At the first moment of the project, a platform would be developed where the user would communicate with the devices via app, this communication would occur as follows; The app connected to the establishment's network would send the data via wifi network to esp, this data would be sent via MQTT protocol, so esp would be in charge of sending the signals to tasmota which in turn would operate the devices present in the building.

However, during the project it was noticed that most of the devices on the market today are not open source, and in order to configure such devices, we would need to have them in hand, which is not possible today, and thus limiting the development of the automation project.

However, when researching suppliers of building and industrial automation line, the Intelbras Izy line was located where it presents the best cost benefit, without giving up reliability.

The Izy line features the following branches of automation:

- **Energy**: Control environments remotely via the Izy Smart app or via voice command, turning lighting on and off at home or work, and activate appliances or program their operation.
- **Lighting:** The Intelbras smart lighting line allows you to turn lights on and off in a practical and intelligent way: remotely, via the Izy Smart app, or by voice command.
- **Entertainment**: Control environments and devices via the Izy Smart app or voice commands. TV with optimized navigation and more
- **Security**: The Intelbras Izy line has a wide range of security cameras, presence sensors, door opening sensor, smart locks with digital opening and / or RFID card, temperature and humidity sensor, electronic gate operator, gas detector, smoke detector, carbon monoxide sensor, among others.

The aforementioned automation line will meet all the demands present in the coworking building, thus also having a guarantee of the entire installation due to the manufacturer being national and having all the necessary support in case of future unforeseen events.

8 AUTOMATION PRESENT IN THE PROJECT

The building will have to be intelligent and qualified to the technological needs imposed on it. Automation will be applied in several areas of the building, such as:

8 .1 LIGHTING SYSTEM

Automation allows centralized control of turning lights on and off, as well as adjusting the intensity of the light according to the external luminosity or the use of the environment.

8 .1.1 Internal Lighting

For the lighting control of the entire internal plant, the Led Spot Smart Wi-Fi Lamp EWS 440 will be used, controlling lights in environments from anywhere through the Izy Smart app for smartphones or with voice assistants. With 38° of light beam opening, the LED spot lamp guarantees a warm white tone effect (for a more relaxing environment) or cold white (for a work environment that requires focus), and up to 16 million different colors.

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Figure 1: EWS 440 lamp

Source: Intelbras, Google (2023)

8.1.2 Dimmer Switch

The smart dimmer switch EWS 1101 allows you to control the light intensity of the room via touch keys, smartphone or voice assistant. The touch dimmer switch, designed for use with dimmable lamps and easy to install in 4×2 boxes, allows you to adjust the intensity of the lighting to create a more pleasant environment and avoid excess light, saving electricity. The Izy Smart app allows you to create schedules to turn on the light automatically, as well as trigger actions from sensors and other devices in the Izy range.

Figure 2: EWS 1101 switch

Source: Intelbras, Google (2023)

8.1.3 Intelligent Switch

With the EWS 1003 smart switch it is possible to control the lighting of the environment from anywhere via application, voice commands and through the touch buttons of the switch, which have indicator lights facilitating its use. The programming of schedules and routines are

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possible with this device, as well as, the interconnection with other devices of the Izy line thus making the environment automated.

Figure 3: EWS 1003 switch

Source: Intelbras, Google (2023)

8.2.4 External Lighting (Parking Lot)

The lighting in the parking lot will be controlled by a Khomp IoT LoRa photocell. These devices, which are mounted above the luminaires, use programmatic dimming, i.e. automatically decreasing or increasing the light intensity according to the time of day, to reduce energy consumption. The Khomp IoT photocell models continue to surprise, performing various measurements via LoRa communication, including voltage, current and electrical power factor. In addition, there are models that provide incident reports such as power outages and load overcurrents. Others have a high level of intelligence and include integrated GPS (which makes it easier to locate a vehicle for maintenance) or an accelerometer/gyroscope (which monitors the angle of the sun in case of an accident).

Figure 4: LoRa IoT photocell

Source: Amazon, Google (2023)

9 ACCESS CONTROL

9.1 DOORS MEETING ROOMS

For the access control of the meeting rooms (01 to 05), access controllers of the SA202 model will be installed from 390ntelbras, this type of controller has the control of up to 1000 users where they only entered the enclosure if they obtain in hand the RFID card already previously registered at the gatehouse. For the cleaning of the enclosures the SA202 also has opening from password, which the respective employees will have access.

Figure 5: Access control SA202

Source: Intelbras, Google (2023)

9.2 EXCLUSIVE ACCESS DOORS

For places where access will be limited such as CPD, management, administration, among others; The Intelbras Ifr 7000 Smart lock will be installed, this lock has access by biometrics, RFID card and password and can be limited only to biometrics. With it you can generate commands to open curtains, turn on or off lights, view camera images, turn equipment on and off, among others. It allows up to 100 biometrics, 100 tags, 9 passwords and access through the IZY app. It comes with 2 physical keys.

Figure 6: Intelbras Ifr 7000 lock

Source: Intelbras, Google (2023).

9.3 ELEVATORS

The access control to the floors of the building will be performed by the BIODigi G4 device, where only previously authorized people will have access to each respective floor. With registration capacity for 5000 users, this device has TCP/IP connection and record of up to 200,000 events. It also has access by biometrics, RFID card and password.

Figure 7: BIODigi G4

Source: MTGTech, Google (2023)

10 SECURITY

10.1 SMOKE DETECTOR

The building's fire system has another component of the Intelbras automation line, the IDF 620 is a smoke detector that signals the presence of smoke with an audible alarm and in the Izy application already installed on the smartphone in addition to having an output for more complex fire fighting systems. The IDF 620 battery is included and has an autonomy of up to 5 years. In addition, when it is close to the end, a notification will be sent.

Figure 8: IDF 620

Source: Intelbras, Google (2023).

10.2 GAS DETECTOR

With the same operating principle as the IDF 620 mentioned above, the gas detector (IDG 620), acts when it detects the presence of LPG gas in the environment.

Figure 9: IDG 620

Source: Intelbras, Google (2023).

10.3 MONOXIDE DETECTOR

The smart carbon monoxide detector identifies carbon monoxide leakage situations and emits an audible alarm along with a notification in the Izy app installed on the smartphone, In addition to accompanying a battery with autonomy of up to 3 years, the IDM 620 indicates when the battery is close to the end.

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Figure 10: IDM 620

Source: Intelbras, Google (2023).

10.4 APERTURE SENSOR

The opening sensor present in the building will be the Smart ISA 1001 this Intelbras sensor has a connectivity with the hub of up to 100m outdoors, and it will be in charge of sending a notification to the device if there is any door, window or drawer opening where it was installed, and thus having greater security and control of the establishment.

Figure 11: ISA 1001

Source: Intelbras, Google (2023).

10.5 PRESENCE SENSOR

In order to detect people traveling through corridors and enclosures, and also to save electricity, the building will have presence sensors previously installed in strategic locations. The ISM 1001 motion sensor is completely wireless and features ZigBee technology, ensuring a longer battery life and operating speed. With it, it is also possible to create automation scenarios, such as opening the curtain of the room, when detecting presence in the place.

Figure 12: ISM 1001

Source: Intelbras, Google (2023).

11 CLIMATIZATION

11.1 TEMPERATURE SENSOR

To control the temperature and humidity of the building's environments, Intelbras Izy line temperature sensors (IST 1001) will be installed, which will automate the cooling system of the enclosures, programming by the application, the user will put the condition as if it is desired for the air conditioning to turn on as: time, temperature, if there is someone in the enclosure, and when the air conditioning will be turned on.

Figure 13: IST 1001

Source: Intelbras, Google (2023)

12 CONTROLLERS

12.1 CURTAIN ACTUATOR

With the smart curtain actuator of the Izy line from Intelbras it is possible to activate the opening and closing of the curtains from wherever you are, program the opening and closing of the curtain for the time you want, adjust the opening and closing time. With the IAC 110 it is also possible to activate the device through a voice command.

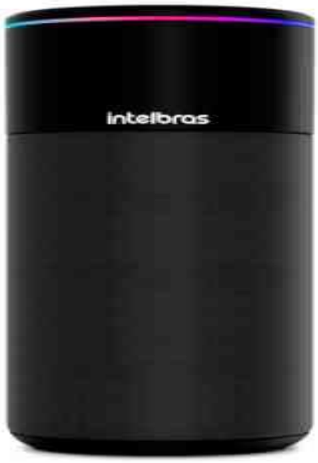
Figure 14: IAC 110

Source: Intelbras, Google (2023)

12.2 SMART SPEAKER

As much of the control of the meeting and administrative rooms will be automated, the building will also have voice assistants to raise and lower air conditioning temperatures, control lighting and devices present in all rooms.

Figure 15: ISS 102 A



Source: Intelbras, Google (2023)

13 CONNECTION AND CONNECTIVITY

13.1 HUB

For the connection of the automation devices it is necessary to install a central HUB where the devices will be connected. For this, the HUB already required by the chosen devices was dimensioned, which is the ICA 1001 from Intelbras, where it is possible to connect up to 32 devices per HUB within a radius of 100 meters, and thus allocating all to a single platform. This HUB is compatible with voice assistant and has ZigBee technology, this device will be in the CPD room where it will connect with the devices.

Figure 15: ICA 1001

Source: Intelbras, Google (2023)

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13.2 ROUTER

For the connectivity of employees, customers and devices, it is necessary to install routers that communicate with each other and support all the demand present in the building.

For this, Intelbras Wifi 6 Mesh, IH 3000, was dimensioned. The 802.11ax Wi-Fi standard is the latest technology in wireless connection, capable of traveling much more content and more speed. With dual band capability it is possible to generate up to 3 Gbps* of traffic (INTELBRAS, 2023). With embedded technology, the Wi-Fi 6 signal will have a connection with more performance and a more intelligent signal direction. Each IH 3000 router expands up to 300 m² and up to 128 connected devices on each.

Figure 16: IH 3000

Source: Intelbras, Google (2023)

14 APP

The app will be in charge of unifying and centralizing all automation devices on a single platform. The app that will be used is Izy Smart, with this app it is possible to control the devices from wherever you are, so from manager to user everyone will have access to the devices, therefore having the access that fits each one.

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Figure 17: Smartphone with the Izy App installed

Source: Intelbras, Google (2023)

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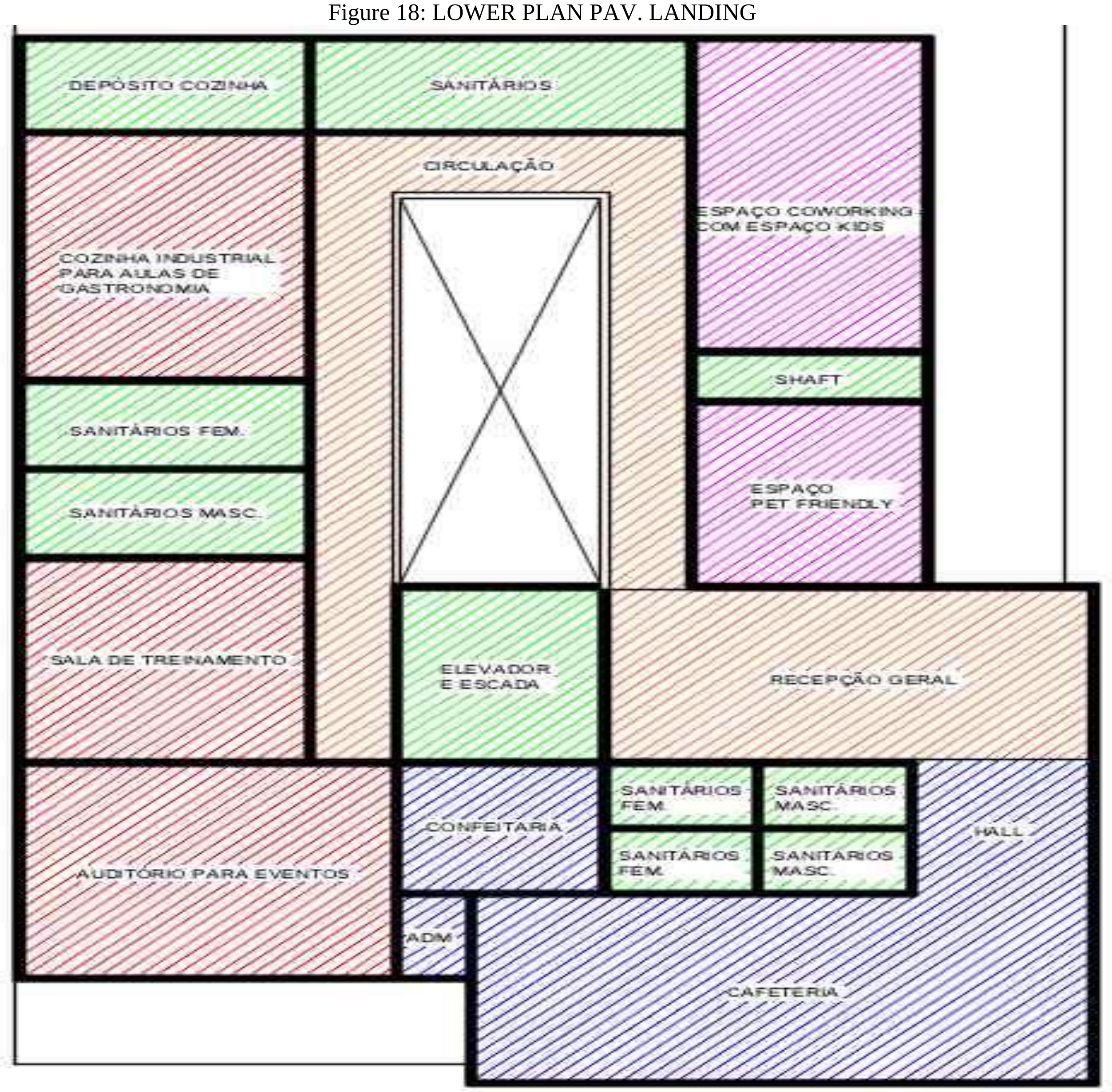
15 PLAN

Figure 18: LOWER PLAN PAV. LANDING



Source: The author

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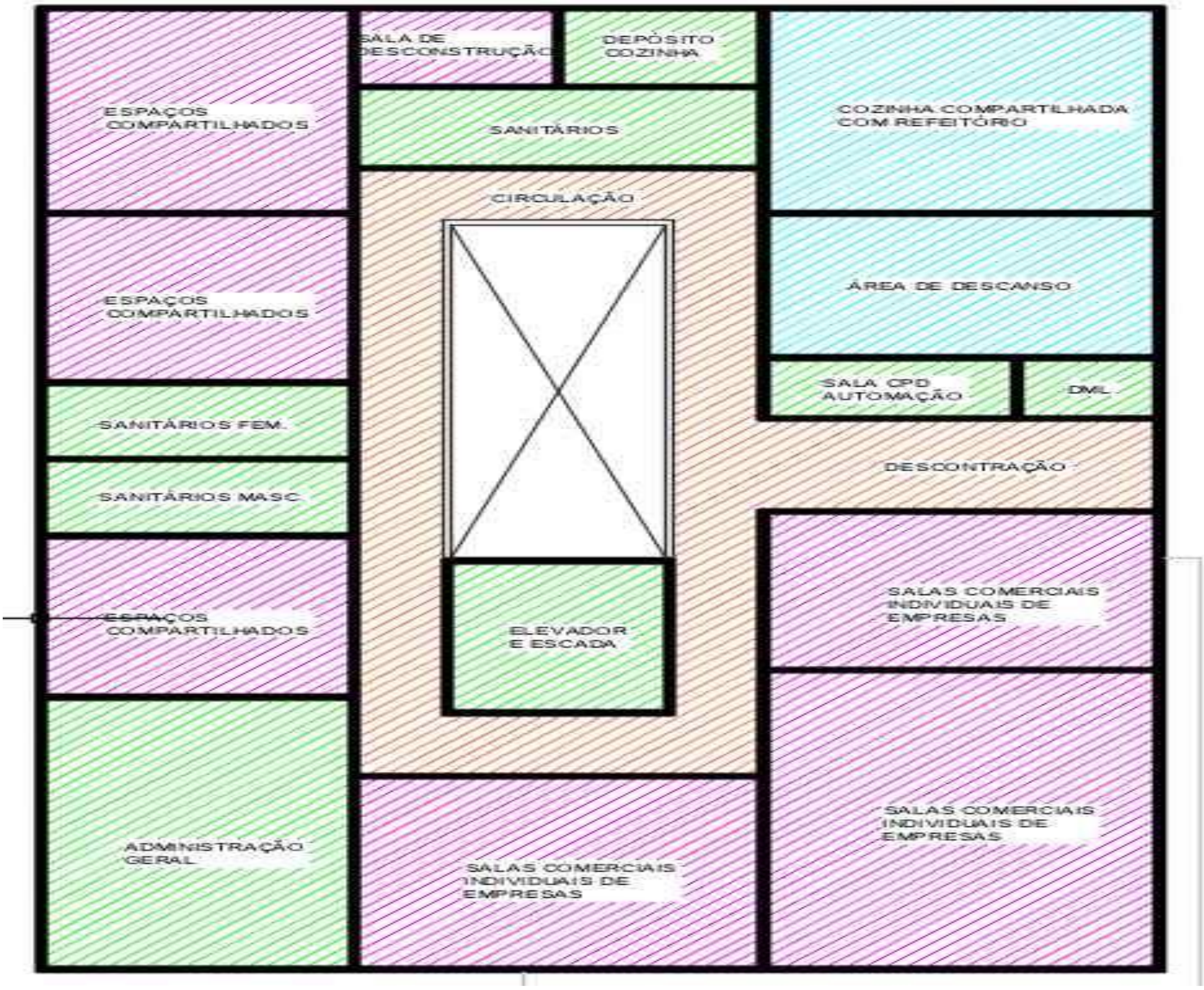
Figure 19: LOWER PLAN 1st PAV.



Source: The author

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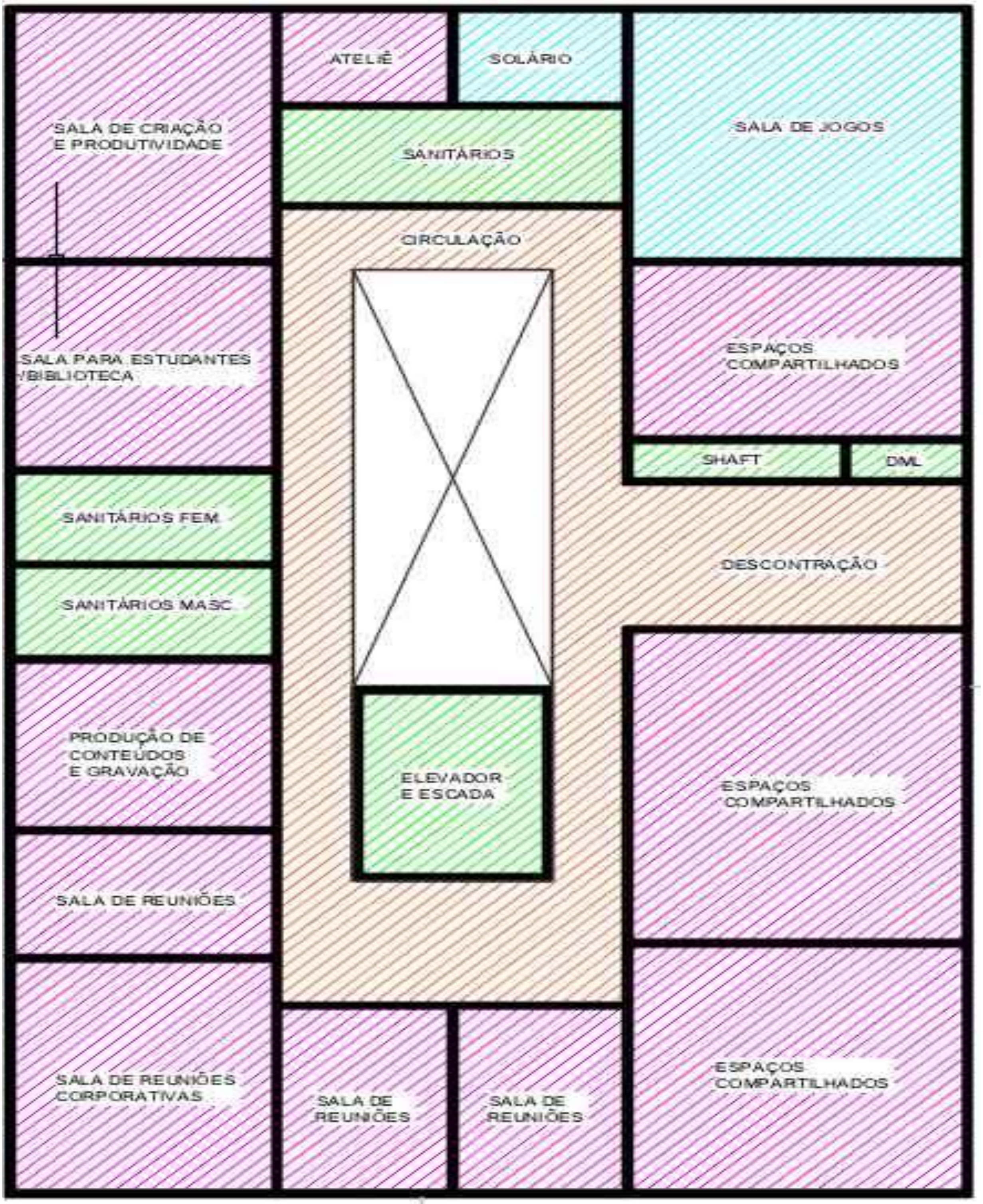
Figure 20: LOWER PLAN 2nd PAV



Source: The author

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