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Does the shared vision of social identities influence the quality of civil construction by reinforcing the type of thermal insulation, and by creating or improving thermal comfort?

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Abstract. The building sector in Algeria is one of the most energy intensive sectors due to the lack of culture of thermal insulation among the occupants and the lack of awareness in the use of this technique to obtain better thermal comfort in the long term and reduce energy bills. This article aims to study the influence of the shared vision of social identities on the quality of existing civil constructions by reinforcing the type of thermal insulation to achieve better thermal comfort for individuals regardless of the conditions climatic. To do this, the study was based on the knowledge of the specificity of the region studied (climatic and energetic characteristics), and on the other hand to present real examples in the region of Bechar which affects a variety of types of existing constructions.

Keywords. Desert regions, Residential building, Consumption, Thermal comfort, Awareness, Insulation

1. Introduction

Comfort in its general concept is the physical well-being resulting from the comfort of what we have like heat, cold, light, noise, landscape, water, green spaces... others, and can also be seen as a balance between man and the environment in which he finds himself at a given moment. On the contrary, discomfort is a situation of imbalance between man and his environment that leads to stress and suffering [1]. In the dwelling, comfort has several types: respiratory comfort, visual comfort, acoustic comfort and thermal comfort [2].

Thermal comfort is a stable state of thermal equilibrium, integrating the different physical, physiological and psychological mechanisms between man and his environment. The notion of thermal comfort varies between individuals according to age, gender and geographical location. However, it can be defined as a feeling of well-being satisfied with the thermal environment [3, 4, 5 and 6]. The feeling of thermal comfort is based on several criteria and parameters, including physical norms related to the environment such as (air temperature, air

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speed and relative humidity of the air). Individual personal parameters, which are multiple, have two main parameters (physical activity and clothing). Parameters related to internal thermal gains, gains generated in space from internal sources other than the heating system (lighting, electrical appliances and computers...) [3, 7 and 8].

Various other factors mentioned by the authors [9, 10 and 11] are specific to the dwelling and affect its thermal comfort such as (orientation, natural ventilation, size of openings, shape and compactness, colour, protection from the sun and prevailing winds and thermal insulation).

The thermal insulation factor is one of the most influential factors, and it is very necessary for good thermal comfort for the occupants, because it gives a good feeling of comfort during the winter and summer periods [12, 13 and 14], because the building actually loses some of its heat permanently, as large thermal leaks occur on surfaces (ceiling, walls and glass), as these hot spots in the build can generate up to 60% of heat loss, and the joints between the walls are heat leaks and are called thermal bridges. Can contribute 5-25% to heat leakage [15].

Currently, the realization of thermal comfort by a low energy consumption in buildings, has become a very fundamental and central subject in various disciplines including (civil engineering, architecture and mechanical engineering...). Especially residential constructions, because it is the place of shelter for individuals and protection from the climatic elements of the sun, extreme temperatures, wind and rain. Since the facade of the buildings serves as a protective membrane and separation between the inside and the outside, thus representing an architectural element of great importance in several aspects such as the aesthetic and symbolic aspect as well as many functional aspects such as thermal and acoustic insulation, so the researchers [16, 17, 18 and 19] consider the facade as an integrated and homogeneous system between functional and aesthetic.

In fact, in recent years, Algeria has experienced multiple and intensive social building projects of various formats, which consume a lot of energy and which, unfortunately, are not subject to any regulatory requirements in terms of thermal comfort of individuals, as on the one hand, engineering and design standards in Algeria are only subject to practical requirements in the field such as construction, the energy dimension in projects is not taken into account, which leads to uncomfortable and energy-intensive buildings (excess energy).

On the other hand, in the private residential sector, we also find the mentality of people and the ignorance of the thermal insulation culture, they attach importance to the aesthetic aspect of the buildings' facade to the detriment of their thermal comfort and the high energy costs they consume. For example, the cost of insulating an ordinary building on the outside walls or ceiling with polystyrene panels does not cost the owner much compared to the cost of the energy consumed annually that he pays in three or five years and other costs such as restoration, adding another floor to the building, etc..., Especially in desert zones with a harsh environment (hot and arid climate), these zones, especially during the summer period, require continuous air-conditioning throughout the day in order to provide adequate thermal comfort to the occupants, which results in high bills.

2. **Methodology**

We shall present in this work, a social awareness in order to change people’s thinking on the use of effective techniques in construction to improve thermal comfort in the residential sector, such as thermal insulation of the external vertical walls and roof using materials adapted to the region of our study. To do this, we first presented a general description of the current construction context and the materials available in the city of Bechar. Thereafter a general analysis on the different techniques induced in the construction of the envelope (external walls

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and roofs) in order to select the best technique that adapts to the climate of Bechar (hot and arid) and reinforcing it to improve the thermal comfort of the residential habitats with the least energy consumption.

The city of Bechar is located 1150 km south-west of the capital Algiers, 852 km north-east of Tindouf and about 80 km east of the Moroccan border (Figure 1). It is surrounded by mountain ranges to the north by Djebel Antar (1953m), to the east by Djebel Bechar (1206m) and to the north-west by Djebel Grouz (1835m). The municipality of Bechar covers an area of 5050 km² [20].

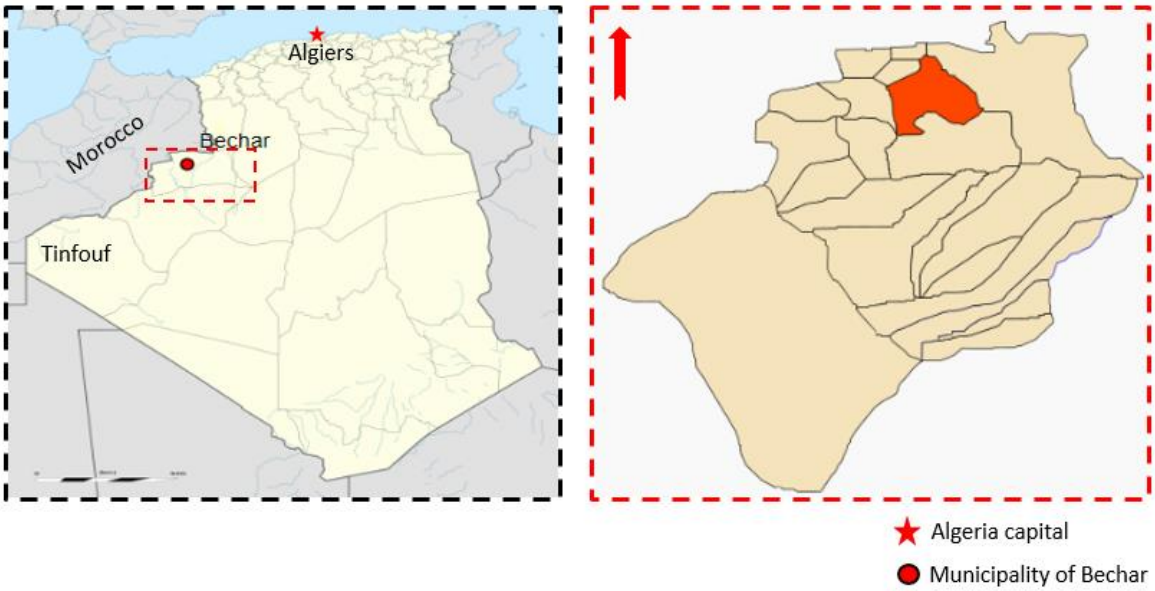

Figure 1. Geographic location of the Bechar region

The Bechar region, despite the presence of several resources capable of meeting the need for building materials, remains dependent on those coming from other regions: [6]

- **The breeze block:** is available, manufactured locally, it is used especially in individual construction;
- **The red brick:** has thermal and sound insulation, and a waterproofing and fire resistance, is used in different types of construction;
- **Earthen construction:** or the earthen brick 'adobe', is completely abandoned in the study area;
- **SIPOREX (autoclaved cellular concrete):** it has good thermal insulation for floors and exterior walls.

Currently, the **Cement** material is manufactured locally by the cement plant of Bechar (GICA group, Saoura Bechar company, Algeria), as it is the number one ingredient in construction in the region, used for the manufacture of reinforced concrete and breeze blocks.

3. Climate and energy context

3.1. Bechar climate

The climatic and meteorological analysis of the city of Bechar indicates two important periods: overheating (a long, hot and dry summer) and a moderate winter at moments. The

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overheated period is more important because it presents a large part of the year when living conditions are uncomfortable requiring high energy consumption.

The city of Bechar is characterized by a continental desert climate [6]. Two types of zones can be distinguished (Figure 2):

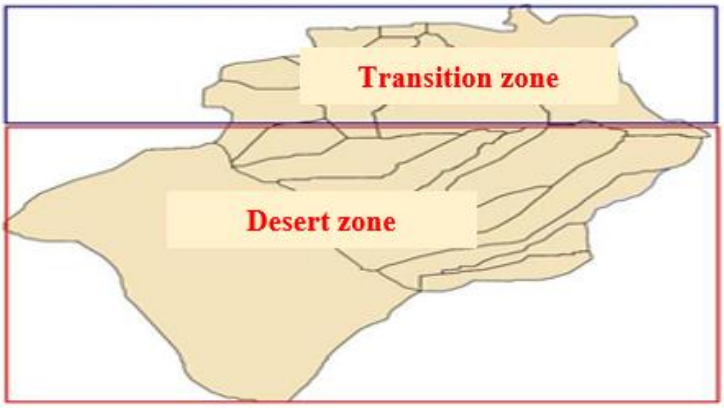

Figure 2. Climatic zones of the Bechar region

- **The transition zone:** bounded by Beni Ounif to the north and the Igli parallel to the south, very hot in summer (+ 45°C) and very cold in winter (2°C to 3°C).

Precipitation is around 60 mm/year. The sandy winds are frequent and often violent (100 km/h).

- **The desert zone:** extends beyond Beni Abbes. Precipitation is in the order of 40 mm/year. Sand winds are very frequent.

Recall that the climatic data include: precipitation, Max and Min temperatures of the Bechar zone [21], are illustrated in Figure 3:

Climatic data for Bechar, Algeria, 31.62° North 2.22° West, 747m at sea level.

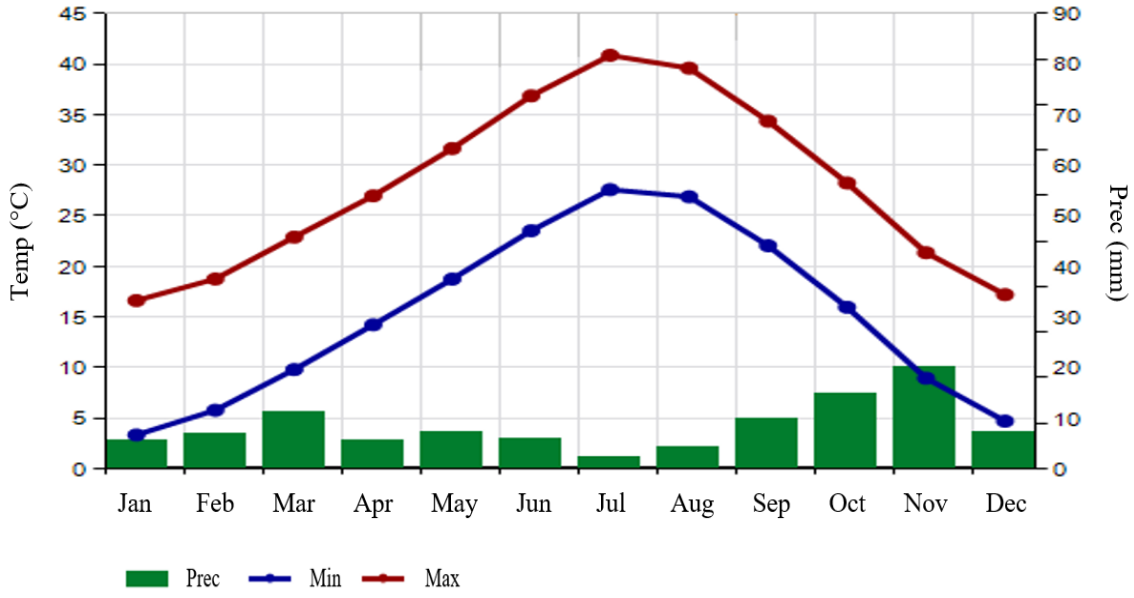

Figure 3. Climatic data in Bechar. Series (1991-2020)

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In Bechar, the **average temperature** of the coldest month (January) is 10.0°C, that of the hottest month (July) is 34.2°C. **Precipitation** totals 100 millimeters per year: it is therefore at desert level. In the least rainy month (July) they amount to 2 mm, in the wettest month (November) they amount to 20 mm.

3.2. Energetic context of the city of Bechar

According to the data collected from the national company "SONELGAZ" in the city of Bechar [22], concerning the quarterly consumption of electricity and natural gas per GWh for the years 2019, 2020 and 2021 in all construction sectors in the city of Bechar, we can note the following:

- Electricity consumption in Bechar is increasing, especially in the third quarter for the years 2019, 2020 and 2021. The graphs (Figure 4-a) show the evolution of consumption from 201,325 GWh in 2019 to about 225,856 GWh in 2021. This is due to the excessive use of air conditioners in summer.
- Gas consumption is also increasing, but in the first quarter of the years 2019, 2020 and 2021 due to the operation of heating appliances in winter. The graphs (Figure 4-b) show the evolution of consumption from 141,030 GWh in 2019 to approximately 145,212 GWh in 2021.

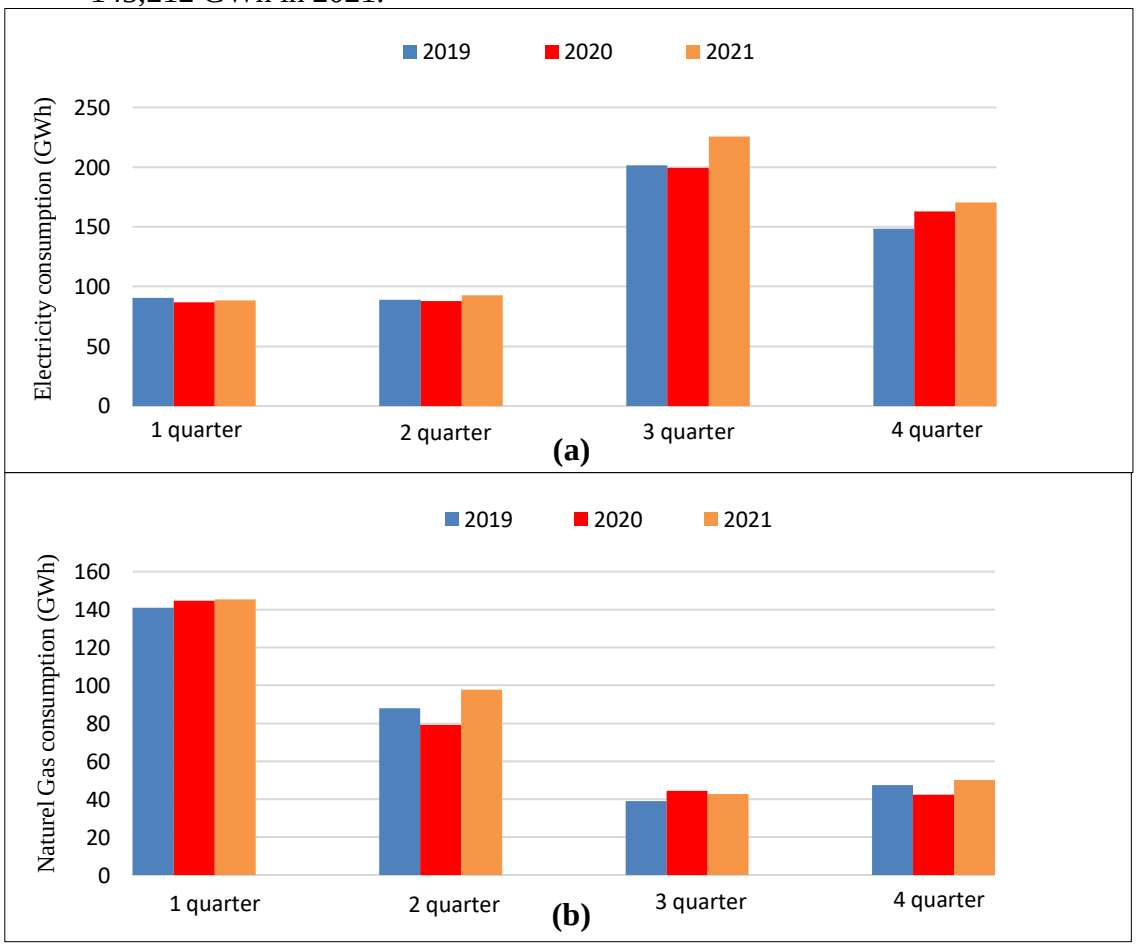

Figure 4. Quarterly energy consumption in GWh in all construction sectors in the city of Bechar during the years 2019, 2020 and 2021
(a): Electricity consumption; **(b):** Natural gas consumption

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4. **Dominant compositions for exterior walls and terrace roofs in the region**

Subsequently, we presented a real description of the composition of the local building envelope, including the exterior walls and roofs. Recall that the most frequent cases in the region for exterior walls are (Cases 1, 2, 3 and 4). While cases 5 and 6 exist but are few compared to the previous cases.

The most commonly used cases for roof construction are Case 1 and 2. While cases 3 and 4 exist, they are rare compared to the first and second cases.

The different techniques are summarized in the table. 1 to select the best cases for exterior walls and roofing from its U and R thermal coefficients.

Table 1. Real description of the envelope components of existing buildings in the Bechar region

Envelope	Cases	Description of the different cases (from inside to outside)	Total thickness (cm)	U- value (W/m².k)	R (m².k/W)
External walls	Cas 1	Plaster coating (2cm), breeze block (15cm), cement coating (2cm)	19	2,647	0,378
	Cas 2	Plaster coating (2cm), breeze block (20cm), cement coating (2cm)	24	2,363	0,423
	Cas 3	Plaster coating (2cm), red brick (15cm), cement coating (2cm)	19	1,805	0,554
	Cas 4	Plaster coating (2cm), red brick (20 cm), cement coating (2cm)	24	1,520	0,658
	Cas 5	Plaster coating (2cm), red brick (30 cm), cement coating (2cm)	34	1,154	0,867
	Cas 6	Plaster coating (2cm), red brick (10 cm), air space (5 cm), red brick (15 cm), cement coating (2cm)	34	0,362	2,762
Roofs	Cas 1	Plaster coating (2cm), heavy concrete (20cm), sand and gravel (5cm), cement mortar (2cm), tiling (2cm)	31	2,458	0,407
	Cas 2	Plaster coating (2cm), slab block (16cm), heavy concrete (4cm), sand and gravel (5cm), cement mortar (2cm), tiling (2cm)	31	2,170	0,461
	Cas 3	Plaster coating (2cm), terracotta slabs (20cm), heavy concrete (4cm), sand and gravel (5cm), cement mortar (2cm), tiling (2cm)	35	2,043	0,489
	Cas 4	Plaster coating (2cm), expanded polystyrene slabs (20cm), heavy concrete (5cm), sand and gravel (5cm), cement mortar (2cm), tiling (2cm)	36	0,179	5,587

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From this table we can see that:

- The construction techniques of the buildings present have no thermal comfort, especially with regard to their performance in terms of transmission and thermal resistance;
- The best procedure for the construction of vertical walls is obtained by case 6 with a thermal transmission coefficient U = 0,362 (W/m². k) and a resistance R = 2,762 (m². k/w);
- The optimum technique for roof construction is obtained by case 4 with a thermal transmission coefficient U = 0,179 (W/m². k) and a resistance R = 5,587 (m². k/w).

At the end of this analysis, for the different techniques, we can encourage the use of other techniques and methods for the thermal insulation of buildings, in order to pass the phase from energy-intensive buildings to energy-saving buildings that are comfortable for the occupants.

5. **Analysis of the current situation of the building construction modality**

Viewed at the uncomfortable thermal situation of individuals and the high energy consumption experienced by the Algerian building sector, particularly residential, we have had to analyse in depth the construction of buildings, as well as the influence of people and their thoughts in the design of their dwellings in the desert, especially in the city of Bechar, as they are primarily responsible for the thermal performance of their buildings. Through this analysis, we can summarize the most important criteria that influence and it has a relationship with the shared vision of social members on the type of thermal insulation and thermal comfort.

5.1. Community members culture on thermal performance of buildings

Currently, people still lack awareness and culture about the thermal performance of buildings and are totally indifferent to the construction of low-energy dwellings that would provide adequate thermal comfort for individuals regardless of the climatic conditions to which the building is exposed. They provide temporary thermal comfort in their residences, especially during the winter and summer periods, through the intensive use of heating and cooling devices of different capacities and sizes (sometimes for long hours during the day). It should be noted that this has a negative impact on energy consumption, e.g. the Bechar region suffers from several power cuts due to saturation of energy consumption resulting from the simultaneous operation of several conditioners, usually during the afternoon period when temperatures rise in summer. So that in most cases we find a single building of medium volume and ground floor only containing more than one heating and air-conditioning unit, i.e. each zone of the building such as the living room, kitchen, bedroom and lobby requires heating and air-conditioning, which confirms the total lack of thermal comfort in the building, and therefore high energy bills paid by the occupants.

Another majority of people also make alterations and restorations to their properties at high cost such as changing the colour or shape of the paint, changing the floor tiles and replacing them with new ones, adding another floor, enlarging the rooms and making them modern with a luxurious feel, decorating the ceiling with ultra-modern decorations (Figure 5 and 6) and even replacing the old bathroom design with new ones.

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Figure 5. Example of internal decorations (Authors, 2023)

Figure 6. Example of ceiling decorations (Authors, 2023)

5.2. Perception and culture of community members in building construction

On the other side, we find the mentality and conjectures of people in building their buildings. They prefer to shelter and the aesthetic aspect of their lodgment to the detriment of the functional aspect, which is to provide a good thermal comfort to individuals. The biggest proof of this is that most people invest large amounts of money to decorate their facades such as decorations, modern paintings (Figure 7), doors and windows with luxury character etc.

Figure 7. Example of modern paintings (Authors, 2023)

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Although they do not attach importance to improving their thermal comfort by using the simplest thermal insulation techniques to save energy such as double construction of external walls with air space, using high performance double glazed windows for good thermal insulation. While using medium-cost thermal insulation such as the expanded polystyrene panel insulation technique on the external walls of the building facade does not cost much, especially if the building has one or two facades at most, in return for the high energy bills paid by the occupants annually or even for other works such as the restoration and decoration of the facade walls.

On the another hand, the materials that go into the composition of the roof of the building are ordinary materials with concrete base that do not meet a good role in thermal insulation, especially as ceilings are mainly responsible for the greatest energy loss in buildings of 30%, which ultimately results in low thermal comfort for individuals.

5.3. Current building construction system

The construction sector in Algeria, in particular the residential sector, is characterised by a unified construction system in order to achieve rapidity with ease of implementation, as we note that concrete and reinforced concrete are the backbone of all construction elements such as facade walls, roof floors, staircases, etc… This type of construction system is the same in all the regions of Algeria in its different hot and dry, cold and humid regions, because the main defect of these systems is the low thermal resistance and the lack of thermal comfort inside the dwelling, which confirms in a general and official way that insulation in Algeria, in particular thermal insulation, is a neglected and almost non-existent field. In addition, the majority of dwellings are characterised by the indiscriminate and untested use of façade construction materials. For example, the same materials are used in the North as in the South and in the East as in the West, whether in a cold or hot climate, ignoring the facade that is most vulnerable to climatic factors such as sun, rain and wind, which necessarily require building materials with a high and appropriate thermal efficiency.

5.4. Other criteria

The desert areas of Algeria are characterised by larger areas than other regions (highlands and hills). This has allowed the state to give and divide land with large areas over some of the inhabitants of these areas, which has led some of them to consider converting their dwellings into dual use (residential and commercial) at the same time. Some proprietors dedicate the ground floor to commercial activities with high heights (4 m to 5 m) such as shops, warehouses for storing goods and other commercial activities..., while he resides on the first floor. However, sometimes this conception simply becomes ink on paper and these shops actually close for many reasons, the most important of which is the movement of commercial activity in the district. It should be noted on this point that the proprietors plan to take advantage of their residence and invest it in other activities, particularly commercial ones, and that they do not plan to improve their thermal comfort by designing efficient buildings with low energy consumption.

Another point to note is that in recent years some categories of social members have ignored the provision of thermal comfort by improving and modifying their buildings using high efficiency thermal insulation techniques and materials on the pretext of high cost, while in return they tend and prefer to use modern heating and air-conditioning devices such as central heating (Figure 8), and large capacity air-conditioners with a very high cost (cost of purchasing

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the devices, cost of labour to install and cost of energy bills) to provide them with temporary thermal comfort.

Figure 8. Illustration of materials and accessories for central heating of a residential building located in the city of Bechar (Authors, 2023)

Figure 9 shows two types of central floor heating, where figure (9-a) shows medium performance heating, while figure (9-b) shows high performance heating due to the quality of the materials used.

Figure 9. Description of existing central floor heating for the bathroom (Authors, 2023)
(a): Medium performance heating; **(b):** High performance heating

6. Conclusion

At the end of this study, we were able to answer the initial question concerning the influence of the shared vision of social identities on the quality of civil construction by reinforcing the type of thermal insulation, and creating or improving thermal comfort.

From the detailed analysis, we can draw the following conclusions:

- The majority of people have a unified view of how buildings are constructed and this is particularly evident in the residential sector through the facade walls, low floor, roof and stairs to achieve ease of execution ignore other factors of great importance including the thermal performance of the building;
- In the case of the city of Bechar, the social identities attach more importance to the aesthetic and luxury aspect of their buildings, such as façade decoration and modern coatings, while neglecting the important aspect of improving their thermal comfort by using technical solutions such as thermal insulation;

- Thermal comfort for community members is achieved by installing the latest heating and conditioning equipment such as central heating and high capacity air conditioners.

In the perspective, in order to encourage and improve the study, there are still other parameters to be taken into consideration:

- Analyse other types of building sectors such as administrative offices, industrial buildings, education and training institutions;
- Real study of a dwelling in order to derive other factors affecting their thermal performance;
- Conduct research and other studies in this axis with the aim of educating and rationalising social members in energy consumption by including thermal insulation techniques in their buildings.

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