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The works must be unpublished and refer to issues of international architecture, technological innovation in architecture, industrial design, business design techniques, multimedia design, advertising design, web system design, residential architecture and other topics related to Engineering Sciences and Technology.

Presentation of the Content

In Issue 12, in the fist article we present, *Alternative material with PET: Comparison of CEB-PET, CEB and Concrete block*, by MOLAR-OROZCO, María Eugenia, with adscription at Universidad Autónoma de Coahuila Unidad Saltillo, in the next article we present, *Design and construction of dancing fountains controlled by pic16f877a* by MONTES-OSEGUERA, Jesus Rogelio, GÚZMAN-VILLALVAZO, Daniel Ulises, GARCÍA-BARAJAS, Jazmín Guadalupe and VILLALVAZO-LAUREANO, Efrain, with adscription at Universidad de Colima, in the next article we present, *Lattice design made with recycled polymeric concrete for the facade of a single-family house* by CRUZ-MARTÍNEZ, Dalia, FRANCO-MARTÍNEZ, David* and SÁNCHEZ-SOLÍS, Antonio, with adscription at Universidad Nacional Autónoma de México, Centro Tecnológico, Facultad de Estudios Superiores Aragón, UNAM and Instituto de Matemáticas, UNAM, in the last article we present, *Transcending boundaries in Architecture: A Transdisciplinary inquiry into public space* by MERY-RUIZ, Miriam Elizabeth and with adscription at Universidad Autonoma de Coahuila.

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Alternative material with PET: Comparison of CEB-PET, CEB and Concrete block

Material alternativo con PET: Comparativa del BTC-PET, BTC y Bloque de concreto

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Abstract

Climate change has generated the need to propose alternatives that reduce the impact of human activities and the real estate market is one of these, an area of opportunity is the production of construction materials that demand energy and use of non-renewable resources. , taking into account one of the indicators of the 2030 Agenda for Sustainable Development, objective 11, of the 11c that says: Provide support to the least developed countries, so that they can build sustainable and resilient buildings using local materials. The objective was to compare the CEB-PET prototype with respect to the CEB and the concrete block, as an alternative for the construction of walls in Saltillo Coahuila. The methodology was quantitative, quasi-experimental, carrying out laboratory and field work. The results indicate that the CEB-PET has a Compressive Strength of 82,194 kg/cm^2 and can be used as a load-bearing wall; Regarding cost, it can compete with a concrete block and in relation to its application in the work, it is handled in the same way as a concrete block.

Alternative, Sustainable, Prototype

Resumen

El cambio climático ha generado la necesidad de proponer alternativas que reduzca el impacto de las actividades del ser humano y el mercado inmobiliario es uno de estos, un área de oportunidad es la producción de los materiales de construcción que demanda energía y uso de recursos no renovables, tomando en cuenta uno de los indicadores de la Agenda 2030 para el Desarrollo Sostenible, el objetivo 11, de la 11c que dice: Proporcionar apoyo a los países menos adelantados, para que puedan construir edificios sostenibles y resilientes utilizando materiales locales. El objetivo fue comparar el prototipo del BTC-PET respecto al BTC y al bloque de concreto, como alternativa para la construcción de muros en Saltillo Coahuila. La metodología fue de enfoque cuantitativo, cuasiexperimental, realizando trabajo de laboratorio y de campo. Los resultados indican que el BTC-PET cuenta con una Resistencia a la Comprensión de 82.194 kg/cm^2 pudiendo ser empleado de muro de carga; respecto al coste puede competir con un bloque de concreto y en relación con su aplicación en la obra se manipula igual que un bloque de concreto.

Alternativa, Sostenible, Prototipo

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Introduction

Climate change has generated the need to propose alternatives that reduce the impact of human activities, the real estate market is one of these, the production of construction materials demands energy and use of non-renewable resources. In addition to this, the generation of urban waste in cities increases, including Polyethylene terephthalate (PET), that not only is it found in the streets, islands of this waste have also been formed by its excessive consumption. The proposal of the 3 Rs (recycle, reuse and reduce) is the key to reducing the footprint of the human being on the planet along with the construction of land.

According to Vázquez, Guzmán and Iñiguez (2015), they point out that the compressive strength of CEB exceeds traditional adobes by around 500% and in terms of moisture resistance the same thing happens and the reason is because being pressed reduces the number of pores, therefore, absorption is lower. In addition to this, the use of the hydraulic press helps to reduce the production time of the parts. This is achieved by having a machine with a mechanical mixer and a press with a multiple mold (3 simultaneous blocks) can produce 70 to 100 CEB per hour with the participation of 4 workers.

Other works by Roux and Velázquez (2015) corroborate the resistance of CEB with respect to the blocks and bricks used in homes, indicate that 100% of CEB made with CinvaRam are above the resistance of concrete blocks and 90% above the resistance of regional brick.

In Mexico there is the NMX-C-508-ONNCCE-2015 CONSTRUCTION INDUSTRY COMPRESSED EARTH BLOCKS STABILIZED WITH LIME-SPECIFICATIONS AND TEST METHODS, which allow their use in construction as load bearing walls or dividers may or may not be apparent and in the ceilings in vaults.

Seisdedos and López (2008) of Hábitat Tierra-CEETyDeS point out:

The enormous impact of the construction sector on the environment makes it necessary to develop construction techniques with minimal environmental impact, capable of offering a more natural and healthy environment for people. The use of compressed earth blocks (CEB) in building is one of the most suitable current construction systems in ecological terms due to the minimum environmental impact of its Global Life Cycle (pp. 289).

Gutiérrez, Medina and Arteaga Medina (2011) comment that:

Materials that use earth will endure in construction, because of their economy, because they are resistant – with a study of the material and structure, and with a coherent design – and because earth is an abundant, recyclable and productive material. In terms of strength, this element is not far from competing with other types of materials, because due to its perforations it can be reinforced and stabilized; Reinforcement can be with a rod, drafted by a mixture of fluid cement (pp. 67).

It is for this reason that, masonry with CEB is an economical construction technique that presents better resistance and durability properties than those built with adobe, it also has a great potential for industrialization of its units (Herrera Villa, 2018).

Roux and Velázquez (2016) indicate that:

In thermal delay tests they found that BTC improve the feeling of thermal comfort inside homes, considerably better than concrete block and fired brick, since it has a thermal delay of up to 5 h against half an hour than these. It is found that, throughout the day, the BTC will present a lower temperature on the outside of the wall, as well as inside the house when exposed to a heat source than the other materials tested (pp. 11 and 12).

Pastormerlo and Souza (2013) (cited by Roux and Velázquez, 2016, pp.12) point out that with CEB walls a house will be cooler in summer and hotter in winter, due to the thermal mass of this material that is 1740 kJ / m3, against 1360 kJ / m³ of brick and 550 kJ / m³ of the concrete block, in addition to consuming less energy resources by having a thermal delay higher than conventional materials (concrete blocks and annealed bricks).

Where the use of these low embodied energy materials (Bradley et al, 2018) compared to clay bricks, reduce the amount of energy required in construction and transportation, being an abundant and recyclable natural resource (Hegyi et al, 2016; Mansour et al, 2017).

Ramos Rivera and López Zerón (2019):

When performing comparative test they found that bricks formed by soil only or compressed earth block (CEB) provided considerably higher compressive strength (double) than traditional clay bricks. On the subject of absorption, CEB bricks with soil and cement can be qualified as moderate weathering. According to this parameter, this type of bricks can be used for masonry walls that are exposed to the weather in a moderate way (pp. 92 and 93).

Bestraten Castells and Hormias Laperal (2012).

They carried out tests to compare the resistance of adobe vs CEB, finding that the resistances of CEB are significantly improved by the introduction of cement in the composition and compression of the raw material, being able to multiply by 3.8 the capacity of adobe (pp.10).

With this in mind, Auza and Chambi (2012) warn of the advantages of using a certain percentage of PET with a certain type of clay soil, from a sustainable, economic aspect in the design of the pavement.

So much so that Andrade and Morocho (2023) recommend that to have a better use of PET in a reinforced mortar, the percentage should be low to improve its resistance.

Consequently, López and Pascual (2023) suggest considering the size of the particles for a better obtaining in the physical-mechanical properties, they must pass through sieve No. 4 to be more manageable, than if larger particles are used.

Similarly, the application of fire retardants in construction materials used in closed spaces should be considered (FibraPlus, 2017) as it increases the ignition resistance of plastic. Some plastics, especially those that could generate fire, contain flame retardants, in proportions of 5 to 30% (Teuten, et al, 2009).

Above all, to avoid human losses due to fires in construction, work has begun with materials with additives so that when exposed to the heat source the chances of its propagation decrease, one of these are halogenated compounds that have been effective for years in several types of polymers including PET (Buezas, 2010). Flame retardants act in three ways, for example, they form a crystalline barrier on the surface of the material, displacing oxygen in combustion reactions or form water molecules that stop the process, this inhibits combustion, prevents the formation of flames and fumes (Buezas, 2010; Wäger, Schluep, Müller and Gloor, 2011).

Consequently, an area of opportunity is generated in the production of new construction materials that demand energy and use of non-renewable resources, taking into account one of the indicators of the 2030 Agenda for Sustainable Development, goal 11, of the 11c that says: Provide support to the least developed countries, so that they can build sustainable and resilient buildings using local materials, it aims to make a comparison of a Block of Compressed Earth with PET (CEB-PET) with the Concrete Block and a CEB, starting with the hypothesis that including particular PET to the prototype will obtain a better resistance of the material, without emitting toxic gases, at a low cost to be used in construction in the city of Saltillo, Coahuila.

Methodology to be developed

The approach was quantitative, quasi-experimental and conducting laboratory and field work. For the stress tests, the criterion (NMX – C – 404 – ONNCCE – 2005) was taken to identify its type.

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An estimate of the mathematical cost was made to obtain the value of CEB-PET in the market taking into account the equipment, hours of work and material used.

In order to determine its feasibility in the construction process, a specialized workforce was hired to build a module of 1.4m x 2.22m x 2.36m, taking into account the execution time, the handling process and the opinion of the master builder.

Finally, tests in a chemistry laboratory were considered to determine if the PET when heated could release any toxic:

– Infrared test, the sample of the soil-PET material was placed in four crucibles, then introduced to a muffle and the temperature was raised to 100, 200, 300 and 400°C, in order that the material lost all moisture and organic material. When the muffle reached 100°C, one of the four crucibles was removed and carried to infrared (IR) analysis, the background was first performed, to eliminate the possible effects of air on the sample. The test was performed from 600 to 4000 cm-1, then at 200°C the second crucible was removed and the test was performed in the same way, then at 300°C and finally at 400°C.

– Thermogravimetric analysis, this test was performed on a PerkinElmer analysis equipment, with a temperature of 30 to 800°C and a nitrogen gas flow of 20 mL/min

– Direct fire test to the PET dust samples with the goal of injecting the smoke for analysis, consists of applying a flame from a Bunsen burner for 10 seconds to one end of the specimen held vertically in a vertical position with tweezers and removed until the fire is extinguished and repeated again (in total there are 3 samples) and a classification is made depending on several aspects such as the self-extinguishing of the flame, the dripping of the inflamed material or its reaction.

Results

Resistance to compression tests were carried out for structural use in buildings, with previously produced prototypes. The ITAL MEXICANA S.A machine was used for the test with the CEB-PET, figure 1.

Figure 1 Endurance to comprehension test, 2022, brand
Own Elaboration

Resulting in a Compression Resistance of 82,194 kg / cm^2, being greater than required. For infrared (IR) testing, dry samples were taken at 100, 200, 300 and 400°C of the material, Figure 2.

Figure 2 Image of the samples, 2022
Own Elaboration

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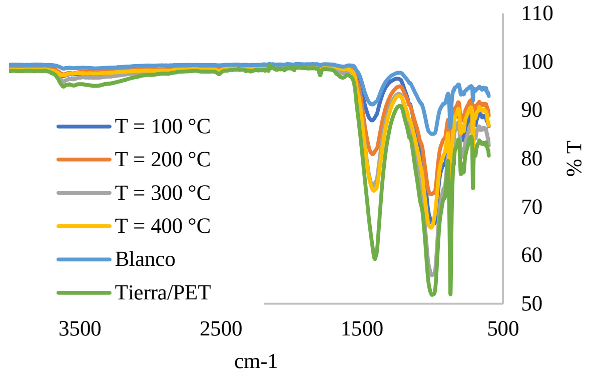

Figure 1 PET soil IR test, 2022
Own Elaboration

In graph 1, the characteristic peaks of PET are observed at the wavelengths of: 1600, 1100, 1000 and 750 cm-1, where the peaks of 1000 and 750 cm-1 are spliced with the peaks of white (soil without PET), and it is observed that the soil without PET does not present the peak of 1600 cm-1 of PET. Another characteristic that can be identified in the graph is that, as the temperature of permanence of the sample in the muffle increases, the peaks become less intense, that is, the characteristic groups of the compound are being lost. The peak of 1000 cm-1 that presents the soil corresponds to the inorganic groups of oxides, it can be silicon, selenium, chlorine hypochlorite etc; However, in order to determine it, an elemental analysis of the compound is needed.

In relation to thermogravimetric analysis (TGA)

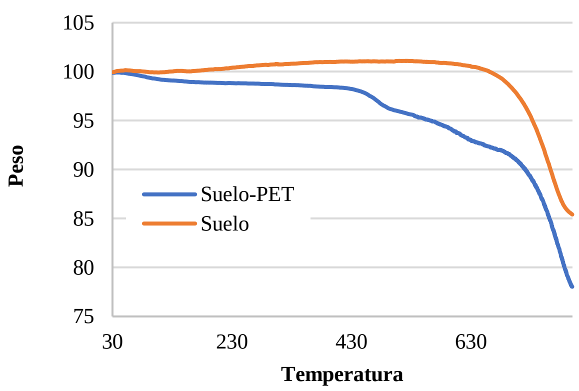

Figure 2 Thermogravimetric test result, 2022
Own Elaboration

In graph 2, the weight losses in the CEB, composed with PET are observed, since the soil contains inorganic compounds that are lost at very high temperatures, the losses presented in the graph are given by the PET.

The first weight loss is 1.69%, at 448°C; the second weight loss occurs at 596°C with a loss of 2.3% of weight.

From the test performed on the PET sample over direct fire, it is turned on and off immediately without releasing smoke to inject.

Test results:

- TGA shows material loss, possibly organic matter and PET.
- The IR shows that there is no chemical change in the material when exposed to high temperatures.
- It is determined that the PET used has some retardant.

For the calculation of the cost of a CEB-PET, the following data were taken and processed, table 1.

CEB cost (unit)		
Material	Cantidad	Cost ($)
Soil	18.2 Kg.	2.22
Cal	0.6 Kg.	1.1
Cement	0.6 Kg.	2.32
Pet	0.6 Kg.	1.2
Water	2 LITRES	0.56
Labor	3 PEOPLE	0.01
Electricity	Cost of 1 peso per hour	0.001
Machinery	$42,500 (20 years) / 1,657,500 ceb	0.02
Local (installation)	100 pesos per day (rent)	0.01
		7.441
	30% PROFIT	2.23
		9.671

Table 1 Cost, 2022
Own Elaboration

In the construction process for CEB

The execution time for the construction of a module of 3.11 m 2 by 2.36 m high was 3 days, of normal days, its handling by labor was documented, figure 3 to 6, when questioning if there was any difference in its use indicated that it is equal to a normal concrete block and the weight is similar, Figure 7.

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Figure 3 and 4 CEB-PET mobility by skilled labor, 2023
Own Elaboration

Figure 5 and 6 Placement of CEB-PET by skilled labor, 2023
Own Elaboration

Figure 7 CEB-PET module developed by skilled labor, 2023
Own Elaboration

For the comparison, the data of the other materials were collected and the data of each one were observed, Table 2.

Material	Dimension	Resistance to comprehension (NMX-ONNCCE-2005)	Cost per piece
CEB-PET	20 x 40 x 12	82.194 kgf/cm^2 (obtained in the laboratory 2022)	$ 9.68
CEB	20 x 40 x 12	71.43 kgf/cm^2 (obtained in the laboratory 2015 y 2020)	$14.00
Concrete block	14.5 x 39.5 x 19	31.66 kgf/cm^2 (Morales 2008)	$ 11.10 o 13. 77 It depends if it is wholesale

Table 2. CEB-PET, CEB and concrete block
Own Elaboration, 2022.

Gratitude

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Conclusions

It was tested with the objective of the hypothesis. According to the results it can be indicated that there is viability for its use in construction, since it does not generate any problem in its handling by labor, in addition it can be assured with the tests that the PET included in the prototype does not allow the spread of fire in the constructions or gives off smoke or toxic gas that damages the health of the inhabitant, as highlighted by Teuten, Buezas, Wäger among other authors.

It coincides with the characteristics of PET and soil, along with the percentage indicated by Auza, Chambi, López, Pascuales, Andrade and Morocho. The resistance obtained from CEB-PET is optimal, as indicated by López, Pascuales, Andrade, Morocho, Rivera, Zerón, Vázquez, Guzmán, Iñiguez, Roux, Velázquez, Bestraten and Hormias for its use as a load-bearing wall and its cost highlighted by Gutiérrez, Medina, Arteaga Medina and Herrera Villa, therefore, it can compete with the concrete block, in addition, there are tests carried out that demonstrate its good thermal behavior and the reduction of the impact of PET as urban waste that will be published in other publications.

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Design and construction of dancing fountains controlled by pic16f877a

Diseño y construcción de fuentes danzarinas controladas por pic16f877a

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Abstract

This article shows the design and construction of some dancing fountains controlled by a pic16f877a. It also shows the code programmed inside this microcontroller, which was made using a PIC-C-Compiler for C language. The simulation and preliminary tests were performed in ISIS PROTEUS; the program converts the frequency signal to voltage. After the conversion, voltage ranges were assigned to activate each pump of the fountains' jets. The height that can be reached depends on how high the frequency is; then, the audio signal was coupled to an amplifier to improve the power of the audio signal to hear the music clearly, at par with the spectacle of the fountains working. In addition, the electronic designs of each board used are shown in detail. Finally, a vumeter was designed and installed to improve the visualization of the jets with illumination with LED lights changing to the rhythm of the music and the power of the output sound.

Resumen

En el presente artículo se muestra el diseño y construcción de unas fuentes danzarinas controladas mediante un pic16f877a. También se muestra el código programado dentro de este microcontrolador, el código se realizó empleando un compilador PIC-C-Compiler para lenguaje C. La simulación y pruebas preliminares se realizaron en ISIS PROTEUS; el programa convierte la señal de frecuencia a voltaje, posteriormente, cuenta con una serie de rangos los cuales cuentan con un voltaje definido por el código para activar cada una de las bombas de las fuentes, el orden en que encienden las bombas depende de la frecuencia a la cual este la música, posteriormente cuenta con un acoplo donde la señal de audio entra hacia un amplificador para mejorar la potencias de la señal de audio para escuchar la música en forma clara, a la par con el espectáculo de las fuentes funcionando. Además: se muestran a detalle los diseños electrónicos de cada una de las tarjetas empleadas. Finalmente, se diseñó e instaló un vúmetro con el propósito de mejorar la visualización de los chorros con iluminación con luces LED cambiantes al ritmo de la música y la potencia del sonido de salida.

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State of the Art

Water sources have been built and developed throughout history. The first fountains provided access to water provided by nature, to meet the basic needs of man and domestic animals.

Water fountains have been used for thousands of years for climate control, beautification, entertainment and as a means of relaxation. Among the most popular fountains are those that incorporate elements of surprise and/or special effects. These fountains elegantly combine engineering and artistic features. They are now a major tourist attraction because of the variety of lights, designs, heights and colours of the water jets.

Dancing fountains are an extraordinary tourist attraction when using a variety of frequencies that operate through various electronic devices. Today they are used to decorate parks and squares; to honour people or events that create an aesthetic design. Some musical water fountain projects consist of Arduino UNO, sound sensor with external MIC, submersible motors, LCD, relay modules, mobile sound generation, ARGB LED strip lights and adapters [1].

Musical waterscape control technology is an important part of the whole system, in the back accurately through music information retrieval technology to extract musical characteristics, and musical waterscape according to these musical characteristics to make the rhythm of the action change [2].

The system can design the performance programme of the musical source reflecting the musical connotation according to the characteristics of different songs. Through the comprehensive use of computer animation, automatic control, and other technologies, it greatly improves the efficiency of the development of the music source performance programme [3]. The artificial music fountain usually has two compositions of the system, one is the control program system, the main control of the style and flow of water, the other is the music control system, mainly through computer programming code, and according to the different music, programming, so as to achieve the synchronous form of music and water combined to send a different style of artistic effect [4].

In all kinds of modern fountains, the musical fountain can integrate human's sense of sight and hearing in real time, and plan the perfect environmental artistic effect in the urban landscape. On this basis, the theory of musical feature recognition was proposed, and the fountain shapes and the main points of the arrangement and layout were analysed in different environments [5].

In this paper, the design and implementation of a musical sound driven water fountain is addressed. The scenario is to decompose the adopted sound signal into four frequency bands, where each band occupies a narrow frequency range and represents the output signal of its IIR (Infinite Impulse Response) filter and allow each band to drive a submersible pump. The filter is Arduino-based, controlling the analogue voltage to control the magnitude and frequency of the voltage supplied to the pumps in order to determine the height of the water and the luminous intensity of the coloured light bulbs. [6].

1. Control block

A microcontroller was used, which is basically an integrated circuit that is used as a small computer or brain. It has a RAM memory where orders are stored to be able to carry out actions or processes in an electronic circuit. It has analogue or digital inputs.

Microcontrollers can have either of two types of memory, either the Von Neumann architecture which says that the data bus and memory are in the same place, therefore, it makes them slower. On the other hand, there is the Harvard architecture which is divided in two, data and instructions. The microcontroller used has a Harvard architecture.

In this part is where the analogue to digital conversion is done by means of the code loaded in the microcontroller, the ranges are determined - with which the pumps will switch on if the voltage reaches them. There are 6 pumps in which two are defined for each range, number 1 and number 4 are the low ones because they have a range from 2.55 Volts to 2.60 Volts; while pumps 2 and 5 are the medium ones with a range from 2.61 Volts to 2.7 Volts; finally there are 3 and 6, whose range are the high ones that have by definition 2.71 Volts to 4.0 Volts.

2. Programation

For this particular project "CCS C Compiler" was needed because it was the tool that was available, here all the programming is done and then the file is saved and passed to "Master Prog", the language used to make the code is C language because the program required it.

Step-by-step explanation of the code:

C programming code (libraries and declarations)
#include <16f877a.h>
#device ADC = 10
#fuses HS,NOWDT,NOPROTECT,NOPUT,NOLVP,BROWNOUT
#use delay(clock=4M)
#use standard_io(D)
#define led_1 PIN_D3
#define led_2 PIN_D4
#define led_3 PIN_D5
long valor_adc;
float voltaje (1)

Table 1

In this part of the code you can see the libraries and commands required to program a microcontroller such as NOWDT which means that there is no watchdog (as it is usually called). This is in charge of the blocking inside an application in case you want to open it to be used in another pic or application, it only allows it to be used in the microcontroller. In addition to this, the ADC converter is also observed. In this same part is the declaration of the microcontroller model that is being used which is the 16f877a and the ports needed to operate the pumps, in this case, were called as LEDs because, for practical purposes, LEDs were used to see if it worked properly. Finally, two variable declarations can be seen, the voltage it receives and the ADC value of the one it has. (1)

C code (main)

```
void main()
{
  //lcd_init();
  setup_adc_ports(ALL_ANALOG);
  setup_adc(adc_clock_internal);
  //a0 bajos
  while(true)
  {
    set_adc_channel(0);
    delay_us(2);
    valor_adc = read_adc();
    voltaje = (valor_adc*5.0) /1023.0 (2)
```

Table 2

It is observed what is a while cycle which is divided into three sections. We can see the procedure of an operation that includes 3 values, the first is the value received from the upset, the second is 5 because it is the maximum value to which the voltage can reach in the microcontroller, all this is divided by 1023 which would be the equivalence to 8 bits (2).

C code (if-cycle, high frequency section)

```
//high
if((voltage >= 2.71)&&(voltage <= 4.0))
   {
     output_high(led_1);
     delay_ms (2000);
   }
  else
   {
     output_low(led_1);
   } (3)
```

Table 3

In this part there is a conditional "if" which in this first part covers the section where the frequencies or high voltages are, which have a range from 2.71 to 4.0 volts, but this case will only occur with songs with very high notes (3).

C code (if-cycle, average frequency section)

```
//means
  if((voltage >= 2.61)&&(voltage <= 2.70))
   {
     output_high(led_2);
     delay_ms(500);
   }
  else
   {
     output_low(led_2);
   } (4)
```

Table 4

In this part we continue with the if cycle but in this case the conditional is that the voltage is between 2.61 and 2.70 volts which is reached in a more frequent way because it is an average voltage and most songs can have it. (4)

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C code (if-cycle, average frequency section)

```
//low
     if((voltage >=2.55 )&&(voltage <= 2.60))
      {
        output_high(led_3);
        delay_ms(500);
      }
      else
      {
        output_low(led_3);
      }

   }

} (5)
```

Table 5

In the final part of the code you can find the part of the bass, which are defined by a range between 2.55 to 2.60 volts, this because any song generates enough voltage to enter that range. This range starts from 2.55 volts because if it is lower the sources would always be on because it always enters a minimum voltage of 2.50 volts (5).

3. Electronic design

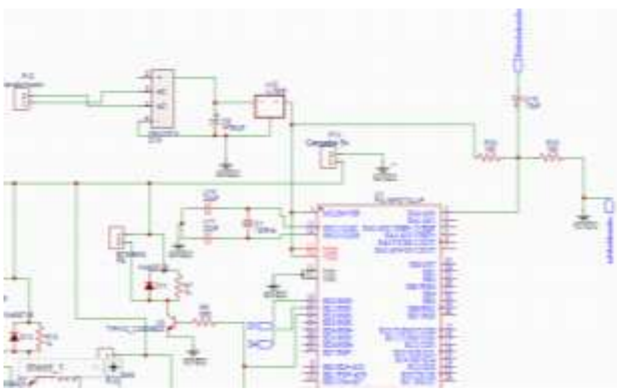

Figure 1 Circuit diagram (control part)

The circuit is divided into four parts.

In figure 2 is a 5v source, in this source can be seen a diode bridge which is responsible for changing the alternating current entering the transformer to direct current, followed by the diode bridge is a capacitor which functions as a filter that eliminates noise and finally reaches a voltage regulator to control the output voltage of the source.

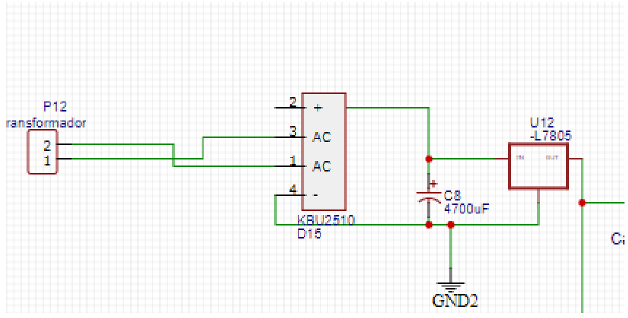

Figure 2 Power supply to feed the microcontroller

Figure 3 shows an upset, which is used to raise the voltage coming from the audio input because the microcontroller must receive a voltage of 0-5v, otherwise it may burn out.

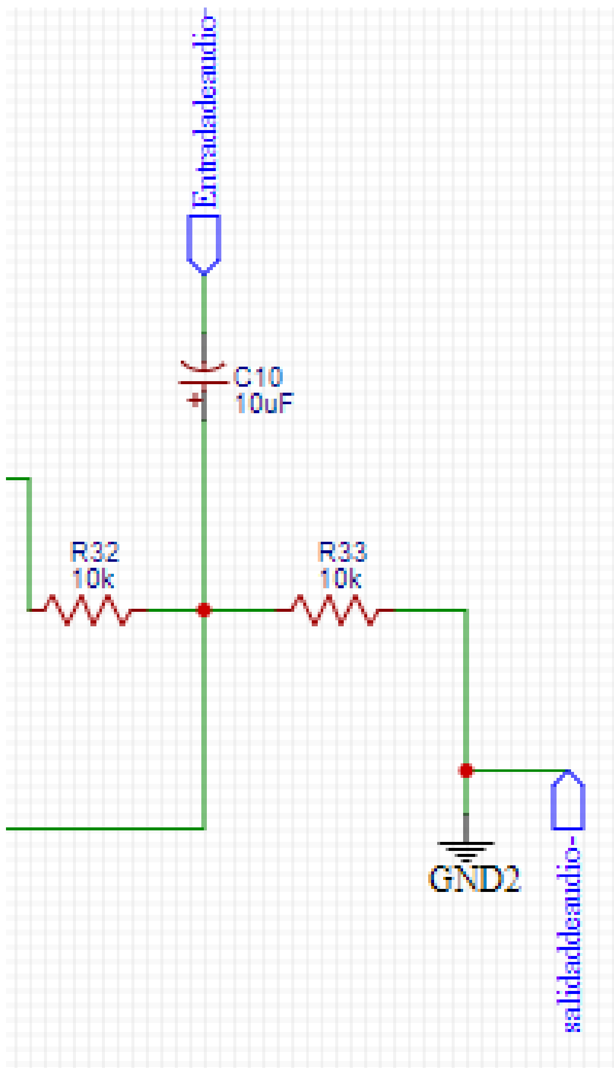

Figure 3 Diagram of the upset

Finally there is the PIC with its crystal and two capacitors (black box) that work as a filter in the case of the capacitors and the crystal is that it helps the microcontroller to oscillate, inside the microcontroller is already loaded the code that controls the operation of the sources (Figure 4).

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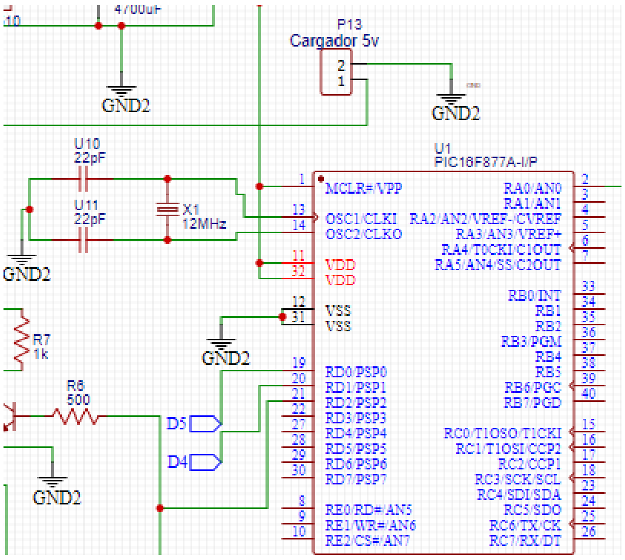

Figure 4 PIC16F877A microcontroller diagram

Figure 2 shows an arrangement consisting of a diode (1N4007) reverse biased to prevent the flow of current from the terminal block where the sources are connected to the PIC, there is also a resistor that goes one part to the terminal block and the other part is connected to a transistor (TIP441) that is used to give more power to the pumps, because if they demand all the power to the PIC can be damaged or heat up.

4. Power block

In this block is the arrangement of a transistor (TIP 41) which helps the pumps do not demand all the current to the microcontroller, in addition to the transistor, an inverted diode was added, which helps when the pump stops the current does not return to the PIC, finally has a resistor to protect the pump from a higher voltage than it is designed.

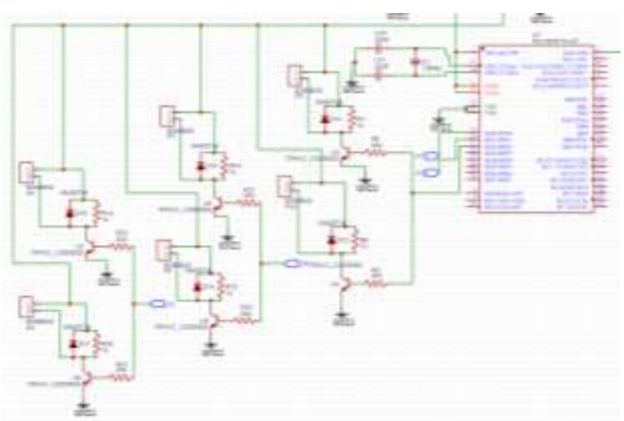

Figure 5 Decoupling part and pump swich

The transistors (TIP 41) support a maximum current of 6 Amperes so they are widely used in power amplifiers either in low power audio amplifiers or power supplies because they can dissipate up to 65 watts and withstand a temperature of up to 150 ° Celsius. The diode (1N4007) that accompanies the transistor was chosen due to its capacity to dissipate a power of 3 watts and its resistance to temperatures up to 150°, besides being a protection because it is inversely polarized and this prevents the pump from returning the current generated when it is turned off. Finally, there is a 100 ohms (Ω) resistor to protect the pumps in case a voltage higher than they can withstand reaches them.

In this same block is the PIC, which is programmed to make the switching of the pumps (turn them on and off) depending only on the frequency, has an analog-to-digital converter because the pumps need a digital signal to be driven in the right way.

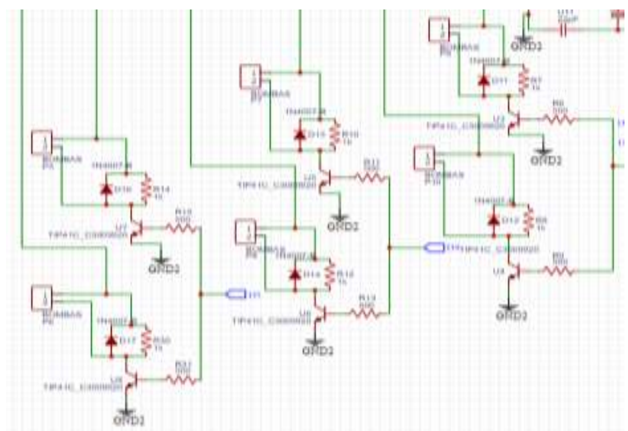

Figure 6 Diagram of the power stage

5. Amplifier

The diagram used for the amplifier was consulted on the internet which consumed up to 3 effective watts. This amplifier was selected because we have a very large speaker, therefore, an amplifier that supports more power is necessary.

A potentiometer was added to control the volume at which the music is needed to be heard, besides this inside the same circuit is added the power supply of this, which is 32 volts positive and at the bottom has a power supply of 32 volts negative.

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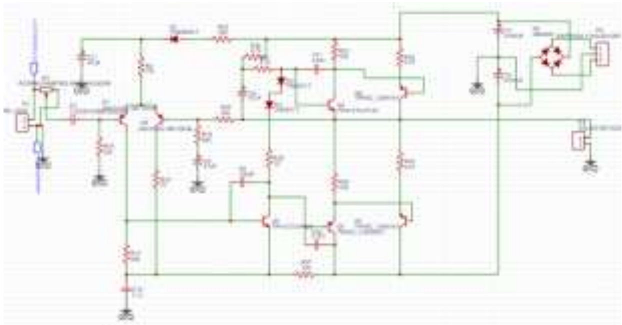

Figure 7 Diagram of the amplifier

It can be seen in the diagram the diode bridge, which is responsible for rectifying the sine wave received from the transformer, because the circuit needs direct current for optimum performance.

At the input of the amplifier there is a capacitor, which is in charge of filtering the stray noises that could reach the amplifier.

In this model of amplifier some diodes are used, which are reverse biased to protect some of the parts of the circuit where it should not enter much voltage, because the horn has a winding and could return some current, therefore, protection is necessary (Figure 7).

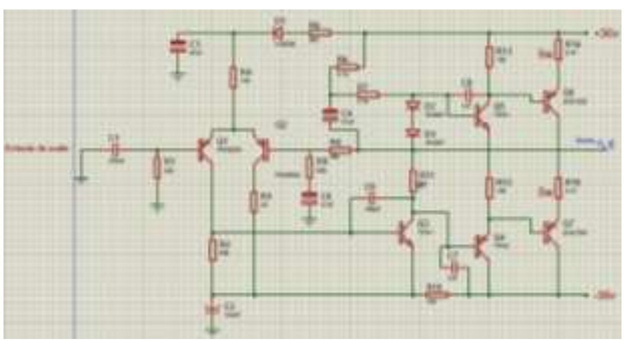

Figure 8 Proteus amplifier

The diagram of the amplifier made in proteus can be seen, which was helpful at the time of testing, to know its operation and then pass that same amplifier to the final boards (Figure 8).

6. Vumeter

It implements an integrated circuit called LM3914 which is a vumeter. The way it works is detecting voltage levels controlled by some audio input or potentiometer and displays them in a series of 10 LEDS which turn on or off depending on how high or low is the voltage at the input of the integrated circuit (VUmeter).

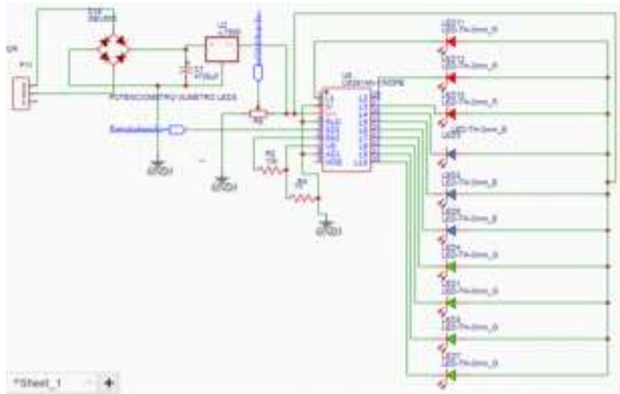

Figure 9 Vumeter and 5V source diagram

Vumeter diagram:

The diagram is made up of a series of 10 LEDS connected to a shared ground, which through the vumeter are controlled by a voltage input, either from an audio input or from a potentiometer. In addition to the LEDs, it has the vumeter, which is connected at its input to a potentiometer to control the sensitivity with which it receives the music.

To feed the vumeter, it is powered by the transformer, because the transformer gives alternating current is rectified by a diode bridge and a capacitor of 4700uF, in addition to adding a voltage regulator, which allows only 5 volts to enter the vumeter, which are necessary for its operation (Figure 9).

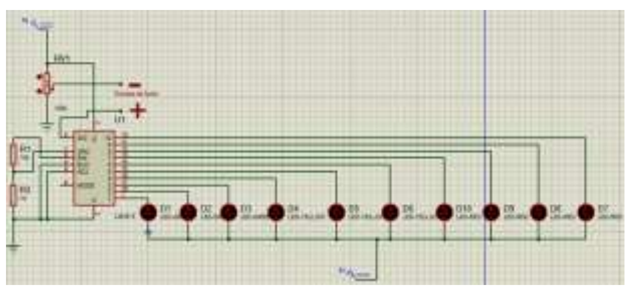

Figure 10 Vumeter in proteus

The vumeter presented in proteus is shown, in this way the voltages at which the music arrives can be observed.

The green LEDS represent the low levels, the yellow LEDS represent the high levels and finally the red LEDS represent the high levels (Figure 10).

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Results

Next, it is possible to appreciate what is everything that conforms the part of sound and visualization of the dancing sources, two sources can be observed which, one of them feeds the amplifier and the second one that is smaller feeds the vumeter.

This all in test plates because it is necessary to test its operation to later pass it to the plates that will remain as final, this to avoid any bad connection and that this generates a short circuit in the final plate, in addition to this, it also works in case you need to make any changes or something else (Figure 11).

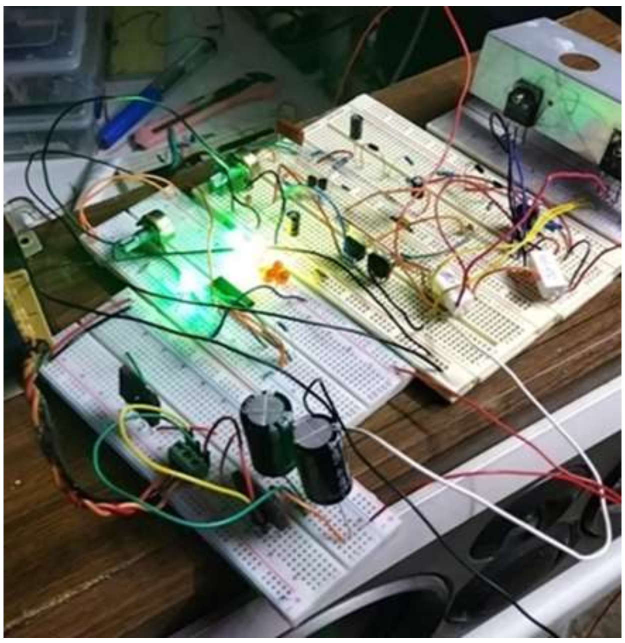

Figure 11 Combined amplifier-vumeter circuit

In this part you can see the final structure of the project, it consists of a fish tank lined at the ends with vinyl to avoid any accidental cut, in addition to this, at the base has two rubber strips to prevent any slippage. Inside the fish tank you can see 6 pumps, these pumps will be our fountains. In addition to the pumps we added 4 LED lights and some fish tank stones for aesthetic purposes.

In the lower part of the structure is where the horn and a transformer are placed, from where practically the power supply for the whole circuit is taken. In the upper right part of the structure is where the end plate with its heatsink goes, plus a small fan which serves to dissipate the heat that the power transistors generate (Figure 12).

Figure 12 Structure

Finally, the final prototype is shown, which already includes the power stage that can be seen with a red box and consists of an array of transistors, resistors and diodes.

There is also a blue box with the control part which is the microcontroller (16f877a) together with its 5v power supply.

In the black box you can see the vumeter (LM3914) with all its LEDS and its 8v power supply.

Finally, there is the amplifier with its audio output to the speaker, its audio input to the 3.0 jack, its potentiometer to control the level at which the volume is required, its source of +36v and -36v that enters the positive part to the top of the amplifier and the negative part to the bottom of the amplifier (Figure 13).

Figure 13 Structure

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In this part is the final board that was used, this is the final design with all its components already soldered, besides having a heatsink on the power transistors to prevent them from overheating.

The board was sent to be machined for aesthetic purposes, because at the time of making it there were several flaws, with the machined board only the other components are assembled and it is ready for use (Figure 14).

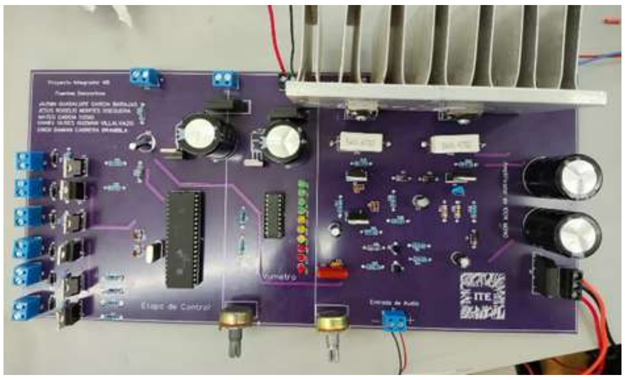

Figure 14 End plate

Conclusions

The objective of designing and creating dancing fountains was achieved, there were setbacks and errors, but they were solved in time. Several tests were performed to verify its operation and also some adjustments happened at the time of making the circuit, but in the end we tried to find a better way to make the pumps follow the rhythm of music.

This project was very beneficial for learning control through a microcontroller, design of power stages and decoupling, card design and assembly of amplifiers, also this project was beneficial to learn to work in a team and lead a team, stress management.

Team work can be a little complicated if you do not have good communication when delegating tasks, however, you learn to communicate and delegate work to other members making them see the areas of opportunity and accepting constructive criticism. The way to manage the team well is to allocate 3-4 days per week to make significant progress in the development of the team.

The project was very demanding because it had not worked with microcontrollers, so it was necessary to spend a lot of time to see how it worked and finally to implement what was learned to control the sources, then it was found with the power stage and decoupling for which it was necessary to investigate in different sources of information to make it, finally an amplifier diagram was consulted on the internet, which was modified and adapted to certain needs to use it.

This project has a great focus on electronics because it asks for a design for the board, it is necessary to know about power stages and decoupling, it is necessary to have knowledge about controlled sources as well as amplifiers. Because of this, the expected results were obtained, because the amplifier worked very well, the sources turned on according to the music, the board does not overheat and looks good aesthetically.

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Lattice design made with recycled polymeric concrete for the facade of a single-family house

Diseño de celosía hecha con concreto polimérico reciclado para fachada de vivienda unifamiliar

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Abstract

There has been an increase in the generation of urban solid waste and special handling waste in Mexico in recent years; today there are not enough final disposal sites to dispose of the waste that is generated. Urgent measures that reduce the number of waste that enters these sites through proper reuse and recycling. For this reason, this article shows how–through an appropriate recovery–materials and elements can be re-purposed for the construction of single-family homes. For this, a lattice for an exterior facade was designed from a recycled polymer concrete in order to improve the range of thermal comfort and mitigate energy consumption inside a single-family home in the municipality of Cuautla Morelos. An experimental and descriptive methodology was carried out where the elaboration of molds was carried out to later obtain the lattice and finally mechanical, thermal tests and digital simulations of the wind tunnel. Favorable results were obtained from the geometry applied to the lattice and the performance of the material in a hot climate.

Lattice, Recycled Polymeric Concrete, Facade

Resumen

Se han registrado en los últimos años un incremento en la generación de residuos sólidos urbanos y de manejo especial en México, mientras que hoy en día no se cuenta con suficientes sitios de disposición final para disponer de la basura que se genera, por lo que urgen medidas que disminuyan el número de residuos que ingresan a estos sitios a través del rehúso y recuperación apropiada de ellos. Por este motivo el presente artículo muestra como a través de un reciclaje adecuado se pueden crear materiales y elementos para la construcción en viviendas unifamiliares. Para ello, se diseñó una celosía para una fachada exterior a partir de un concreto polimérico reciclado a fin de mejorar el rango de confort térmico y mitigar el consumo energético al interior de una vivienda unifamiliar en el municipio de Cuautla Morelos. Se llevó a cabo una metodología experimental y descriptiva donde se realizó la elaboración de moldes para obtener la celosía y finalmente se hicieron pruebas mecánicas, térmicas y simulaciones digitales de túnel de viento. Se obtuvieron resultados favorables de la geometría aplicada en la celosía y el desempeño del material en un clima caluroso.

Celosía, Concreto Polimérico Reciclado, Fachada

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Introduction

In Mexico and worldwide, the number of municipal solid wastes (MSW) produced each year has increased, generated primarily at home, work, school, etc. and resulting from the disposal of products used in daily activities. This stems from the increase in population requiring more goods and services that are necessary for their daily activities.

For this reason, appropriate landfills must be available to dispose of waste, otherwise they will be places that contaminate drinking water, ecosystems and are subject to the spread of infections and diseases.

However, Mexico faces problems in the management of MSW, from its correct separation to its final disposal, since these sites have inadequate infrastructure and 65% of these sites have already concluded their useful life, 20% have more than 10 years of operation and the rest have between 1 and 5 years of proper operation (Patiño, 2022, para. 11).

This means that there are no more places to dispose of waste in Mexico today, while waste generation is increasing, so measures are urgently needed to reduce the amount of waste arriving at these disposal sites in the first place.

One of the most polluting wastes is plastic, specifically polyethylene terephthalate (PET), since its useful life is very short and it can take up to 100 years to degrade. One of the problems with this material is that it occupies a large volume of space and causes clogging of drains, seas and rivers, as well as invading the physical environment if it is not disposed of responsibly.

Another type of waste that is used in the production of the latticework is that generated by the construction industry, better known as "rubble" or special handling waste, as this sector is responsible for producing 45% of waste worldwide (Institute of Construction Technology (ITeC) 2022, para. 7).

For this reason, this article will show the design process that was carried out in order to create a lattice made from recycled materials and with the correct use of its properties to contribute to the energy consumption of a single-family house.

In order to design the lattice it was necessary to know more about the material used, so we will see background information about what polymer concrete is and how the recycled raw material was used to make it, we will see the recovery processes of each of its components, the beginning of the lattice design according to the NMX-C-441-ONNCCE-2013 standard and the moulds that were made to work with the recycled polymer concrete and obtain the final piece. Subsequently, in order to evaluate the lattice, mechanical, thermal, water absorption and fluid simulation tests were carried out. However, only the mechanical tests carried out on the lattice will be shown in this article.

1. Background of polymer concrete

Polymer concrete is a material composed of two phases, the first one is a polymeric matrix and the second one is a granulated reinforcement that can be natural stones such as sands, gravels, clays, marble, etc.

This material has good mechanical, physical and thermal properties, however, most of its applications today are made from polyester resins and natural aggregates, so the option of working from recycled aggregates was seen. When visiting the Materials Research Institute (IIM) of the National Autonomous University of Mexico (UNAM), Dr. Antonio Sánchez Solís gave the option of working with a polyester resin obtained from the chemical recycling of a PET bottle recovered from the rubbish. So we worked with this recycled unsaturated polyester resin as the polymeric matrix of the composite material and the granulated reinforcement was composed from recycled plain concrete, obtained from ACCUBO S.A. de C.V. located in Iztapalapa, Mexico City.

1.1 Unsaturated polyester PET resin

PET bottles are most frequently recovered in Mexico through mechanical recycling, however, when PET is subjected to this process it undergoes thermal and mechanical degradation, so that its properties will be modified to the original ones and even below those of virgin PET, so that it will require other processes or additives to improve its properties and comply with strict sanitary requirements demanded by the food industry.

On the other hand, chemical recycling is an alternative and from this process the unsaturated polyester resin of PET is obtained, a glycolysis development is carried out and this is similar to the vulcanisation process used when manufacturing tyres, in this process some additives are added that will modify the polymer, whose objective is to create cross-links or bridges between the different chains of the original polymer. (Tecnología de los Plásticos, 2012, para. 1).

PET has a long spaghetti-like structure, formed by the bonds of many monomers, when it undergoes a process of glycolysis, the structure will separate into small parts and through the cross-linking of its bonds a polyester resin is obtained from this material.

This process is irreversible, since we are talking about a thermosetting resin and once it acquires its rigidity, it cannot be melted again, unlike thermoplastics that can be melted and rigidified as many times as required.

However, thermosets have other advantages, among them a high resistance to high temperatures, so that when they reach a higher temperature they begin to decompose, i.e. carbonise.

It is an alternative to recover a material through the decomposition of its parts and modify it to create another purpose.

Figure 1 shows how the resin with which we worked has a dark appearance that even looks dirty, but this is the result of the chemical process it was subjected to.

1.2 Recycled concrete

Simple concrete was used for the granulated reinforcement, in accordance with the classifications of construction and demolition waste presented in the NACDMX-007-RNAT-2019 standard.

The recovery process starts with the identification and separation of the type of material on site as a first step to facilitate its recycling

Figure 1 Unsaturated polyester resin from recycled PET
Source. Own photograph 2022

Standard 007 contains separation classifications, of which "concrete from prefabricated elements, concrete from structural and non-structural elements, concrete leftovers (without metallic elements)" was identified within category A) as simple concrete (Secretaria del Medio Ambiente [SEMANART], 2021. p. 100).

It is worth mentioning that when working with recycled aggregates it was detected that there is a non-uniform mixture of its components, i.e. traces of glass and red mud were found. The following figure shows the aggregates in their dry state.

Figure 2 Recycled granular aggregates
Source. Own photograph 2022

2. Latticework design proposal

A lattice was designed, which is a masonry element of non-structural use for interior and exterior dividing walls, the latter being the most recommended.

For the design of the geometry, the first idea was to work with triangular shapes that would give greater stability to the wall, as if working with a reinforced structure, however, the complementary technical standards were consulted and "geometric and reinforcement requirements are imposed that are mainly based on the experience of the behaviour of real structures" (Official Gazette of Mexico City, 2020, p. 14).

Thus, when analysing the requirements of measurements, modulations and geometries, the original idea was changed without losing the essence of the design, so that the triangular shape was adapted to a prismatic one, as shown in figure 3. This was done in order to facilitate the transfer and placement of the piece so that it would not suffer any mishap such as spalling when it was handled on site.

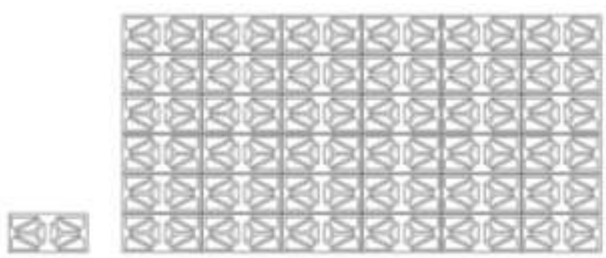

Figure 3 Second lattice proposal
Source. Own elaboration in AutoCAD 2022

Several empirical experiments were made with different moulds to see if the proposal worked with normal concrete casting, however, several observations were made after failed attempts, where the geometry was not adequate, since the thicknesses of the interior walls were 15 mm and as they were so thin the concrete did not enter easily, so the NMX-C-441-ONNCCE-2013 standard was consulted, which establishes the characteristics that partition walls, blocks, bricks and masonry elements must comply with. It was found that the minimum thickness in interior walls is 17 mm to work with concrete.

It was then decided to work with a square module that would allow to have the appropriate thicknesses and to join two pieces together to form the pattern of the original idea. As shown in the following figure.

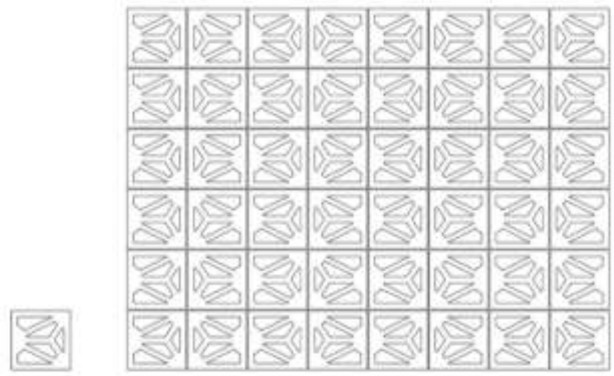

Figure 4 Final lattice proposal
Source. Own elaboration in AutoCAD 2022

2.1. Latticework dimensions

The lattice measures 19 x 19 x 10 cm (height, width, thickness) and complies with the net area of 50% of the gross area of the part. As shown below.

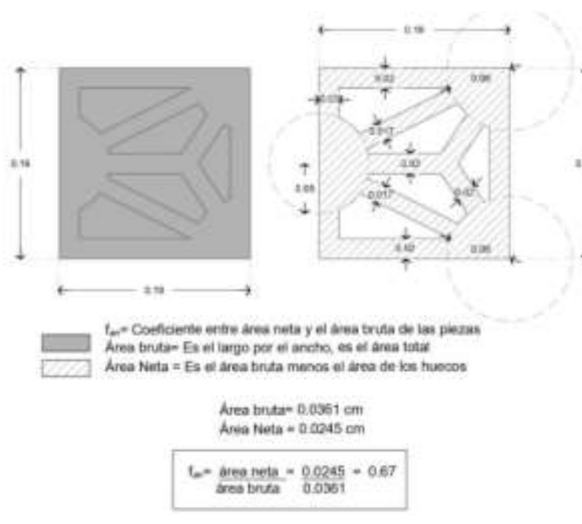

Figure 5 Net area of the lattice design
Source. Own elaboration in AutoCAD 2022

3. Preparation of moulds for its manufacture

To start working with the recycled polymer concrete, two moulds were required, a positive mould or mother mould, which was the main mould we worked with, and a negative mould to be able to make the positive mould.

3.1. Negative mould

First the negative mould was made, where the lattice was modelled in Solidworks and printed at 1:1 scale in 3D with PLA filament, then the printed piece was placed in a wooden box to be able to make the silicone casting with which the final mould would be made. The result is shown in the following figure.

Figure 6. Negative mould made
Source. Own elaboration, Dalia Cruz Martínez 2022

3.2. Positive mould

The positive mould was made of P-53 silicone, which among the rubbers has good properties such as high resistance to tearing and is elastic, making it ideal for working with natural stones such as marble, granite and concrete.

The process required a catalyst or TP, which is an initiator that helps the vulcanisation process, this process goes through three important stages, first from a liquid to a solid state, the second is that there is a gel point, meaning that it is already sticky and finally the curing or total vulcanisation, when the silicone is completely solid.

Once the silicone is poured into the mould, it is left to cure for 24 hours, obtaining the following results.

Figure 7 Final positive mould
Source: Own elaboration, Dalia Cruz Martínez 2022.

4. Process of making the lattice with recycled polymer concrete

Once the final mould was obtained, work began at the Materials Research Institute (IIM) of the UNAM with Dr. Antonio Sánchez Solís, who provided the recycled resin with which work began.

Two sizes of aggregates of ¼" and 3/8" of an inch were used, which were perfectly mixed in a dry state.

A process similar to vulcanisation was carried out, i.e. a chemical reaction where the resin begins to harden and goes from a liquid to a solid state, as well as being an irreversible process, so the resin will acquire its maximum resistance in approximately 24 hours.

To carry out this process, a catalyst, a monomer and an accelerator were required, all the aggregates are perfectly incorporated and once they are homogeneously mixed, they are poured into the mould and left to cure for 24 hours to proceed with the demoulding of the final piece. The following figure shows the result obtained.

Figure 8 Pouring of aggregates and final result
Source: Own elaboration, Dalia Cruz Martínez 2022

Results

When the piece was demoulded, two types of finishes were obtained, a smoother one, which is where the resin was more concentrated, and a rougher part, which is where the granular aggregates that were used stand out more. Obviously each one will have different properties, the first is that the smooth part is totally impermeable to water and the rough texture allows the flow of water very well, which makes it a permeable finish.

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This was the result of the effect of gravity in the mould, as the resin, being liquid, was concentrated in the lower part of the mould and the granular aggregate was more exposed in the upper part, so we proceeded to work with these results.

Once the work at the Materials Research Institute was completed, the material and the design of the proposed lattice were evaluated. To do this, 10 more pieces had to be made, of which they were made at home with the appropriate protection and the necessary care. The following figure shows the results achieved in the experimental phase of the production of the pieces.

Figure 9 Lattices obtained in the experimental phase
Source: Own elaboration, Dalia Cruz Martínez 2022

Recycled polymer concrete was proposed in a lattice because it is a non-structural element and recycled aggregates can currently be used in noble and masonry uses. In addition, by working with this material, favourable mechanical and thermal properties were obtained to propose it in an exterior wall of a single-family house in Cuautla Morelos.

5. Tests carried out to evaluate the geometry and the material used

It was necessary to evaluate the mechanical behaviour of the lattice through individual and diagonal compression tests, its thermal behaviour by measuring its thermal transmission coefficient (k), water absorption, i.e. resistance to humidity and finally digital fluid simulations were carried out to see how the wind behaves through the proposed geometry.

In this article only the mechanical tests will be discussed.

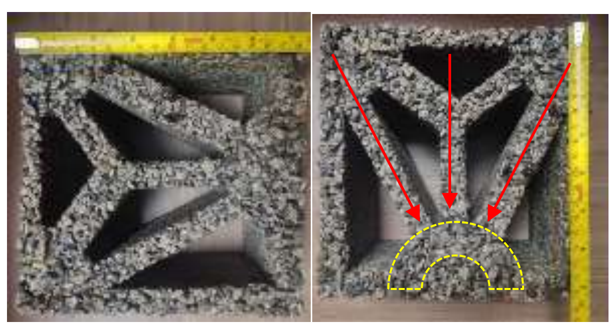
5.1. Mechanical tests

The individual compression test was carried out where a sample of at least 5 pieces was required. It is worth mentioning that 10 lattices were made at home with a custom workshop and I individually made as many pieces as possible.

The lattices, although they are not structural masonry elements, must have the necessary stability against external forces such as an earthquake or wind, so they must comply with the minimum resistances established by the NMX-C-036-ONNCCE-2013 standard that specifies the test methods for compressive strength tests of blocks, partitions, bricks, lattices and paving stones.

The tests were carried out on a universal machine in the mechanics of materials laboratory of Civil Engineering (L4) of FES Aragón, which has a capacity of 120 tonnes. Five pieces were individually subjected to this machine. The interesting thing about this test was that it was proved that the geometry of the lattice does influence the load capacity of the piece independently of the material used.

That is to say, 3 parts were placed horizontally, as shown in a) in the universal machine and supported half the load compared to when they were placed vertically, as shown in b) in figure 10. So when the lattice is placed vertically it has a capacity of 61.31 kg/cm2 this capacity is very good as it complies with the NMX-C-441-ONNCCE-2013 standard that establishes the minimum individual compressive strength for lattice pieces.



a) b)

Figure 10 Comparison of two ways of installing the lattice. Source. Own elaboration, Dalia Cruz Martínez 2022

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It is important to evaluate the individual resistance of the piece, however, its behaviour must be measured when it is already placed in a wall, to see how it works with the type of binder with which the lattice is going to be glued.

The second test was then carried out, where a 40 x 40 cm wall was made for the thickness of the piece and placed at home with the help of a master mason, then it was left to cure for approximately 8 days and the wall was taken to the Civil Engineering laboratory of FES Aragón to undergo the diagonal compressive strength test.

In this case, type I mortar was selected as the binder to glue the wall. This mortar has a compressive strength greater than or equal to 12.5 MPa (125 kg/cm2), so it was expected to have greater stability in the wall.

The wall was placed in the universal machine at 45 degrees with the appropriate heads to receive the load and not to displace the wall, as shown in figure 11.

The result was a shear failure, i.e. the bond between the masonry element and the binder failed. However, the diagonal compressive strength complies with the requirements of the NMX-C-464-ONNCCE-2010 standard for testing walls and piles, as it is within the parameters established in the standard.

The diagonal compressive strength was:

$$\upsilon'_{\mathcal{M}} = \frac{Vm}{1+2.5Cv} = \frac{4.74}{1+2.5(0.1)} = \mathbf{3.792}$$

Figure 11 Laying of the wall in a universal machine. *Source. Own elaboration, Dalia Cruz Martínez 2022*

Conclusions

Technological advances in the development of materials are becoming increasingly progressive. Concern for the environment and the proposal to recover waste to be used in other applications in order to reduce the use of raw materials and reduce the pressure exerted on natural resources is an objective that is sought from the circular economy.

In the field of construction, it is the responsibility of the construction industry to take care of the waste that is generated on a daily basis.

It was demonstrated that elements for construction made from solid urban waste can be proposed and, through appropriate recycling, they can be used for a second application.

As lattices are part of a non-structural wall, this means that they do not form part of the load-bearing elements of the structure of a building, so their applications are dividing walls, parapets, parapets, facades, etc. However, these pieces need to be able to resist external actions to the structure, for example, their own weight, ground movements, such as an earthquake, and wind thrust if they are outside.

As a result, the parts have to be analysed individually and placed in the final position in which they will work.

For the time being, favourable results were achieved in the individual compressive strength tests, as they comply with the NMX-C-441-ONNCCE-2013 standard on specifications for non-structural masonry pieces.

These tests were used to verify their individual resistance and the correct position in which they will be placed in the wall, as it was observed that, by positioning the lattice with the interior walls vertically, they would withstand twice the weight if they were placed horizontally.

On the other hand, in the diagonal resistance test, there was a shear failure, i.e. the adhesion between the resin or the smooth part of the lattice and the mortar failed, since the rough part had a better adhesion to the mortar. However, the parameters obtained are within the permitted limits of the NMX-C-464-ONNCCE-2010 standard, so the construction system with type I mortar is maintained.

However, improvements can be made to the design of the piece so that the smooth part can have a better adherence to the mortar, such as adding teeth or channels at the ends of the lattice so that it can receive the mortar and the diagonal reinforcement such as a rod, in order to finally have a better grip and avoid displacement.

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Transcending boundaries in Architecture: A Transdisciplinary inquiry into public space

Trascendiendo las fronteras en la Aquitectura: Una investigación Transdisciplinaria sobre el espacio público

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Abstract

This chapter offers a comprehensive exploration of architectural public spaces through a transdisciplinary lens, focusing on morphology, security, and daylight. In the context of urban development, these spaces play a vital role in shaping social interactions, fostering community cohesion, and enhancing the quality of life. The transdisciplinary approach adopted in this research integrates insights from environmental psychology, sustainable architecture, landscape design, architectural anthropology, spatial analysis (space syntax), perception theories, and concepts of self-security. This paper illuminates the complexities involved in the design, usability, and impact of these spaces, aiming to bridge existing knowledge gaps. It further provides practical recommendations for architects, urban planners, policymakers, and other relevant stakeholders. By merging diverse disciplinary perspectives, the paper underscores the importance of a transdisciplinary discourse in the design and utilization of architectural public spaces, contributing to a broader understanding of urban life quality and sustainability.

Architectural design, Daylight, Morphology, Security perception, Sustainable Architecture

Resumen

Este capítulo ofrece una exploración integral de los espacios públicos arquitectónicos a través de una lente transdisciplinaria, centrándose en la morfología, la seguridad y la luz del día. En el contexto del desarrollo urbano, estos espacios juegan un papel vital en la configuración de las interacciones sociales, fomentando la cohesión comunitaria y mejorando la calidad de vida. El enfoque transdisciplinario adoptado en esta investigación integra conocimientos de la psicología ambiental, la arquitectura sostenible, el diseño del paisaje, la antropología arquitectónica, el análisis espacial (sintaxis del espacio), las teorías de la percepción y los conceptos de seguridad personal. Este documento ilumina las complejidades involucradas en el diseño, la usabilidad y el impacto de estos espacios, con el objetivo de cerrar las brechas de conocimiento existentes. Además, proporciona recomendaciones prácticas para arquitectos, urbanistas, formuladores de políticas y otras partes interesadas relevantes. Al fusionar diversas perspectivas disciplinarias, el documento subraya la importancia de un discurso transdisciplinario en el diseño y la utilización de espacios públicos arquitectónicos, contribuyendo a una comprensión más amplia de la calidad de vida urbana y la sostenibilidad.

Antropología arquitectónica, Arquitectura sostenible, Psicología ambiental, Diseño del paisaje, Análisis espacial

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1. Introduction

Architectural public spaces, essential for the formation and reinforcement of community and cultural identities, are areas that facilitate an array of public interactions and activities (Kaklauskas *et al*., 2021). They contribute significantly to the vibrancy and quality of urban life, and their design and functionality—encompassing morphology, security, and lighting—are integral to their usability and effectiveness (Gehl, 2020). The significance of these components becomes pronounced when seen through a transdisciplinary lens that integrates insights from environmental psychology, sustainable architecture, urban planning, landscape design, architectural anthropology, spatial analysis, perception theories, and concepts of self-security (Mayya, 2021; Lobo *et al*., 2020; Salama, 2020).

A transdisciplinary approach is instrumental in unifying diverse disciplinary perspectives into a comprehensive framework to holistically explore the complexities of public spaces (Wahlrab, 2023; Pohl *et al*., 2021). This approach moves beyond the confines of individual disciplines, transcending them to create new syntheses (Cockburn, 2022). It's especially relevant when exploring architectural public spaces due to their multifaceted nature.

This study aims to harness the power of transdisciplinarity to delve into the interplay of morphology, security, and daylight in such spaces. The methodology of this research is primarily qualitative, incorporating extensive literature review, transdisciplinary framework development, detailed analysis of key aspects, and insightful discussions.

The inclusion of diverse disciplines like environmental psychology helps understand how humans interact with these spaces (Gifford, 2007), while sustainable architecture and landscape design provide insight into the ecological and aesthetic aspects of their design (Byrne, 2022; Kim, 2021). Architectural anthropology offers a cultural perspective (Moore, 2019; Ruiz, 2019), and spatial analysis, particularly space syntax, sheds light on the spatial configuration and its influence on social interactions (Lee *et al*., 2023; Yao *et al*., 2019; Hillier *et al*., 1976).

Perception theories elucidate how individuals perceive and interpret these spaces (Lynch, 1960), and the concept of self-security informs the study of security in public spaces (Cozens, 2002; Jung, 1971). The primary aim of this research is to build a cohesive understanding of architectural public spaces, focusing on the roles and interrelationships of morphology, security, and lighting. By employing a transdisciplinary approach, we aspire to fill existing knowledge gaps and offer practical recommendations for urban planners, architects, policymakers, and other stakeholders. By exploring these facets within the broader realms of environmental psychology, sustainable architecture, landscape design, and others, the aim is to contribute to the discourse on improving the design and functionality of public spaces.

2. Methodology

Research design, approach, data collection, and rationale of the study

The research design of this study is based on a qualitative, exploratory approach that is suited to the investigation of complex phenomena and the interrelationships between various components, table 2.1. A transdisciplinary framework was used, drawing upon concepts, methods, and theories from a range of disciplines including environmental psychology, sustainable architecture, urban studies, landscape design, architectural anthropology, spatial analysis, perception theories, and security studies. This research design enables us to synthesize these diverse perspectives into a comprehensive analysis of the morphology, security, and daylighting of architectural public spaces.

A transdisciplinary approach surmounts the restrictions of individual disciplines, assimilating their unique insights into a comprehensive whole (Alba Dorado, 2022). In this investigation, such an approach prompts the amalgamation of expertise from a plethora of disciplines mentioned before, with each contributing distinct perspectives into the intricate dynamics of architectural public spaces. It's this rationale that propels the application of this method in the ongoing analysis of morphology, security, and daylighting within these spaces.

This application necessitates the integration of design principles, cultural considerations, spatial configurations, environmental factors, perceptual responses, and safety measures.

Furthermore, in conducting the data collection for this study, a comprehensive literature review was undertaken. This review facilitated the gathering of a broad range of academic and professional knowledge on the key topics. For data analysis, a thematic approach was employed. This approach identified key themes related to the morphology, security, and daylighting of public spaces as represented in case studies.

These themes were scrutinized in connection with the concepts, principles, and theories derived from the transdisciplinary framework. In addition, the decision to employ a qualitative, exploratory research design and a transdisciplinary approach was driven by their potential to provide a comprehensive and nuanced understanding of architectural public spaces. These methodologies facilitate the exploration of the multifaceted nature of these spaces and shed light on how the interplay among morphology, security, and daylighting influences their use and experience.

Components	Details
Research Design	Qualitative, exploratory approach
	Utilizes a transdisciplinary framework
Transdisciplinary Approach	Draws from environmental psychology, sustainable architecture, urban studies, landscape design, architectural anthropology, spatial analysis, perception theories, security studies
	Integrated analysis of morphology, security, and daylighting
Data Collection and Analysis	Comprehensive literature review
	Thematic analysis of data
Rationale	To provide comprehensive understanding of architectural public spaces
	To understand the multifaceted nature of these spaces

Table 1 Methodological approach of the study
Source: Elaborated by Miriam Mery-Ruiz. 2023

3. Results

3.1 Multidisciplinary, interdisciplinary or transdisciplinary? A comparative study of the approaches in understanding architectural public spaces

The study of architectural public spaces has a multifaceted nature, demanding insights from numerous fields, such as environmental psychology, sustainable architecture, landscape design, architectural anthropology, spatial analysis, and more. The role of architectural public spaces in urban environments is complex, involving the physical, social, and cultural components that are ever-changing and often interdependent. Scholars have approached these complex issues through various lenses, namely multidisciplinary, interdisciplinary, and transdisciplinary approaches.

In our journey to grasp the multifaceted nature of architectural public spaces, we find ourselves standing at the crossroads of diverse approaches. Each path offers a unique perspective, beckoning us with their distinctive insights and contributions. We embark on this comparative quest not just to choose our path, but to understand the essence of each, and how they shape our understanding of architectural public spaces.

The multidisciplinary approach can be visualized as a harmonious ensemble. It is akin to an orchestra where each musician – or discipline in this context – plays their part in an independently exquisite manner, while contributing to the overall melody (Goryunova & Lehmann, 2023). Like seasoned urban planners scrutinizing spatial configurations, environmental psychologists diving deep into human behavioral influences, and architects crafting aesthetic, technology and designs, each discipline, in its unique way, crafts an understanding of the architectural public space. The melody is rich, but each note rings distinct and independent; the individual findings may not necessarily converge or integrate figure 1.

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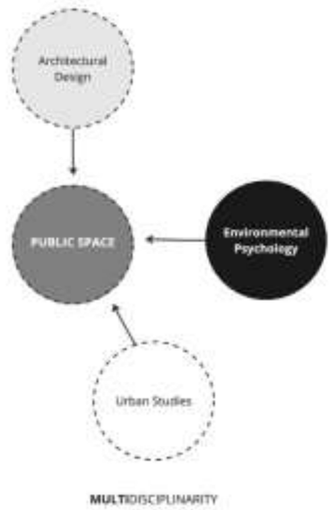

Figure 1 Multidisciplinary approach of the study problem
Source: Elaborated by Miriam Mery-Ruiz. 2023.

Contrastingly, the interdisciplinary approach promotes a captivating dance of ideas, methods, and theories, as they intertwine and move fluidly across disciplinary boundaries. This is an intellectual waltz where new understanding emerges from the seamless fusion of disciplinary insights, creating an exciting outcome that is more than just the sum of its parts (Dwivedi *et al*., 2022). Envision urban planners, architects, and environmental psychologists engaging in a dynamic ballet to understand how physical design influences human behavior in architectural public spaces. Their collaborative dance could give rise to innovative design principles that amplify the social, psychological, and aesthetic benefits of the space (Escobar, 2018; Newell, 2001), figure 2.

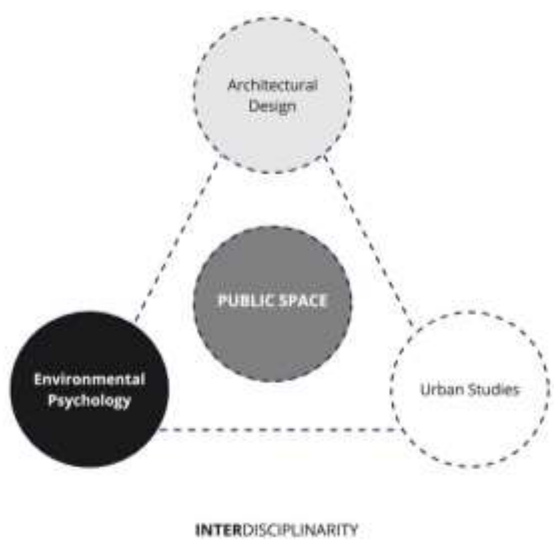

Figure 2 Interdisciplinary approach of the study problem
Source: Elaborated by Miriam Mery-Ruiz. 2023

Transcending these integrations, the transdisciplinary approach creates a holistic tapestry of knowledge (Nicolescu, 2002). Imagine a multitude of threads - concepts, theories, and methods - from various disciplines coming together, weaving a comprehensive understanding that surpasses the scope of any single discipline. Studying architectural public spaces in this light opens the stage to not just academics, but practitioners, policymakers, and community members. Together, they create a diverse, rich tapestry that offers a nuanced understanding of public spaces (Stokols, 2006), figure 3.

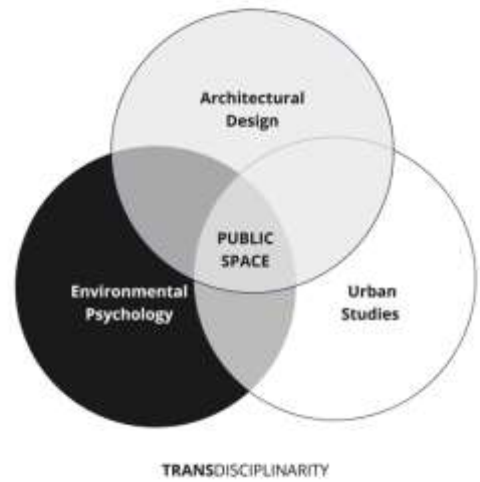

Figure 3 Transdisciplinary approach of the study problem
Source: Elaborated by Miriam Mery-Ruiz. 2023

In the quest to decode the complexity of architectural public spaces, a transdisciplinary approach emerges as a powerful tool. It paints a comprehensive picture, capturing the intricate play of light and shadow, the meandering paths of user experience, and the towering structures of public policy and urban planning. It promises the potential for novel models and frameworks capable of grappling with the myriad challenges posed by these complex spaces (Lawrence & Després, 2004). While each approach - multidisciplinary, interdisciplinary, and transdisciplinary - offers unique perspectives and methodologies, it is the transdisciplinary approach that appears to most deftly capture the dynamic intricacies of architectural public spaces. With its capacity to weave together a broad spectrum of disciplines and perspectives, it provides a nuanced understanding that transcends and integrates. Yet, the chosen approach, be it a single note, a dance, or a tapestry, largely depends on the nature of the research questions, the context, and the resources at hand.

3.2 The importance of architectural public spaces in urban environment: transdisciplinary approach

Architectural public spaces play a fundamental role in urban environments, serving not only as physical structures but also as sites that foster community engagement and cultural expression (Bleibleh & Awad, 2020). They are arenas that facilitate diverse public interactions and activities, thereby contributing to the vibrancy of urban life (Gehl, 2014). A city's public spaces, including parks, squares, plazas, and streets, are essential components of its urban fabric. These spaces have a direct impact on the health, well-being, and quality of life of city dwellers (Whyte, 1980). They provide settings for recreation, relaxation, social gatherings, and cultural events, enriching residents' day-to-day experiences (Bansal & Bhandari, 2020). Furthermore, the design and functionality of these spaces, including their morphology, security, and lighting, play a vital role in their usability and effectiveness, figure 4.

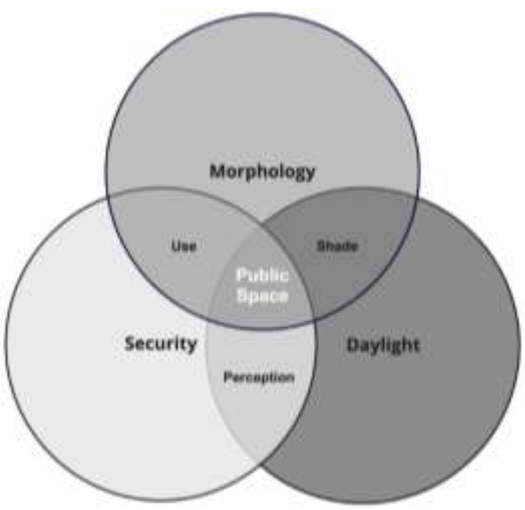

Figure 4 Influence factors of the study on design and functionality of public spaces.
Source: Elaborated by Miriam Mery-Ruiz. 2023

These factors influence how people perceive, use, and engage with these spaces (Gómez-Varo *et al*., 2022; Jacobs, 1961). For instance, spaces that are well-lit and designed with an emphasis on user safety tend to encourage more public use, particularly after dark, contributing to a lively urban environment (Park & García, 2020). From the perspective of environmental psychology, public spaces are seen as "behavior settings" that can influence people's behavior and social interactions (Raja & Heras-Escribano, 2023; Hamedani *et al*., 2021).

They can facilitate or inhibit certain actions, depending on their design and management (Sharifkazemi & Dezfuly, 2021). In addition, from a sustainability standpoint, public spaces also play a key role in urban environments. They provide opportunities for improving urban ecology, enhancing biodiversity, managing stormwater, and mitigating heat islands (Singh et al., 2020). Landscape design principles applied to these spaces can help achieve these sustainability goals while also creating aesthetically pleasing and inviting environments for public use (Cabanek et al., 2020). The importance of architectural public spaces in urban environments, thus, cannot be overstated. They significantly contribute to urban vitality, citizens' well-being, and the overall sustainability of cities.

Along, the transdisciplinary approach represents an evolution beyond traditional research methodologies. This approach moves beyond simply working between, across, and within disciplines and strives to transcend them altogether, to create a holistic framework that integrates and synthesizes knowledge (Nicolescu, 2002). This is done by developing shared concepts, theories, and methods that go beyond the scope of individual disciplines (Espino et al, 2004). Transdisciplinarity is particularly relevant in tackling complex, real-world problems that cannot be adequately addressed by one discipline alone. In such instances, a transdisciplinary approach can draw on diverse perspectives to generate innovative solutions.

By transcending disciplinary boundaries, it opens up the possibility for new models and frameworks that can address the intricacies of these complex issues (Stokols, 2006). Not no mention that in the context of the study of architectural public spaces, a transdisciplinary approach can prove to be invaluable. Given the multifaceted nature of these spaces, understanding them requires insights from numerous fields, including environmental psychology, sustainable architecture, landscape design, architectural anthropology, spatial analysis, and more.

The interplay of elements such as morphology, security, and lighting in these spaces is complex and requires a comprehensive approach for its understanding (Mohareb *et al*., 2023).

A transdisciplinary approach can integrate these varied perspectives into a cohesive framework, thus offering a more nuanced understanding of architectural public spaces. All this, providing an understanding that these spaces and their use greatly depends on three fundamental elements: morphology, security, and lighting (natural or artificial). The interaction among these components not only shapes the physical attributes of such spaces but also molds the perceptions, actions, and experiences of the individuals interacting with them. To study morphology is to delve into the form and structure of public spaces, which is fundamental in determining how these areas are perceived and used (Hillier *et al*., 1984).

To analyze spatial configuration, encompassing the layout, size, and shape of these spaces, is to influence pedestrian movement, accessibility, visibility, and the potential for social interactions. To create spaces that are well-connected and easily accessible is to potentially attract more users (Hillier, 1996). Similarly, to arrange and orient buildings and other physical elements within a public space can enhance or inhibit visibility, thereby influencing its use (Brantner *et al*., 2021).

What´s more, ensuring security in public spaces is a vital aspect of their use. According to Newman's defensible space theory, designing and managing physical environments can deter criminal activities and promote a sense of safety (Newman, 1972). To enable natural surveillance in public spaces, where activities can be easily observed by others, can lead to safer spaces and, consequently, increased usage (Jacobs, 1961).

Furthermore, to adopt a more inclusive and sustainable approach to security is to emphasize the importance of social, economic, and environmental factors, alongside physical design (Cozens, 2002). Taking in account that adequate light levels in public spaces holds significant power over their usage. Daylight enhances visibility, improves orientation, and instills a sense of safety. (Boyce, 2014). Despite the expansive body of research surrounding public space use, morphology, security, and daylight, there exist notable gaps in the current literature that demand further investigation.

Firstly, a large portion of existing research on public space morphology tends to focus on individual elements such as building arrangement or pedestrian pathways, such as the works of Nawawi & Shamsudin (2023), Anggraini & Wijayanti (2023), Thai *et al*. (2022), and Carvalho & Bertol (2019), among others. However, there is a lack of comprehensive studies that holistically consider the interplay between these various morphological elements and their collective impact on public space use. Regarding security, while Newman's (1972) defensible space theory and Jacob's (1961) eyes on the street concept have been widely accepted, the incorporation of socio-economic and environmental aspects into security considerations remains limited (Cozens, 2002). It calls for broader perspectives that go beyond mere physical attributes and design factors in shaping secure public spaces.

In the realm of daylight, the majority of studies focus on its application in interior spaces as the works of Espinoza Cateriano (2022), Marzouk *et al*. (2022), Nadiri *et al*. (2021), Mousavi (2021), and Tabadkani *et al.* (2021), among others. There is a clear dearth of research examining the effect of daylight on outdoor public spaces and how it influences users' perceptions, behaviors, and usage patterns. Lastly, and most importantly, a significant gap exists in the integration of these three aspects - morphology, security, and daylight - in public space studies.

Although these elements have been individually studied, few research efforts have attempted to analyze them in a cohesive and integrated manner. In addition, the exploration of these components from a transdisciplinary perspective is noticeably lacking. An understanding of these elements' interdependencies and their collective influence on public space use could offer valuable insights for enhancing the quality and effectiveness of these spaces.

3.3 The Transdisciplinary Framework: An Integration in the Study of Public Spaces

A transdisciplinary approach transcends traditional boundaries of individual disciplines, integrating and synthesizing diverse perspectives to address complex real-world problems (Hiver *et al*., 2022).

This approach goes beyond the mere juxtaposition of different disciplinary insights that interdisciplinary and multidisciplinary approaches often represent. It necessitates a comprehensive and holistic approach, weaving together theories, methodologies, and findings from various fields into a coherent whole. In the context of this study, a transdisciplinary approach is employed to understand the interplay between morphology, security, and daylight in architectural public spaces. The disciplines of environmental psychology, urban planning, architectural anthropology, and landscape design, among others, provide valuable perspectives that are integrated and synthesized in the analysis. Environmental psychology, for instance, offers insights into how people perceive and interact with their environment (Gifford, 2014). This psychological lens helps interpret how aspects of public space morphology, security, and daylight influence individuals' behavior and usage patterns, see figure 5.

Figure 5 Transdisciplinary Framework on the Study of Public Spaces
Source: Elaborated by Miriam Mery-Ruiz. 2023

Urban planning and architectural anthropology provide a socio-cultural perspective, emphasizing how public spaces should cater to the diverse needs of the community, promote inclusivity, and contribute to the social fabric of the urban context (Crawford, 2021). Landscape design, on the other hand, offers a critical perspective on the role of daylight in enhancing the aesthetic and functional qualities of public spaces (Sorvig & Thompson, 2019). By integrating these diverse disciplinary perspectives, the transdisciplinary approach can yield a richer, more nuanced understanding of public spaces and their use. Such an approach is also more likely to generate actionable insights for improving public space design and management.

The comprehensive examination of architectural public spaces necessitates a multi- and transdisciplinary perspective, recognizing the complexity and multifaceted nature of these shared environments. Through the amalgamation of several disciplines, each contributes unique insights to further our understanding of public spaces. The role of environmental psychology is paramount in dissecting the psychological interactions between individuals and their physical surroundings (Gifford, 2014).

This discipline elucidates the ways individuals perceive, behave, and interact within public spaces. By examining human behavior in response to environmental stimuli, we can design public spaces that foster positive engagement and provide a deeper understanding of the elements that invite or deter usage. On top of that, complementing this psychological perspective, sustainable architecture contributes by emphasizing the design of energy-efficient, environmentally friendly built environments that enhance human well-being (Kibert, 2016).

In the realm of public spaces, sustainable design promotes the optimal use of daylight, contributing not only to energy efficiency but also enhancing psychological well-being through exposure to natural light. Furthermore, urban studies provide a macro view of the urban context, shedding light on socioeconomic conditions and cultural factors that can influence the usage of public spaces (Carmona, 2019; Madanipour, 2019, 1999). Understanding the dynamics of urban morphology, movement patterns, and issues of inclusivity are essential for creating public spaces that truly reflect and accommodate the needs of their urban context. Contributions from landscape design further enrich our understanding of public spaces, particularly in regard to their aesthetics and functional aspects (Sorvig & Thompson, 2018).

The effective use of greenery, water features, seating arrangements, and pathways can significantly enhance the attractiveness, comfort, and user-friendliness of these spaces. The cultural lens provided by architectural anthropology underscores the importance of cultural practices, social norms, and community values in the design and use of public spaces (Avrami *et al*., 2019).

Recognizing the influence of cultural contexts is key to creating spaces that are not only functional but also meaningful to the communities they serve.

In addition to this, spatial analysis, particularly the methodological approach of Space Syntax, is utilized to analyze the configuration of spaces and their impact on movement, visibility, and social interactions (Hillier, 1996). These insights allow us to understand and optimize the spatial structure of public spaces to encourage positive interactions and engagement. Perception theories offer insights into how individuals perceive their surroundings and how these perceptions shape their behavior, providing a critical perspective in studying the impact of security measures and daylighting in public spaces (Fish, 2021; Gibson, 2002; Rock, 1983). Understanding perceptions helps shape public spaces into environments that are welcoming and secure.

Finally, security studies provide risk assessment and management strategies, insights into crime prevention, and principles for the design of safe environments (Cozens, 2002). These aspects are fundamental in fostering a sense of security in public spaces, enhancing their overall usability and appeal.

3.4 Morphology in Architectural Public Spaces: Analysis of Key Aspects

The morphology of architectural public spaces - their physical shape, form, and layout - is a fundamental attribute that directly impacts their functionality, usability, and aesthetic appeal. This morphological dimension, which encompasses aspects such as size, geometry, and the spatial arrangement of various elements within the space, wields a profound influence on the use and experiential qualities of these spaces.

It impacts a range of factors, including accessibility, navigability, comfort, safety, and sociability, shaping the way individuals perceive, interact with, and inhabit these shared environments (Casciani, 2020), see table 2 Accessibility, one of the key factors influenced by spatial morphology, relates to the degree of ease with which public spaces can be entered and engaged with. Those spaces that are open, prominently situated, and visually connected to their surroundings tend to invite greater use.

Conversely, spaces that are physically or perceptually isolated, or difficult to access, often deter public engagement (Askarizad, *et al.*, 2022; Yamu *et al.*, 2021; Hillier, 1996 Whyte, 1980). The internal layout of the space, the arrangement of physical elements such as seating, vegetation, pathways, and amenities, significantly shape its navigability and comfort. Well-considered designs guide user movement, encourage exploration, and provide comfortable, inviting spaces for rest and socialization.

Aspect	Influences	Discipline	Transdisciplinary Insights
Accessibility	Ease of entering and engaging with public spaces	Landscape Design	Design elements enhancing accessibility
Navigability and Comfort	Movement and relaxation within public spaces	Architectural Anthropology	Customized layouts reflecting local customs and values
Safety	Perception of safety and security	Spatial Analysis	Visibility and accessibility based on spatial configuration
Sociability	Interaction and community building	Urban Studies	Broader urban context influencing social interactions
Aesthetics and Functionality	Attraction and usability of public spaces	Landscape Design	Aesthetic principles and functional design

Table 2 Morphology of Architectural Public Spaces
Source: Elaborated by Miriam Mery-Ruiz. 2023

Safety is another fundamental aspect of public space usage influenced by morphology. Spaces that are open to view from surrounding areas, have clear sightlines, and are well-illuminated, contribute to an environment that feels safe and secure. By contrast, spaces with obscured views, hidden recesses, or inadequate lighting can elicit feelings of insecurity, discouraging use (Cozens *et al.,* 2005).

The sociability of a public space, or its ability to foster social interaction and community-building, is also inextricably tied to its morphological properties. Public spaces that include inviting places to sit, areas for play, and spaces for communal gathering encourage people to stay, interact, and engage in communal activities, thus enhancing community bonds and the liveliness of the space. To fully grasp the complex interrelationships between the morphology of public spaces and their usage, a transdisciplinary approach is required. This approach integrates diverse disciplines, each offering unique insights and perspectives. Landscape design, for instance, interprets public space morphology in terms of aesthetic and functional design principles.

The choice and arrangement of elements within the space, the selection of materials, and the incorporation of greenery and water elements, all contribute to the attractiveness and user-friendliness of the space (Sorvig & Thompson, 2018). The lens of architectural anthropology underscores the significance of cultural practices and social norms in shaping space morphology. It emphasizes that public spaces should not merely be aesthetically appealing and functional, but also culturally resonant and sensitive to local customs and values (Bartmanski, 2022).

Over and above that, spatial analysis, notably the space syntax approach, provides quantitative methods to analyze the configuration of spaces. This reveals how spatial structure influences movement patterns, visibility, and social interactions within public spaces (Hillier, 1996). The broader field of urban studies enriches our understanding by highlighting the macro-urban context of public spaces. It reminds us that the form and function of a public space are shaped by broader urban morphologies, land-use patterns, transportation networks, and socioeconomic conditions (Madanipour, 1999).

3.5 Security in Architectural Public Spaces: The Essentials

Architectural public spaces, often the beating hearts of urban environments, play a pivotal role in human life. They are stages where the daily drama of human existence unfolds, providing venues for social interaction, cultural events, and communal gatherings. Yet, underpinning the bustle and vibrancy of these spaces is an omnipresent, yet often unnoticed, actor—security (Cozens, 2002), see table 3.

Aspect	Influences	Discipline	Transdisciplinary Insights
Accessibility	Freedom of access in public spaces	Urban Planning	Creating inclusive and easy-to-access spaces
Trust	Perception of safety and well-being in spaces	Sociology	Building community trust and ensuring user safety
Freedom vs. Safety	Balance between unrestricted use and security	Architecture	Design principles that enhance safety without hampering freedom
Fear and Discomfort	Negative emotions due to mishandled security	Law Enforcement	Strategic planning to implement effective security measures
Harmonious Urban Life	Preservation of urban rhythm and vitality	Sociology	Social aspects influencing the harmony and vitality of urban spaces

Table 3 Security in Architectural Public Spaces
Source: Elaborated by Miriam Mery-Ruiz. 2023

Akin to an invisible director, security orchestrates the intricate urban performance, influencing the spatial dynamics and use patterns of these public spaces. It facilitates accessibility, ensuring that the public realm remains open and inclusive for all. It underpins a sense of trust within these spaces, reassuring users of their safety and well-being (Newman, 1972). Like an unseen puppet master, it subtly shapes and molds the behaviors and experiences of individuals interacting within these architectural settings.

However, the role of security in architectural public spaces is no mere exercise in vigilance or surveillance. Mishandled, it can cast an ominous shadow, instilling discomfort or fear, and disrupting the harmonious rhythm of urban life (Jacobs, 1961). Therefore, the challenge lies not merely in the implementation of security measures but in their careful orchestration to maintain the delicate balance between safety and freedom in our public spaces.

This nuanced and complex role of security eludes simplistic interpretations and demands a kaleidoscopic, transdisciplinary approach (Nicolescu, 2002). Envision the study of security in public spaces as a grand intellectual symphony—a symphony where the melodies of diverse disciplines harmoniously intertwine. The meticulous map of the urban planner overlaps with the insightful ethnographic notes of the sociologist. The aesthetic schematic designs of the architect find a counterpoint in the strategic plans of law enforcement officers. Each discipline contributes a unique note to the grand composition, resulting in a rich, multi-layered understanding of security in architectural public spaces (Stokols, 2006).

This symphony of knowledge, woven from disparate threads of insights, transcends the boundaries of individual disciplines. It forms a comprehensive understanding of security that encompasses the complexity and diversity of public spaces. This transdisciplinary approach paves the way for an empathetic and effective approach to creating and managing secure public spaces, a necessity in our complex urban environments (Lawrence & Després, 2004).

As we continue to shape our cities and urban environments, recognizing and appreciating the nuanced role of the invisible protagonist—security—in our architectural public spaces becomes vital. By adopting a transdisciplinary approach, we can compose a harmonious symphony that ensures our public spaces are not only vibrant and inclusive but also safe and secure.

3.6 Daylight in Architectural Public Spaces: Significance, Effects and Influence on Space Usage

Within the realm of architectural public spaces, daylight emerges as a vital conductor that choreographs the tempo of urban life. Similar to a city's heartbeat, it sets the stage for a continuum of action and tranquility. The availability and quality of daylight in these environments can profoundly affect their utility, aesthetics, and the perceived level of safety (Kaboli, 2023). Daylight's role stretches far beyond simple illumination.

It infuses a vibrancy into these spaces, subtly swaying the emotions, conduct, and perceptions of those engaging within them (Gehl & Svarre, 2013). Effectively harnessed, daylight bolsters visibility, facilitates navigation, engenders accessibility, and fosters an inclusive environment. Essentially, it fine-tunes the rhythm of urban life, cultivating spaces for social interaction, cultural occurrences, and communal assemblies.

The effects of daylight, however, are manifold and can drastically shift based on its administration. Appropriate management of daylight can boost feelings of safety and comfort, incentivizing daytime activities and nurturing a lively communal atmosphere (Jacobs, 1961). In contrast, a mismanaged daylight environment can induce unease or discomfort, potentially dissuading people from utilizing the space and perturbing the natural cadence of urban existence.

Daylight's influence on the use of space is undoubtedly significant, yet it is intricately complex and nuanced, necessitating strategic planning and design (Heschong, 2021). To comprehend the intricacies of daylight and its influence on architectural public spaces, a transdisciplinary approach is needed.

This approach summons a chorus of disciplines—urban planning, architecture, psychology, sociology, and lighting design—to bring forth their distinctive insights and perspectives (Nicolescu, 2002), see table 4.

Aspect	Influences	Discipline	Transdisciplinary Insights
Utility & Aesthetics	Quality of usage and visual appeal	Architecture	Design principles that optimize daylight utilization
Safety & Accessibility	Perceived safety and easy navigation	Urban Planning	Strategic spatial planning to maximize daylight exposure
Emotional Influence	Feelings of comfort and inclusivity	Psychology	Understanding of emotional impact of daylight on individuals
Daytime Activities	Encouragement of communal activities	Sociology	Knowledge on how daylight influences social behaviors
Strategic Daylight Management	Balance between effective daylight use and overexposure	Lighting Design	Techniques to control and manipulate daylight for desired effects

Table 4 Daylight in Architectural Public Spaces
Source: Elaborated by Miriam Mery-Ruiz. 2023

Picture an intellectual opus bathed in radiant enlightenment, where the unique tones of these diverse disciplines harmoniously resonate. The architect's aesthetic acumen intertwines with the sociologist's comprehension of human behavior, the urban planner's strategic spatial blueprints, and the daylight designer's skillset. This confluence of perspectives coalesces into a comprehensive understanding of daylight's role and influence in architectural public spaces (Stokols, 2006). This transdisciplinary beacon of enlightenment transcends the limitations of individual disciplines, offering a holistic comprehension of daylight and its implications.

The approach equips us to traverse the intricate maze of natural light, space, and human behavior, guiding us towards the creation and maintenance of more vibrant, secure, and inclusive public spaces (Lawrence & Després, 2004). As we strive to mold vibrant, inclusive urban landscapes, the integral role of daylight warrants recognition and appreciation. It is through the transdisciplinary prism that we can fully reveal the multi-dimensional nature of daylight in architectural public spaces, masterfully orchestrating a luminous symphony of urban existence.

4. Conclusion

The transdisciplinary approach, with its inherent capacity to transcend the boundaries of individual disciplines, has immense potential for unraveling the complexity of architectural public spaces. This approach uniquely facilitates a holistic understanding, recognizing the inseparability of the natural, social, and built environments that constitute our public spaces.

When applied to architectural public spaces, the transdisciplinary approach illuminates various dimensions of these spaces that are often overlooked in single-discipline studies. For instance, in the context of daylight, it uncovers its multifaceted role - not just as a physical, measurable entity influencing visibility and aesthetics, but also as an experiential, perceptual factor shaping human behavior and wellbeing. This holistic view not only deepens our understanding but also informs the design and management of public spaces in ways that align with sustainability, inclusivity, and human centricity (Stokols, 2006).

Moreover, the transdisciplinary approach fosters synergy among diverse stakeholders – including architects, urban planners, sociologists, psychologists, and community members – enabling the co-creation of knowledge and solutions. It values the lived experiences and local knowledge of community members, integrating them with academic and professional expertise to yield richer, more contextually appropriate understandings and strategies for public spaces (Lawrence & Després, 2004).

Compared to conventional disciplinary studies that examine architectural public spaces, a transdisciplinary approach provides a more complex, integrated understanding of these spaces. Existing studies often focus on specific aspects, such as the physical design, social interaction, or environmental impacts. While these studies contribute valuable insights, they often overlook the interconnections and interactions between different aspects (Nicolescu, 2002). For example, an architectural study might focus on the role of design and materials in modulating daylight in public spaces, while a sociological study might examine the social interactions facilitated by these spaces.

Separately, these studies provide valuable insights, but they fail to capture the complex interactions between design, daylight, and social behavior. A transdisciplinary study, on the other hand, would integrate these perspectives, offering a more comprehensive understanding of how design and daylight together shape social interactions and vice versa. The transdisciplinary approach can reveal new insights not evident in single-discipline studies.

For instance, by integrating architectural, sociological, psychological, and urban planning perspectives, a transdisciplinary study might reveal how the interplay of design, daylight, social norms, and planning policies influences the inclusivity and vibrancy of public spaces. As such, it holds great promise for informing the creation and management of public spaces that are not only aesthetically pleasing and functional, but also socially inclusive, psychologically enriching, and ecologically sustainable.

Despite the strides made in understanding the complexities of architectural public spaces through a transdisciplinary lens, the exploration of these vital urban fabrics is far from complete. Future research could build upon this study by examining the impact of evolving technologies and societal trends on these spaces. For instance, the role of digital technologies, such as augmented and virtual reality, in reshaping public spaces warrants further investigation.

Additionally, future studies could explore the dynamic nature of public spaces over time. How do these spaces adapt to changing demographics, cultural trends, or climatic conditions? Longitudinal studies could provide valuable insights into these dynamic processes and their implications for the design and management of architectural public spaces. Also, cross-cultural comparative studies could illuminate the diverse ways in which different societies perceive, use, and manage public spaces. Such studies could inform culturally sensitive and contextually appropriate design and planning strategies (Carmona, 2019).

For practitioners and policymakers, the study underscores the value of a transdisciplinary approach in creating and managing architectural public spaces.

Architects and urban planners are encouraged to engage with experts from other fields, such as sociology, psychology, and environmental science, as well as community members, to co-create public spaces that cater to diverse needs and aspirations. Design and planning decisions should consider not only physical and aesthetic factors, but also social, psychological, and environmental dimensions.

For instance, in harnessing daylight, considerations should extend beyond illumination levels to include factors such as visual comfort, circadian health, energy efficiency, and aesthetic appeal (Nasar, 2011). Policymakers, too, have a crucial role in fostering conditions conducive for transdisciplinary collaborations. Policies and regulations should encourage integrated design and planning practices, provide platforms for multi-stakeholder engagement, and incentivize sustainable, human-centric development.

In conclusion, this study sheds light on the immense potential of a transdisciplinary approach in understanding and shaping architectural public spaces. By transcending disciplinary boundaries, it uncovers the rich tapestry of interconnections that animate our public spaces, revealing their true character as vibrant, dynamic, and multifaceted urban organisms. Yet, the transdisciplinary approach is not just an academic endeavor.

It holds profound implications for practice, inspiring architects, planners, and policymakers to rethink traditional processes and embrace a more collaborative, holistic, and human-centric approach to urban development. It invites us all, as inhabitants of these urban spaces, to partake in the creation of cities that are not only built, but also lived, experienced, and cherished.

In the face of escalating urbanization and environmental challenges, the transdisciplinary approach offers a beacon of hope. It points towards a future where architectural public spaces serve as crucibles of sustainability, inclusivity, and wellbeing, fostering a harmonious co-existence between humans and their built environment (Gehl, 2011).

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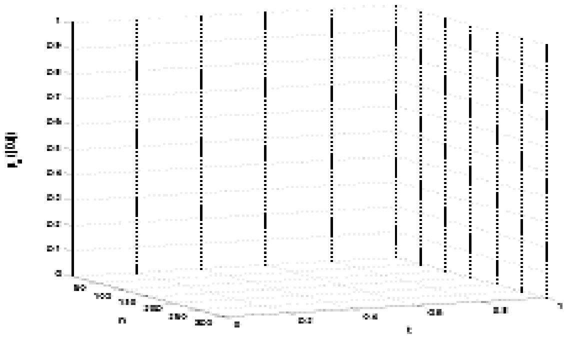

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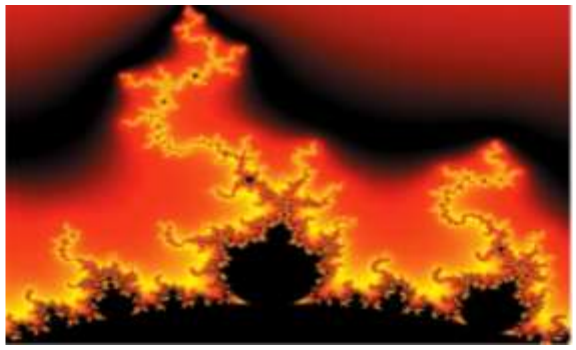

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