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Theme:

Innovative solutions based on the integration of recycled materials and objects (containers) in contemporary architecture: sustainable design strategies and their environmental impact.

The project:

Toy library in Biskra

Examiner's committee

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Dedication

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Abstract

This thesis investigates the potential of recycled materials in contemporary architecture, with a particular emphasis on the reuse of shipping containers as structural and spatial solutions. The study aims to highlight the advantages of this unconventional building system from environmental, economic, social, and architectural perspectives.

Recycling containers in construction not only contributes to the reduction of industrial waste and carbon emissions, but also offers a cost-effective, modular, and time-efficient alternative to traditional methods. The thesis reviews international case studies and projects that demonstrate the successful integration of container architecture in various contexts—ranging from housing and public infrastructure to cultural and educational facilities.

Special attention is given to the climatic and technical challenges of working with steel containers, such as thermal insulation, ventilation, and spatial adaptation. Through simulations, design analysis, and literature review, the research proposes strategies for enhancing comfort and sustainability in container-based projects.

The final phase of the thesis is a practical application: the design of a Toy Library project. This project serves as both a social and architectural initiative, using recycled containers to create a dynamic, child-friendly environment. It includes diverse functional zones that promote education through play, creativity, and interaction, while showcasing the architectural versatility and ecological value of reused materials.

Keywords

Recycled Materials / Shipping Containers / Sustainable Architecture / Modular Design / Eco-friendly Construction/ Toy Library/Children's Spaces / Adaptive Reuse / Educational Architecture / Environmental Design.

Résumé

Ce mémoire explore l'efficacité des matériaux recyclables dans l'architecture contemporaine et se concentre sur l'utilisation de conteneurs maritimes comme solution structurelle et spatiale. Cet objet représente la plus avancée de cette approche innovante, tant sur le plan environnemental qu'économique, social et architectural.

Le recyclage des conteneurs contribue à la réduction des déchets industriels et des émissions de carbone, tout en proposant une méthode de construction modulaire, rapide et économique. La recherche sera appliquée aux écoles internationales, illustrant l'intégration du secteur de la construction dans divers contextes : logements, équipements publics, espaces culturels et éducatifs.

Le mémoire utilise les technologies utilisées pour l'utilisation de conteneurs dans les zones les plus chaudes, notamment l'isolation thermique, la ventilation et la transformation spatiale. Des pistes de recherche, des simulations, des analyses de conception et des stratégies proposent des propositions pour améliorer le confort et la durabilité des projets basés sur les conteneurs.

La partie précédente du mémoire porte sur une application pratique : la conception d'un projecteur pour enfants. Ce projet, à la fois social et architectural, utilise des conteneurs recyclés pour créer un espace spacieux et éducatif pour les enfants. Il comprend des zones plus fonctionnelles qui favorisent l'application de l'environnement, l'interaction et la créativité, le tout en illustrant la valeur environnementale et les matériaux architecturaux utilisés.

Mots clés

Matériaux recyclés / Conteneurs maritimes / Architecture durable / Conception modulaire / Construction écologique / Ludothèque / Espaces pour enfants / Réemploi adaptatif / Architecture éducative / Conception environnementale.

ملخص

تتناول هذه المذكرة موضوع الإمكانيات المعمارية للمواد المعاد تدويرها، مع التركيز بشكل خاص على إعادة استخدام الحاويات البحرية كمكونات إنشائية ووظيفية بديلة في العمارة المعاصرة. يهدف البحث إلى إبراز مزايا هذا النهج غير التقليدي من الناحية البيئية، الاقتصادية، الاجتماعية، والمعمارية.

يُسهم توظيف الحاويات في البناء في تقليل النفايات الصناعية والانبعاثات الكربونية، كما يُوفّر بديلًا اقتصاديًا، مرنًا، وسريع التنفيذ مقارنة بالطرق التقليدية. يعتمد البحث على دراسة حالات من مشاريع عالمية ناجحة استخدمت الحاويات في مجالات متنوعة، مثل السكن، والمرافق العامة، والمراكز الثقافية والتعليمية.

كما تتناول الدراسة التحديات المناخية والفنية المرتبطة باستخدام الحاويات المعدنية، مثل العزل الحراري والتهوية والتكيّف الوظيفي للمساحات. ومن خلال التحليل النظري، والمحاكاة، والمراجع المعمارية، يقترح البحث حلولًا عملية لتحسين الراحة والاستدامة في مثل هذه المشاريع.

وفي الجانب التطبيقي، تقترح المذكرة مشروعًا معمارياً يتمثل في تصميم مكتبة ألعاب للأطفال. يجمع هذا المشروع بين الطابع الاجتماعي والبيئي، حيث يعتمد على إعادة تدوير الحاويات لتشكيل فضاء تعليمي وترفيهي متكامل للأطفال، يضم مناطق متعددة الأنشطة تعزز التعلم من خلال اللعب، التفاعل، والإبداع، ما يبرز مرونة هذه الحاويات وقيمتها المعمارية والبيئية.

الكلمات المفتاحية

المواد المعاد تدويرها / الحاويات البحرية / العمارة المستدامة / التصميم النمطي (المعياري) / البناء الصديق للبيئة / مكتبة الألعاب /فضاءات الأطفال / إعادة التوظيف المعماري / العمارة التعليمية / التصميم البيئي

TABLE OF CONTENTS

LISTE OF FIGURES

LISTE OF TABLES

INTRODUCTORY CHAPTER

I.1 BACKGROUND AND JUSTIFICATION OF THE SUBJECT

The significance of sustainability in contemporary architecture is critical, as it addresses pressing environmental challenges while promoting a harmonious relationship between built environments and natural ecosystems. The construction sector is one of the largest consumers of resources and a significant contributor to global waste, necessitating a paradigm shift toward sustainable design and construction practices that prioritise ecological integrity, economic viability, and social equity (Abdulaziz & Abdulaziz, 2023).

In this context, using recycled materials and developing innovative design strategies are essential for reducing the environmental impact of buildings. These approaches help conserve natural resources, reduce carbon emissions, and enhance the ecological performance of architectural projects, while also providing opportunities to improve their aesthetic and functional qualities (Silva, 2020).

Environmental issues related to construction and waste are multifaceted, encompassing the depletion of natural resources, pollution, and the generation of substantial amounts of waste. The construction industry is responsible for a significant portion of global carbon emissions and resource consumption, leading to an urgent need for sustainable practices that minimise these impacts (Abdulaziz & Abdulaziz, 2023) .The reliance on conventional materials often results in substantial waste, with many materials ending up in landfills, exacerbating environmental degradation (Silva, 2020). Consequently, the architectural community must adopt strategies that prioritize waste reduction, recycling, and the use of sustainable materials to create a more circular economy within the built environment (Altomonte, 2012).

The integration of recycled materials and objects into architectural design represents an innovative solution to the challenges posed by traditional construction practices. Using recycled materials not only reduces the demand for virgin resources but also significantly lowers the embodied energy associated with building projects (Silva, 2020). Research indicates that the use of recycled materials can save over 60% of the initial embodied energy of buildings, highlighting the potential for substantial energy savings and environmental benefits (Silva, 2020). Furthermore, the incorporation of recycled materials fosters creativity and innovation in design, as architects explore new ways to repurpose existing materials and integrate them into contemporary architectural practices (Katia Talento, 2020). This approach not only addresses waste management issues but also promotes a culture of sustainability within the architectural profession, encouraging future generations of architects to prioritise environmental stewardship in their work (Altomonte, 2012).

In addition to the environmental benefits, integrating recycled materials can also lead to cost savings by reducing both material procurement and waste disposal expenses.

Architects and builders can achieve significant savings while contributing to a more sustainable construction industry (Abdulaziz & Abdulaziz, 2023).

Moreover, the growing demand for sustainable and eco-friendly buildings has opened new market opportunities for businesses that use recycled materials and sustainable practices (Lei Cao, 2019). As the architectural landscape continues to evolve, the emphasis on sustainability and the innovative use of recycled materials will be vital in shaping the future of the built environment, ultimately leading to a more resilient and sustainable society.

I.2 PROBLEM STATEMENT

In recent decades, the construction industry has faced increasing criticism for its considerable environmental impact, especially due to excessive consumption of natural resources, high waste production, and contribution to greenhouse gas emissions. Traditional construction methods often depend on virgin materials, which are energy-intensive to extract and process, causing significant ecological damage. At the same time, large amounts of construction and demolition waste are disposed of in landfills, leading to a loss of valuable resources that could be reused. In this context, incorporating recycled materials and objects into architectural design has become a promising approach to minimise environmental impact, promote circular economy principles, and encourage more sustainable building practices.

However, despite growing awareness of the environmental benefits, the architectural application of recycled materials, raises questions regarding design quality, structural performance, user comfort, and aesthetic value. There remains a need for more in depth analysis of how these materials affect architectural outcomes and how they can be effectively integrated into creative and functional spaces. Furthermore, while existing studies have highlighted the environmental and economic benefits of using recycled materials, few have explored how these materials can also transform the creative process in architecture, influence spatial design, and reshape user perceptions of sustainable buildings. There is a need to explore how such materials not only contribute to sustainability goals but also open up new architectural languages and design possibilities.

This study aims to bridge this gap by examining the environmental, architectural, and economic implications of using recycled materials and objects in contemporary projects. Thus, the main questions guiding this study are:

- How can the integration of recycled materials and containers contribute to environmentally sustainable architectural solutions?
- What are the architectural, functional, and aesthetic impacts of using recycled materials in the design of contemporary projects?

I.3 RESEARCH OBJECTIVE

The main objective of this research is to explore strategies for integrating recycled materials and objects—particularly shipping containers—into architectural design to improve environmental performance and design quality. Specific objectives include:

- Identifying the most commonly used recycled materials in construction.

- Examining the benefits and limitations of containers as modular building elements.
- Analysing case studies that successfully incorporate recycled materials into container-based projects.
- Formulating practical recommendations for architects and building professionals to promote the utilisation of recycled materials and modular systems.

I.4 RESEARCH HYPOTHESIS

The central hypothesis of our study is that recycled materials and objects can improve the environmental performance of buildings while simultaneously offering new design potentials, both aesthetic and functional.

I.5 RESEARCH STRUCTURE

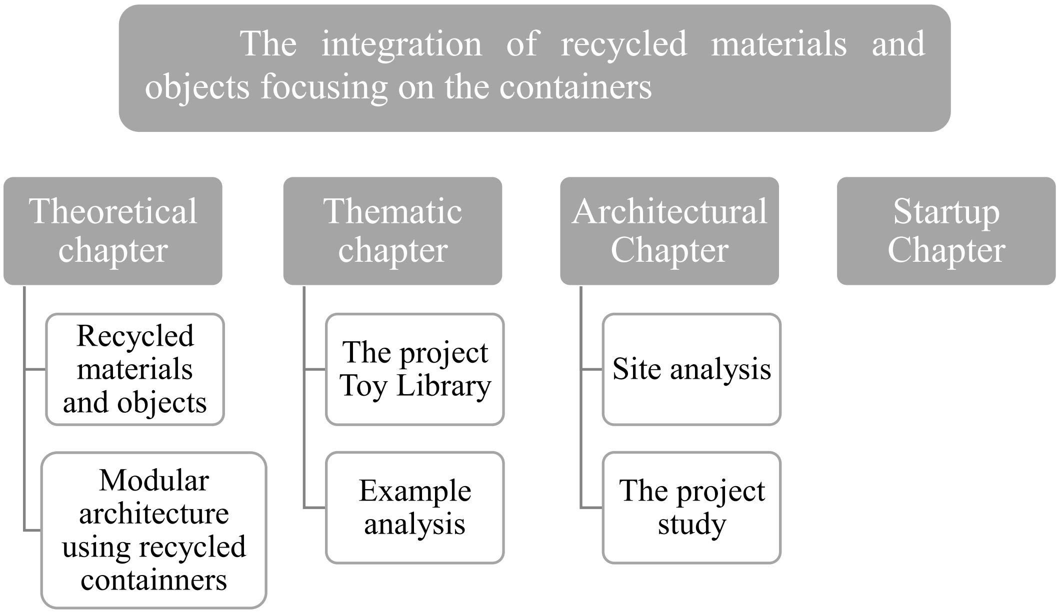
This thesis is structured into four chapters:

The first chapter provides the conceptual and scientific foundation for the research. It first explores the principles of sustainable architecture, focusing on the circular economy and the integration of recycled materials. It then presents a comprehensive classification of recycled materials and objects, including their types, technical performance, aesthetic and functional benefits, and their role in the building life cycle. A specific section is dedicated to modular architecture using shipping containers, detailing their dimensions, composition, benefits, costs, and construction adaptation techniques. The chapter concludes with international case studies of buildings successfully using recycled containers and materials.

The thematic chapter focuses on the Toy library project. It explores the conceptual foundations and motivations for choosing a toy library, emphasizing its educational, social, and cultural significance for children and the wider community. The chapter presents a detailed analysis of the functional and spatial organization of a toy library, highlighting key areas. It also addresses user needs, accessibility, and safety requirements, with reference to architectural standards and norms, In addition, the chapter includes a comparative study of existing toy libraries.

The third chapter presents the full architectural development of the Toy Library project. It starts with a site analysis to understand the environmental and urban context. Then it outlines the design program, including spatial requirements and technical constraints. Finally, it presents the conceptual idea and the final architectural project, demonstrating how recycled containers can be creatively and effectively used.

The final chapter explores the potential of the proposed approach. It highlights how sustainable container-based construction can inspire innovative business models in architecture. It considers aspects such as cost reduction, market demand for eco-friendly buildings, and opportunities for creating a start-up focused on modular container architecture.


The integration of recycled materials and objects focusing on the containers
Theoretical chapter
Recycled materials and objects
Modular architecture using recycled containners
Thematic chapter
The project Toy Library
Example analysis
Architectural Chapter
Site analysis
The project study
Startup Chapter

II. THEORETICAL CHAPTER: INNOVATIVE SOLUTIONS BASED ON THE INTEGRATION OF RECYCLED MATERIALS AND OBJECTS IN CONTEMPORARY ARCHITECTURE: SUSTAINABLE DESIGN STRATEGIES AND THEIR ENVIRONMENTAL IMPACT

INTRODUCTION

This chapter presents the theoretical foundation of the research by exploring the intersection of sustainable architecture and the integration of recycled materials and objects, particularly shipping containers, within contemporary design practices. It aims to provide a comprehensive understanding of how ecological responsibility, circular economy principles, and architectural innovation converge to shape new approaches in building design. The chapter critically reviews key concepts such as sustainable architecture, the circular use of materials, and modular construction, with a focus on their environmental, social, and aesthetic implications.

By examining relevant literature, architectural theories, and exemplary case studies, this chapter seeks to contextualize the innovative use of recycled resources as a response to the growing environmental and urban challenges faced by the construction sector. Emphasis is placed on the role of architects and designers in reimagining discarded materials not as waste, but as valuable resources that contribute to resilient, adaptable, and cost-effective building solutions. In particular, the use of recycled shipping containers is investigated as a modular and flexible alternative that aligns with sustainability goals while addressing pressing needs such as housing, education, and community infrastructure.

II.1 SUSTAINABLE ARCHITECTURE

Sustainable architecture can be defined as an approach to building design and construction that prioritises environmental stewardship, resource efficiency, and social responsibility. This architectural philosophy aims to minimise the negative impacts of buildings on the environment while enhancing the quality of life for occupants and the surrounding community.

Sustainable architecture encompasses a range of practices, including the use of renewable energy sources, sustainable materials, and efficient waste management systems (Udomiaye, Chukwuali, & Kalu kalu., 2020).

According to Udomiaye et al., (2020) sustainable architecture is not merely a set of prescriptive measures but rather an overarching approach, practice, and attitude towards design. This perspective emphasises that sustainable architecture involves a holistic understanding of how buildings interact with their environment and the broader social context. It seeks to create spaces that are energy-efficient, reduce carbon footprints, and utilize materials that are either renewable or recycled, thereby contributing to a circular economy (Aram Min, 2019).

Furthermore, sustainable architecture incorporates principles that address the social and cultural dimensions of building design. It aims to create inclusive spaces that foster community engagement and reflect the values and needs of diverse populations (Olga L. Bantserova, 2023). This approach recognizes that the built environment plays a crucial role in shaping human experiences and interactions, and thus, it should be designed with consideration for both ecological sustainability and social equity (Aurelija Daugelaite, 2021) .

II.2 INTEGRATION OF RECYCLED MATERIALS: A CIRCULAR APPROACH IN ARCHITECTURE

Integrating recycled materials in architecture plays a key role in the circular economy, which focuses on reducing waste and reusing resources sustainably. One important method is adaptive reuse, where existing buildings or materials are repurposed for new functions. This practice helps preserve the embodied energy of materials, reduce environmental impact, and conserve cultural heritage (A. Dongez, 2021). Recycled materials can also add unique aesthetic value due to their texture, history, and character (Incelli, 2023).

The concept of design for disassembly supports future reuse by using materials and construction techniques that enable buildings to be easily disassembled and repurposed (Incelli, 2023). This extends the lifespan of materials and reduces construction waste.

Environmentally, recycled materials help lower carbon emissions. For example, using recycled aggregates in concrete significantly reduces the carbon footprint compared to traditional concrete (Shashank, 2024). Additionally, innovative materials like mycelium-based composites demonstrate the potential of bio-based recycled alternatives that are both sustainable and high-performing in construction (A. Xia, 2024).

By applying these strategies, architects can achieve both functional and environmental objectives while promoting resource efficiency.

II.2.1 Most common recycled materials used in architecture

The most common recycled material used in architecture was Recycled Concrete at 15%; followed by Recycled Asphalt and Wood, with 12 and 8% respectively. Seven percent of the companies did not use recycled material at all. There were a few companies that were not included in the graph. These companies used less than 2% of any given recycled material including tire rubber, silica fume, glass, cement kiln dust, carpet, foundry sand, swine manure, animal fat, soy bean, citrus peels, sewage sludge and date and oil palm tree, which were listed in the survey as usable recyclable materials for construction applications. Other materials that were mentioned that had a low percentage usage were cast iron, copper, brass and sawdust (Fini, 2013).

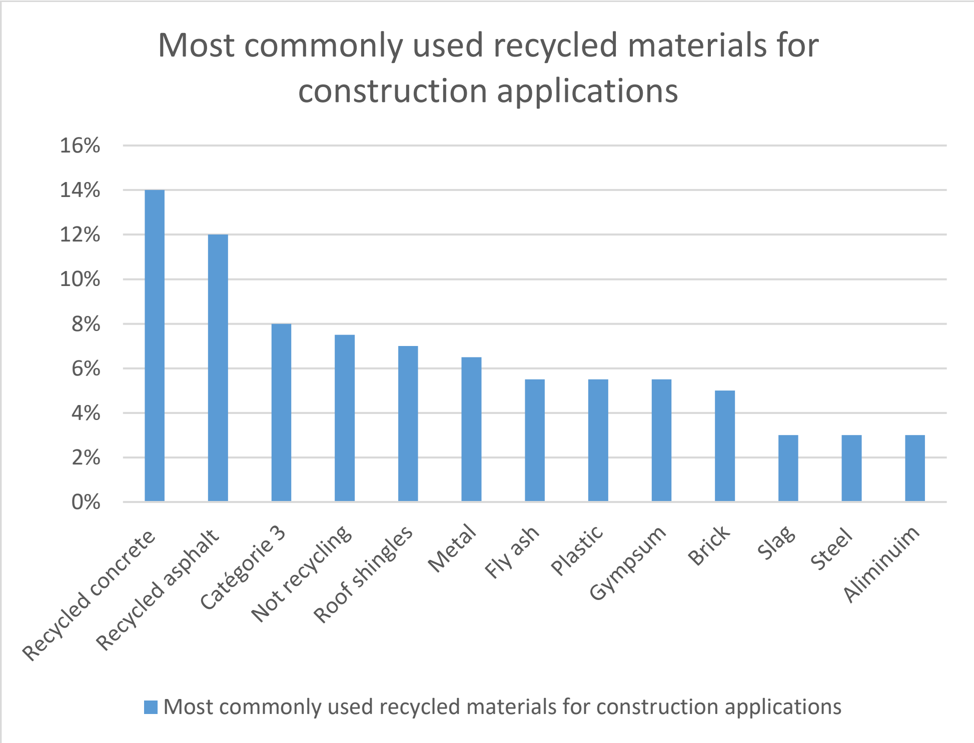


Figure 1: Most commonly used recycled materials for construction applications.

II.2.2 Type of recycled materials

The construction industry is increasingly adopting recycled materials to enhance sustainability and reduce environmental impacts. Various types of recycled materials can be effectively utilised in building construction, each contributing to resource conservation and waste reduction. Below, there are some key types of recycled materials commonly used in the construction sector.

a) Recycled wood

Wood is a sustainable alternative in construction, reducing carbon emissions and improving air quality, especially when it is responsibly sourced. Construction waste, including materials from new projects, renovations, and demolitions, contributes significantly to wood waste, making up 20-30% of construction and demolition waste (CDW), with variations across countries (26.7% in Germany, 10-16% in Brazil, and 6-7% in the U.S.A) (Soto-Paz, et al., 2023).

Wood waste can be categorised into three main types: untreated wood, engineered wood waste (EWW), and preservative-treated or painted wood. Untreated wood can be reused for packaging, furniture, or construction, while treated wood is processed into MDF, OSB, or used as biomass fuel. Despite increasing interest in the reuse of salvaged wood in sustainable construction, recycling remains limited. A study in the UK found that only 10-15% of timber used in new construction is recycled (Kinga Rybak-Niedziółka, 2023).

Figure 2 The process of using recycled wood in the construction technology

b) Recycled plastic

Research on plastic waste management explores solutions for architecture and urban planning, focusing on biodegradation, recycling, and repurposing. Studies highlight historical reuse practices, including container architecture, where materials like plastic are repurposed for economic and environmental benefits

Plastic waste finds applications in contemporary art and architecture, reflecting anti-aesthetic trends that embrace imperfections and aging materials. The movement for integrating plastic waste into architecture emerged in the 1970s, addressing poverty and economic inequality. Scholars classify plastic packaging as a key recycled material in structural components. Given plastic's resistance to degradation, policies promote its reuse in construction, including brick production as an economical and sustainable alternative. Buildings using PET bottles as bricks offer benefits like reduced processing time, energy efficiency, and improved insulation (Kinga Rybak-Niedziółka, 2023).

Recycled plastic is also used in road construction, insulation, and energy generation through pyrolysis. It enhances soil embankments, strengthens asphalt mixtures, and improves pavement durability while reducing environmental impact (Marsahala, 2023).

Figure 3 PET bottles used as flowerpots in a public space in Zurich.

c) Recycled Concrete Aggregate (RCA)

Recycled concrete aggregate (RCA) is produced by crushing concrete debris from demolished structures. It can be reused in new concrete mixtures, offering similar mechanical properties to natural aggregates. This reduces landfill waste, conserves natural resources, and lowers the demand for virgin aggregates (M. N. Soutsos, 2011).

Concrete has a significant carbon footprint, and while RCA helps reduce environmental impact, it presents challenges related to chemical properties, durability, and strength. Recycled aggregates often show lower elasticity and increased shrinkage, making them more suitable for non-structural applications. Innovative techniques are improving RCA quality, including cement slurry impregnation, mechanical abrasion, annealing, and the use of superplasticizers to enhance mechanical properties.

Concrete recycling minimizes raw material consumption, reduces waste, and can cut water usage by up to 30%. The process includes crushing, refining, and classifying materials for different uses in concrete production. (Kinga Rybak-Niedziółka, 2023).

Figure 4 Recycled concret (constructionofamulti-familyhouse,)

d) Recycled Glass

Recycled glass is used in construction as a substitute for natural aggregates in concrete and asphalt, reducing landfill waste while enhancing aesthetics. However, challenges such as workability issues and alkali-silica reactions must be addressed (A. Shyshkin, 2023).

Glass is an isotropic material with properties influenced by its smelting process. It is widely used in modern construction for windows, facades, walls, roofs, and floors, utilizing reinforced, flat rolled, or tempered glass. Glass is chemically stable and can be recycled repeatedly without losing its composition. It offers diverse textures, colors, transparency levels, and thermal properties, making it suitable for various climatic and structural applications. Recycling glass reduces the demand for raw materials and energy, though chemical incompatibility among different glass types poses a challenge. (Kinga Rybak-Niedziółka, 2023).

Figure 5 Glass recycling process. (Source:istockphoto.)

e) Ceramics

In recent years, industrialization and economic growth have improved the quality of life but also increased environmental waste, particularly in the construction sector. Ceramics, a natural material used in construction, can often be reused with minimal processing. However, using them in their raw form may be impractical or economically unfeasible. This has led to growing awareness of waste management, particularly in relation to industrial and construction waste. Pioneers in ceramic recycling, such as Kats and Kvyatkovs kaya, began researching its potential in 1972, but it was after 2000, driven by certification programs like LEED and BREEAM, that recycling gained more traction. Ceramics require thermal treatment for use as building materials, which enhances their strength and provides insulation properties. Reusing ceramics, particularly in historic building renovations, involves cleaning them of mortar and repurposing them as aggregates in concrete or mortar (Kinga Rybak-Niedziółka, 2023).

f) Metals

Metals are extensively used in the construction industry as homogeneous materials and components in various products. However, the production of metal products involves significant environmental costs related to ore extraction and material manufacturing, which are energy-intensive processes. Common metal applications in construction include structural elements such as steel components, reinforcements in reinforced concrete, mechanical fasteners, doors, windows, pipes, electrical cables, and façade materials.

Metal products are categorized into two main groups: ferrous metals, which serve structural purposes in construction, and non-ferrous metals such as copper, zinc, and aluminum, which are used for manufacturing installation components, doors, windows, and cladding. Metals are highly recyclable, making them valuable demolition materials. The extraction of metals involves dismantling large components from steel structures, crushed reinforced concrete, and installations like pipes and electrical cables.(Kinga Rybak-Niedziółka, 2023).

Figure 6 Reinforcing bars made of recycled metal.

g) Reclaimed Asphalt Pavement (RAP)

Reclaimed asphalt pavement (RAP) is derived from the milling and recycling of existing asphalt surfaces. It is extensively used in new asphalt mixtures, with a recycling rate in the United States exceeding 99%. The incorporation of RAP into new pavements enhances durability and reduces the need for virgin materials, thus contributing to environmental sustainability (Reichheld, 2017). The use of RAP is particularly beneficial in road construction, where it can be used for backfilling and reworking base courses (Reichheld, 2017).

Figure 7: Reclaimed Asphalt Pavement (Source: Posillico Materials)

h) Roofing Shingles

Asphalt roofing shingles are another significant source of recycled materials in construction. Each year, millions of tons of asphalt shingles are generated as waste. Recycled shingles can be used in asphalt mixtures, providing benefits such as improved rutting resistance and reduced production costs for hot mix asphalt (HMA) (A. Shyshkin, 2023). The use of recycled shingles not only conserves resources but also reduces the environmental impact of roofing waste (A. Shyshkin, 2023).

Figure 8 : Recycling roofing Shingles (Source: J.N. Davis Roofing)

i) Carpet Fibers

Recycled carpet fibers can be incorporated into concrete mixtures to enhance properties such as toughness and tensile strength. Studies have shown that adding carpet fibers to concrete can reduce shrinkage and improve fatigue strength, wear resistance, and overall durability (A. Shyshkin, 2023). This innovative use of recycled materials contributes to the sustainability of construction practices by reducing waste and enhancing material performance.

Figure 9 Recycled carpet fibers (Rubicon)

j) Fly Ash

Fly ash, a by-product of coal combustion in power generation, is commonly used as a partial replacement for cement in concrete. Its incorporation improves the workability and durability of concrete while reducing the overall environmental impact of construction (A. Shyshkin, 2023). Fly ash can also contribute to energy savings by lowering the heat of hydration in concrete mixtures (A. Shyshkin, 2023).

Figure 10: Recycled fly ash (Construction & Demolition Recycling)

k) Cement Kiln Dust (CKD)

Cement kiln dust (CKD) is a by-product of cement manufacturing that can be utilized in various applications, including soil stabilization and as a partial replacement for cement in concrete. CKD enhances the strength and durability of concrete while minimizing waste (A. Shyshkin, 2023). Its use in construction contributes to sustainable practices by reducing the demand for virgin materials and promoting recycling.

l) Foundry Sand

Foundry sand, a by-product of metal casting, is increasingly being used as a substitute for natural sand in construction applications. Its properties make it suitable for use in concrete, asphalt mixtures, and as fill material in various construction projects (A. Shyshkin, 2023)

In conclusion, the future of architecture lies in its ability to embrace recycled materials as a core component of sustainable design. By leveraging innovative technologies and design strategies, architects can create resilient and environmentally responsible structures that not only meet the needs of contemporary society but also contribute to the preservation of natural resources for future generations. The ongoing discourse surrounding sustainable material selection and the circular economy will undoubtedly shape the trajectory of architectural practices, encouraging a shift towards more sustainable and responsible construction methodologies.

II.2.3 **Technical Characteristics and Performance of Recycled Materials**

Recycled materials are increasingly being utilized in architecture due to their sustainability benefits and impressive performance characteristics. This comprehensive overview will explore the technical aspects of recycled materials in construction, focusing on thermal insulation, acoustic and sustainability properties, supported by specific studies, case examples, and industry insights.

Table 1: Technical characteristics and performance of recycled materials

Thermal Insulation	
Thermal Conductivity and R-Values	**Cellulose and Rice Husk-Based Insulation:** These materials, derived from recycled paper and rice husks, have shown a thermal conductivity of 0.04 W/m·K, indicating good potential for thermal insulation applications (Nacari , Sergio , & Arthur M , 2023)
	Recycled Cardboard Insulation Panels: Panels made from recycled cardboard have demonstrated thermal conductivity values comparable to conventional materials like cork and expanded polystyrene. (Jemi , B, & Meghana , 2023)
	Recycled Concrete with Wood and Perlite: Lightweight thermal insulation recycled concrete (LTIRC) using waste wood and expanded perlite has shown a reduction in thermal conductivity by up to 76.5% compared to conventional concrete. (Chenyang & Wangjie , 2024)
	Bio-Based Insulation Materials: Various bio-based insulation materials, including those made from agricultural waste, have thermal conductivity values ranging from 0.024 to 0.07 W/mK. (Cristian , et al., 2023)
Energy Efficiency Performance	The use of recycled materials in building insulation can lead to substantial energy savings. Walls insulated with recycled polyurethane (PU) materials can achieve an energy saving rate of up to 85.4% per square meter compared to traditional insulation methods. (Yan , et al., 2024). The integration of recycled materials in building envelopes significantly reduces energy consumption for heating and cooling, particularly in regions with extreme temperature variations (Yan , et al., 2024)
Comparative Analysis with Traditional Materials	• Cellulose-based insulation maintains its R-value under temperature fluctuations, offering consistent thermal performance comparable to mineral wool and polystyrene. (Cristian , et al., 2023) • Beyond thermal performance, recycled materials contribute to reduced carbon footprints and lower embodied energy compared to conventional insulation materials. (Cristian , et al., 2023)
Acoustic properties	

Specific Studies and Findings	**Recycled Textile Materials:** Nonwoven fabrics made from recycled polyester and polypropylene fibers have been studied for their sound absorption characteristics. These materials are used as sound absorbers, sound diffusers, noise barriers, and sound reflectors. (Nilgün , Gonca , & Gamze , 2020)
	Recycled Paper and Wool Panels: Panels composed of waste paper and wool fibers have been tested using impedance tubes, showing effective sound absorption across a range of frequencies (100 - 5000 Hz). (Cinzia , Elisa , Elisa , & Giovanna, 2016)
	Bio-based Materials: Which include recycled components have been recognized for their good sound absorbing and insulation performances. These materials are considered eco-friendly alternatives to synthetic options, offering lower environmental impact and effective noise control. (Xiaodong , Birm-June , Qingwen , & Qinglin , 2014)
Sound Absorption and Noise Reduction	Recycled rubber granules and textiles from car interiors have been identified as having good acoustic parameters, making them suitable for sound insulation applications. (Miroslav , et al., 2022) These materials are already used in the production of compact acoustic panels, indicating their effectiveness in noise reduction. (Miroslav , et al., 2022)
Comparative Analysis with Traditional Materials	Panels made from recycled paper and wool fibers have demonstrated acoustic absorption properties similar to those of conventional porous materials like rock wool and glass wool. These recycled panels not only provide effective sound absorption but also offer environmental benefits by reducing waste and production costs. (Cinzia , Elisa , Elisa , & Giovanna, 2016)
Industry insights and market trends	
Market Growth	The global market for recycled plastics in construction is projected to grow from USD 5 billion in 2024 to USD 6.6 billion by 2029, at a CAGR of 5.3%. (Laura , 2024) North America is expected to dominate the sustainable construction materials market due to strict building requirements and environmental laws (Sustainable Construction Materials Market Size, Share, and Trends 2024 to 2033, 2024).

Economic Aspects	While recycled materials offer environment al benefits, the high cost of production can be a barrier to their widespread adoption. However, advancements in technology and increased demand are expected to make these materials more cost-effective over time. Various governments provide financial incentives, such as tax credits and subsidies, to encourage the use of sustainable building materials.

II.2.4 **Sustainable design strategies with recycled materials**

Sustainable design strategies in architecture increasingly emphasise the integration of recycled materials, which align with ecological design methods and bioclimatic approaches. The use of recycled materials not only reduces waste but also enhances the aesthetic and functional aspects of buildings, contributing to a circular economy in the construction sector

a) Bioclimatic approach and recycled materials.

The bioclimatic approach in architecture focuses on optimizing building design according to local climatic conditions, thereby enhancing energy efficiency and occupant comfort. This approach can be effectively combined with the use of recycled materials, which can provide both structural integrity and aesthetic value. For instance, the integration of recycled agricultural materials has been shown to improve mechanical properties and reduce carbon emissions, thus supporting sustainable construction practices (A Jayaraman, et al., 2023). In addition, the use of recycled timber in framing can reduce the carbon footprint associated with new lumber production while providing excellent thermal insulation properties (A Jayaraman, et al., 2023). Furthermore, bioclimatic architecture emphasises the importance of local materials and climate-responsive design, which can be achieved through the use of locally sourced recycled resources (Jarwa & Ikaputra , 2019; El-Sayed, 2023).

In practice, the ECO-Block project in the Netherlands exemplifies this integration. The building utilises recycled concrete blocks made from crushed demolition waste, which not only reduces the demand for new materials but also enhances thermal mass, thereby improving energy efficiency during temperature fluctuations (Jarwa & Ikaputra , 2019) . The bioclimatic design principles applied in this project, such as passive solar heating and natural ventilation, work synergistically with the recycled materials to create a sustainable living environment.

b) Strategies to reduce building gray energy.

Gray energy, defined as the total energy consumed throughout the lifecycle of a building material, from extraction to disposal, can be significantly reduced through the use of recycled materials. For instance, the Green Building Council promotes the use of recycled steel, which can save up to 75% of the energy required to produce new steel (El-Sayed, 2023).

A notable example is the Bullitt Center in Seattle, often referred to as the "greenest commercial building in the world." It incorporates recycled materials such as reclaimed wood and recycled steel, which contribute to a substantial reduction in gray energy. The building's design also incorporates energy-efficient systems, such as a green roof and rainwater harvesting, which further minimize its environmental impact (Mohammadjavad , Seyedmohammadhadi , Razieh , & Ali , 2014).

c) Integration into the Building Life Cycle

The life cycle of a building encompasses three primary phases: construction, usage, and deconstruction. Each phase presents opportunities for the integration of recycled materials.

Table 2 : Phases of the LIFE CYCLE

Phases	
During the construction phase	The use of recycled materials can significantly reduce waste. For example, the **Kendeda Building** for Innovative Sustainable Design at Georgia Tech employs salvaged materials, including reclaimed wood and recycled concrete, which minimizes construction waste and lowers the environmental footprint (Bera & Pranab , 2022).
In the usage phase	Buildings designed with recycled materials often exhibit enhanced energy performance. The **One Central Park** project in Sydney incorporates recycled materials in its façade, which not only provides aesthetic value but also improves thermal performance, reducing the need for artificial heating and cooling (Okoye, Obinna, Christian , & Chukwuemeka , 2020).
During the deconstruction phase	The potential for material reclamation is critical. The "Circular Economy" model encourages the design of buildings that can be easily disassembled, allowing for the reuse of materials. The **Cascadia Green Building Council** has developed guidelines for deconstruction that emphasize the importance of designing for disassembly, thereby facilitating the reuse of recycled materials in future projects (Atefeh , Mohammad , Faezeh , & Farzaneh , 2021).

d) Aesthetic and Functional Optimization

The use of recycled materials in architecture can significantly influence both aesthetic and functional aspects of design. Recycled materials often possess unique textures and colors that can enhance the visual appeal of a building. For instance, the Recycled House project in Australia showcases the use of recycled bricks and tiles, creating a distinctive façade that tells a story of sustainability (Hatem & Ashraf , 2023).

Functionally, recycled materials can improve building performance. The Bamboo House in Vietnam uses recycled bamboo, which is not only a sustainable material but also offers excellent structural properties. The design incorporates bamboo's natural flexibility, allowing the building to withstand seismic activity while providing an aesthetically pleasing environment (Mohamed , Yassine , Driss , & Abdelaziz , 2022).

Moreover, the integration of recycled materials can foster a sense of community and environmental stewardship. Projects like the High Line in New York City, which repurposed an abandoned railway into a public park using recycled materials, exemplify how such designs can enhance urban spaces while promoting sustainability (Manzano-Agugliaro, Sabio-Ortega, & García-Cruz, 2015).

e) Circular approach

Adopting a circular approach in architecture involves designing buildings that are not only sustainable but also capable of being deconstructed and repurposed. This approach aligns with the principles of bioclimatic architecture, which advocates for the efficient use of resources and minimal environmental impact (El-Sayed, 2023). By utilizing recycled materials, architects can create structures that are adaptable and resilient, contributing to a circular economy where materials are continuously reused and recycled (Mohammadjavad , Seyedmohammadhadi , Razieh , & Ali , 2014) (A Jayaraman, et al., 2023) . This not only conserves resources but also reduces the carbon footprint associated with new material production.

II.3 INTEGRATION OF RECYCLED OBJECTS IN ARCHITECTURE

The integration of recycled objects into architecture represents a creative and sustainable response to the growing challenges of resource depletion, environmental degradation, and construction waste. Unlike recycled raw materials, recycled objects, such as shipping containers, windows, doors, wooden beams, metal components, and even furniture, retain their original form or function and are repurposed in innovative ways within new architectural contexts. This approach not only reduces the demand for virgin materials but also gives a second life to objects that would otherwise contribute to landfill waste.

Beyond their environmental benefits, recycled objects introduce unique aesthetic and symbolic dimensions to architectural projects. Their reuse encourages designers to think beyond conventional solutions and embrace new forms of expression rooted in sustainability, history, and cultural meaning. Whether used as structural elements or decorative features, these objects enhance the identity and character of buildings while promoting circular economy principles.

II.3.1 Recycled objects used in architecture

The creative reuse of recycled materials in architectural design encompasses a wide variety of objects, each with unique properties that can be leveraged for sustainable construction practices. Below, we provide examples of various recyclable materials, supported by relevant literature.

f) Shipping Containers

Shipping containers have become a popular choice in architectural design, driven by the demand for sustainable building practices and innovative design solutions. Originally designed for

transport, these containers are being repurposed into various architectural forms, including residential units, commercial spaces, and public facilities. This approach not only reduces waste but also offers economic benefits by using existing materials (Mohamed E. G., 2017).

A major advantage of using shipping containers is their modularity. Containers can be easily stacked, arranged, and modified to create flexible spatial configurations, making them versatile for different design needs. This feature is particularly useful in educational settings, where architecture students can explore container architecture through problem-based learning (PBL) methodologies (Mohamed E. G., 2017) .Additionally, containers' adaptability allows architects to create spaces that fulfill specific functional requirements while maintaining aesthetic appeal (Faragallah, 2022).

Figure 11 : Shipping Container Architecture (Source: Danny Bright)

Thermal performance is another important aspect, especially in extreme climates. Research has shown that shipping containers can be effectively insulated and modified to enhance thermal performance, making them suitable for hot and humid environments. This is essential for occupant comfort and energy efficiency in container-based buildings, contributing to sustainable urban development (Elrayies, 2017).

Figure 12 Container architecture (Source: CONTAINERWERK)

g) Pallets

The reuse of pallets in architecture provides a sustainable solution that meets both functional and aesthetic needs. Primarily made from wood, pallets are commonly used in logistics and transportation, with a significant portion being recycled or repaired. This process is energy-efficient, consuming less electricity than manufacturing new pallets, making it environmentally beneficial.

Pallets offer flexibility in design due to their modular nature, allowing architects to experiment with different configurations. Their structural integrity, including compression strength, plays a key role in ensuring the safety and functionality of architectural applications. By integrating pallets, architects can create innovative designs while minimizing waste and maximizing the use of existing material. Additionally, using wooden pallets helps reduce the carbon footprint compared to non-wood alternatives, contributing to a circular economy where materials are repurposed instead of discarded (Yan , et al., 2024).

Figure 13 : "House among the trees" Architectural example of a house that used panels in its walls (Source: divisare)

h) Tires

Recycled tire rubber is increasingly used in construction, mixed with soil for lightweight fill materials or incorporated into asphalt mixtures to enhance performance. Its high tensile strength and chemical stability make it ideal for various applications. Reusing tires helps reduce environmental issues, as approximately 800 million tires are discarded annually (A. Shyshkin, 2023). Recycled tires are used in earth-sheltered homes, landscaping, and playgrounds. They provide excellent thermal insulation, helping regulate indoor temperatures. Their durability and weather resistance make them suitable for outdoor applications, contributing to waste reduction and environmental sustainability

.

Figure 14 Recycled Rubber Flooring (Commercial Mats and Rubbe)

i) Glass Bottles

Recycled glass bottles are used in construction for walls, decorative elements, and insulation. When incorporated into walls, they provide natural light while maintaining privacy.

Figure 15) Creative way for using recycled Glass Bottles on the wall (milkwood.net)

j) Bricks and Concrete

Bricks and Concrete are commonly reused in construction for structural elements, landscaping, and pathways. Their high durability and strength make them ideal for load-bearing applications.

Figure 16 Reused Bricks (Lendager Group)

k) Textiles

Textiles are used in architecture for tensile structures, insulation, and decorative elements. Their lightweight and flexible nature enables innovative designs, while their insulating properties enhance energy efficiency.

Figure 17 : Recycled textile (https://www.fab-brick.com/)

l) Old Furniture

Old Furniture is repurposed in interior design for partitions, decorative features, and unique furnishings.

It adds character and history to spaces, offering a cost-effective and sustainable solution.

Figure 18 : Reused drawers

m) Wooden Crates

Wooden Crates are commonly repurposed for shelving, furniture, and decorative elements. They are versatile, easily sourced, and easily modified for different uses. Their rustic charm enhances interior aesthetics while promoting sustainability in design.

Figure 19: Reused Wooden Crates

II.4 CONTEMPORARY ARCHITECTURE INTEGRATING RECYCLED MATERIALS AND OBJECTS

In recent years, an increasing number of architects and designers have incorporated the use of recycled materials and objects as a key element of sustainable and innovative design. These practices not only respond to urgent environmental concerns but also redefine the aesthetic and functional possibilities of architectural creation. Through the integration of salvaged materials, such as wood, metal, plastic, glass, and industrial objects, architectural projects can significantly reduce their ecological footprint while showcasing a creative reinterpretation of form and function.

Below we present a selection of contemporary architectural projects that exemplify how recycled materials and objects are being successfully incorporated into design. These examples highlight diverse approaches across different contexts, scales, and building types, illustrating the versatility and potential of reuse in both practical and artistic terms.

II.4.1 The Container City

The "Container City" project in London is an example of innovative architectural design that utilises repurposed shipping containers for urban housing and workspace solutions. The project addresses housing shortages and rising property prices in London while emphasising sustainability, adaptability, and community engagement.

Launched in 2001, the Container City project aims to provide affordable housing and workspaces in a city struggling with housing shortages. The use of shipping containers allows for quick construction and flexible designs, making it an ideal solution for urban development.

By reusing shipping containers, the project reduces waste and contributes to sustainability. Containers, known for their durability, can be reused multiple times, which decreases the need for new building materials. Energy-efficient design elements are incorporated into the project to lower carbon footprints compared to conventional construction.

Container City has sparked discussions about gentrification, as it represents a government-driven initiative to revitalize urban areas. Critics argue that such projects might displace lower-income residents. However, the Container City project strives to be inclusive by offering affordable spaces amidst the rising costs of living in London.

Container City encourages collaboration and interaction among local businesses, artists, and residents. It features studios, offices, and communal areas that promote community engagement. The project aims to create an inclusive environment where diverse communities can interact and thrive.

Figure 20 : Container City(source: simon Richards photography)

The project highlights the versatility of shipping containers as building materials. The modular nature of containers allows for creative designs that fulfill various functional needs. Container City serves as a case study for the integration of unconventional materials in urban design, showcasing their potential in mainstream architectural practices.

Despite its successes, Container City faces challenges in terms of public perception, with some viewing it as a temporary or inferior building solution. Regulatory challenges and building codes that are not fully suited to container construction can also hinder the project’s expansion. Economic factors may also influence the acceptance of such innovative projects.

As London evolves into a smart city, the principles demonstrated by Container City can inform future urban development strategies. The integration of sustainable practices and technology in container architecture aligns with the goals of the Smart London Plan, which promotes innovation, inclusivity, and sustainability in urban planning. Container City serves as a model for future urban projects balancing economic, social, and environmental considerations.

II.4.2 **A temporary office space in Tokyo**

Hiroki Tominaga Atelier's innovative approach to architectural design, particularly through the use of deconstructed pallets to dress a Tokyo office, exemplifies a blend of sustainability, aesthetics, and functionality.

Figure 21 Interior view of the office (dezeen)

The design focuses on the creative reuse of wooden pallets, which are deconstructed and reassembled to form both structural and aesthetic elements. This approach emphasizes sustainability and resourcefulness, aligning with contemporary architectural trends. The use of pallets introduces a tactile connection to the space's material origins and brings a unique quality to the office, reflecting a modern interpretation of traditional timber construction.

The design effectively utilizes vertical space, with pallets being used not only for walls and partitions but also for ceiling treatments and shelving. This innovative use of space maximizes functionality while maintaining an open and airy feel within the office. The strategic arrangement of pallets can also facilitate natural light penetration, enhancing the overall ambiance of the workspace.

The project incorporates biophilic design principles by emphasizing natural materials and textures, which can enhance occupants' connection to nature. The use of wood, a natural material, contributes to a calming environment that can improve productivity and reduce stress levels among employees. This alignment with biophilic design reflects a growing trend in architecture that seeks to create healthier and more sustainable workspaces.

Deconstructed pallets provide a raw, organic aesthetic that contrasts with the typical modern finishes of office spaces. The natural textures and colour variations of the wood create a warm, inviting environment. This choice of material enhances the sensory experience and adds visual dynamism, making the office both a functional and visually engaging space.

The roof is primarily composed of deconstructed pallets, creating a lightweight yet durable roofing system. The modular nature of the pallets allows flexibility in design and efficient load distribution, ensuring stability while minimizing the need for additional structural support. This method aligns with sustainable architecture principles, prioritizing resource efficiency and structural integrity.

II.4.3 **Prahran Hotel**

Prahran Hotel in Victoria, Australia, creatively integrates recycled materials into its design. Despite the name, it's not a hotel but a pub focused on eating and drinking. The building features a striking Art Deco façade and is defined by the unique addition of concrete pipes on the back of the façade, a key element of the renovation.

Figure 22 The hotel prahran (photography by © Peter Clarke)

The concrete pipes are not merely decorative; some are repurposed as cabins with tables and benches for diners. These pipes create a blend of indoor and outdoor experiences, offering an interesting contrast between the enclosed, wood-lined interiors and the open sides that provide diners with views of the street.

The renovation introduces a two-story space with a central courtyard, designed as an informal standing area for drinking. The recycled concrete pipes are strategically placed to create small, open cabins, adding a unique and functional design feature that enhances the dining experience.

II.5 MODULAR ARCHITECTURE USING RECYCLED SHIPPING CONTAINERS

II.5.1 The benefits of modular architecture using recycled shipping containers

The use of modular architecture utilizing recycled shipping containers presents numerous benefits that align with sustainability goals and efficient construction practices. The inherent characteristics of shipping containers, such as their durability, stack ability, and availability, make them an attractive option for modular construction. The global surplus of over 17 million used shipping containers provides a unique opportunity to repurpose these structures, reducing the demand for new materials and minimizing waste in the construction industry. This approach not only conserves resources but also significantly decreases construction time and costs, as the containers can be prefabricated off-site and assembled quickly on location (A Jayaraman, et al., 2023).

Moreover, modular architecture facilitates a more sustainable lifecycle for buildings. By employing a modular design, components can be easily disassembled and reused or recycled at the end of their life cycle, which aligns with the principles of a circular economy (Saoud & Khorramshahgol, 2020). This modularity allows for flexibility in design and functionality, enabling structures to adapt to changing needs over time without requiring complete demolition (Xun et al., 2014). The eco-modular architecture concept emphasizes the importance of designing for disassembly, which enhances the efficiency of material recovery and reduces environmental impact (Kim & Moon, 2016).

In addition to environmental benefits, the economic advantages of modular architecture using shipping containers are noteworthy. The reduced construction time translates to lower labor costs and faster project completion, which can be particularly beneficial in addressing urgent housing needs in urban areas. Furthermore, the modular approach allows for customization and scalability, enabling developers to respond effectively to market demands and consumer preferences. This adaptability can lead to increased competitiveness in the housing market, as modular designs can be tailored to various demographic and economic segments. (A Jayaraman, et al., 2023)

The integration of sustainable practices in modular architecture also extends to energy efficiency. Shipping containers can be retrofitted with energy-efficient systems, such as solar panels and green roofs, enhancing their sustainability profile (Casson et al., 2020). This not only reduces operational costs for occupants but also contributes to the overall reduction of carbon footprints associated with building operations (Lampón, 2022). The potential for incorporating renewable energy sources into container-based structures further underscores the viability of this approach in promoting sustainable urban development (Cui et al., 2020).

The adaptability of shipping containers also extends to their potential for temporary structures, as demonstrated by Bahar et al. in their exploration of modular systems for public healthcare projects (Bahar, Samudro, & Yulianto, 2021). The authors argue that containers can provide rapid, flexible, and sustainable solutions for temporary facilities, showcasing their versatility beyond permanent residential applications. This adaptability is particularly relevant in emergency situations or for addressing urgent housing needs.

Moreover, the use of shipping containers in architecture can contribute to addressing social issues, such as providing housing for internally displaced persons (IDPs). Dardiry's research on emergency architecture emphasizes the role of recycled shipping containers in creating temporary educational facilities for children in conflict zones, demonstrating the humanitarian potential of this building method (Dardiry, 2024). The ability to rapidly deploy container-based structures in response to crises highlights their significance in contemporary architectural practice.

In summary, the benefits of modular architecture using recycled shipping containers encompass environmental sustainability, economic efficiency, and adaptability to market needs. This innovative construction method not only addresses pressing housing challenges but also aligns with broader sustainability goals, making it a compelling solution for modern architectural practices.

II.5.2 Containers dimensions

Shipping containers, commonly used in modular architecture, come in standardized sizes, primarily the 20-foot and 40-foot containers. These dimensions allow for flexibility in design and spatial arrangements in building projects.

20-foot container: 6.06 meters in length, 2.44 meters in width, and 2.59 meters in height.

40-foot container: 12.19 meters in length, 2.44 meters in width, and 2.59 meters in height.

These standard sizes make containers ideal for modular use, where multiple containers can be stacked or arranged to create functional spaces. (Bernardo, Oliveira, Nepomuceno, & Andrade, 2013; Mohamed E. G., 2017).

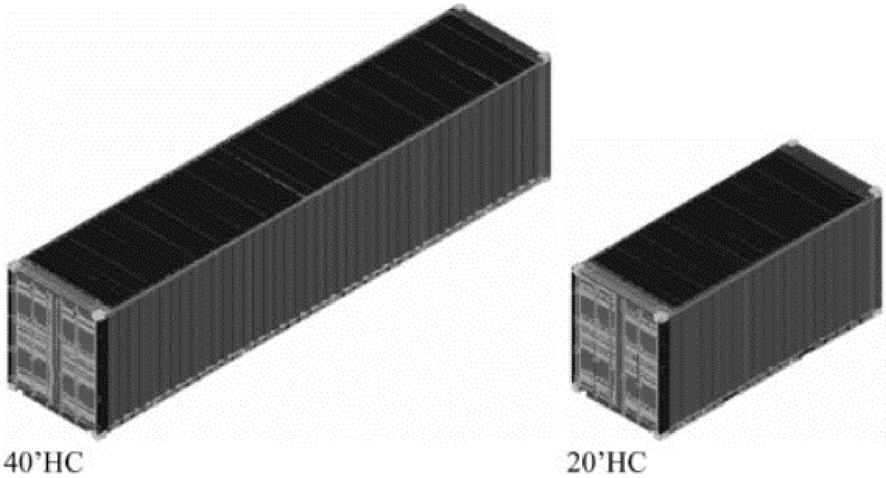


Figure 23 Containers 20'HC and 40'HC (Bernardo, Oliveira, Nepomuceno, & Andrade, 2013)

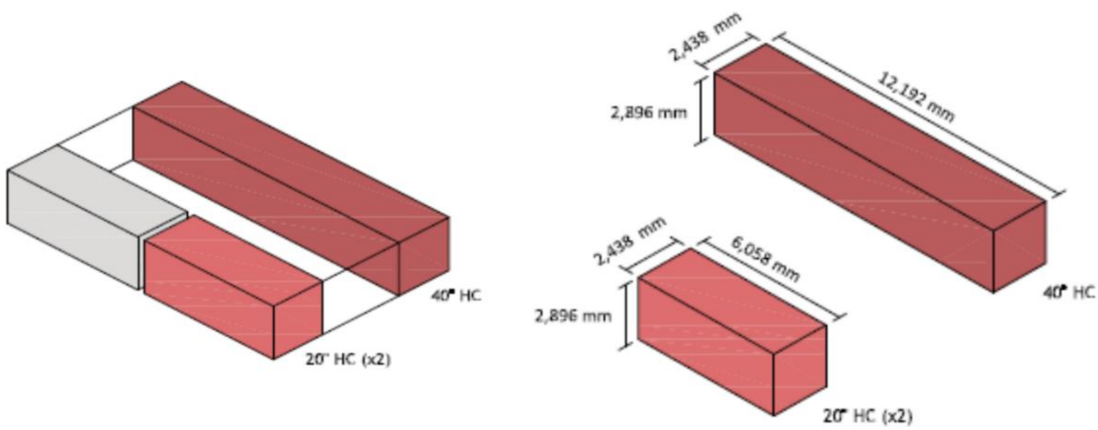


Figure 24 The modules (containers 20'HC and 40'HC). (Bernardo, Oliveira, Nepomuceno, & Andrade, 2013)

Table 3 : Geometrical characteristics of containers 20'HC and 40'HC

Model		External dimensions			Minimum internal dimensions		
		High (mm)	Width (mm)	Length (mm)	High (mm)	Width (mm)	Length (mm)
1AAA	40'HC	2896	2438	12192	2655	2330	11998
1CCC	204HC	2896	2438	6058	2655	2330	11998

II.5.3 **Containers composition**

Shipping containers are composed of several key structural components, which are designed to withstand harsh transportation conditions. These elements are standardized for efficiency and durability in shipping and repurposed construction.

Front Face: Made of two trapezoidal sheets welded together to form a panel. The panel is welded to a frame, consisting of an upper front header, a lower square steel tube, two vertical corner posts, and four corner pieces (Bernardo, Oliveira, Nepomuceno, & Andrade, 2013).

Door Face: Composed of a frame with a lower door sill (channel section), two vertical corner posts (hot-rolled steel and cold-formed steel welded into a hollow section), and an upper door header (cold-formed steel welded into a hollow section). The door leaves include a sheet welded to a frame with a locking device, two hinges, seals, and supports. Doors are often removed and reused in construction.

Lateral Faces: Composed of an upper square steel tube, with side walls made of several trapezoidal sheets welded together.

Roof: Consists of pressed steel sheets, which are not typically considered structural elements due to the absence of reinforcing ribs near the top side rail.

Strengthening Plates: Containers include various local strengthening plates, and the terminology for these elements follows ISO standards for container compone

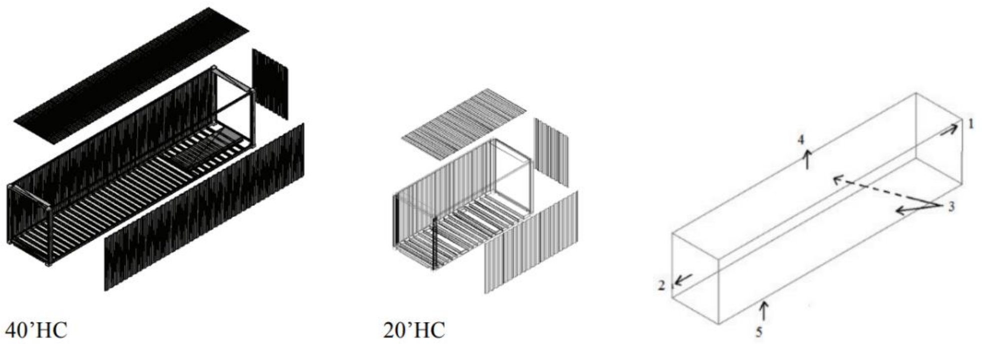


Figure 25 Containers composition. (Bernardo, Oliveira, Nepomuceno, & Andrade, 2013)

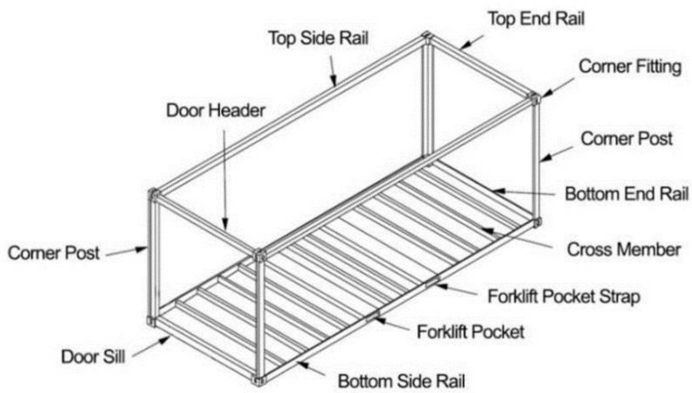


Figure 26Primary structural components for a typical 20' ISO SC

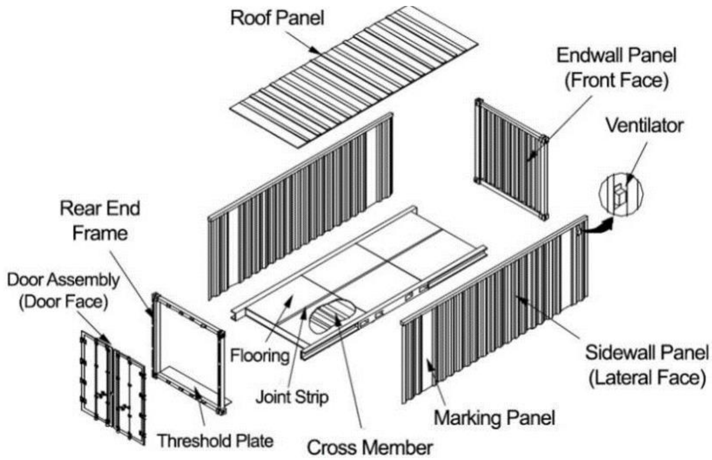


Figure 27 The core envelope of a typical 20' ISO SC

II.5.4 The containers pricing

The pricing of recycled shipping containers can vary significantly based on factors such as condition, location, and market demand. Generally, a used 20-foot container can range from $1,500 to $3,000 (which it is approximately equal to between 202,500 Algerian dinars and 405,000 Algerian dinars) while a 40-foot container may cost between $2,500 and $5,000)It is approximately equal to between 337,500 Algerian dinars and 675,000 Algerian dinars). Additionally, modifications to these containers, such as insulation, windows, and doors, can further influence the overall cost of construction. It is crucial to consider these financial aspects when planning a modular architecture project, as they can impact the project's feasibility and sustainability. (Bernardo, Oliveira, Nepomuceno, & Andrade, 2013).

II.5.5 The process and the adaptation techniques used to adapt containers as a construction

The adaptation of container techniques in architecture has gained significant attention due to the growing need for sustainable and efficient building practices. The process of adapting shipping containers for construction involves several critical steps that ensure the structural integrity, functionality, and sustainability of the final architectural product.

a) The selection of containers

This process begins with the careful selection of containers, which must be assessed for their structural soundness and suitability for conversion into living or working spaces. According to Bernardo et al., the refurbishment of shipping containers for housing construction has gained traction as a sustainable building system, highlighting the importance of understanding the structural project requirements associated with this innovative approach (Bernardo, Oliveira, Nepomuceno, & Andrade, 2013). The authors emphasize that successful examples of container-based construction worldwide demonstrate the potential of this method in sustainable architecture.

b) Designing the architectural layout

Designing the architectural layout of shipping containers for construction purposes involves a multifaceted approach that integrates principles of modular design, spatial efficiency, and sustainability.

c) Modular Design Principles

The modular nature of shipping containers allows for versatile architectural configurations. Each container can be viewed as a module that can be combined with others to create larger structures or distinct spaces. This modularity not only facilitates flexibility in design but also enhances the potential for future modifications or expansions. The arrangement of these modules should consider factors such as accessibility, functionality, and the intended use of the space. For instance, when designing residential units, it is essential to create layouts that promote privacy while ensuring adequate natural light and ventilation (Faragallah, 2022).

Horizontal Modular Coordination: This involves aligning containers along an imaginary plane parallel to the ground, ensuring that the modules are combined and spaced according to a modular system that facilitates their assembly. This is especially important when connecting multiple containers in horizontal configurations to ensure structural integrity and a seamless aesthetic. (Luiz , Bernardo, & Araújo, 1-20)

Vertical Modular Coordination: This involves aligning containers in a vertical arrangement, with careful attention to the weight distribution, load-bearing capacities, and connection points between stacked modules. Vertical coordination allows for multi-story buildings, where the stacked containers must be precisely aligned to avoid structural instability.

The horizontal and vertical modular coordination should be planned carefully to ensure that openings, internal connections, and circulation paths between the modules align properly. This planning helps avoid difficulties during construction and ensures an efficient use of space (Luiz , Bernardo, & Araújo, 1-20).

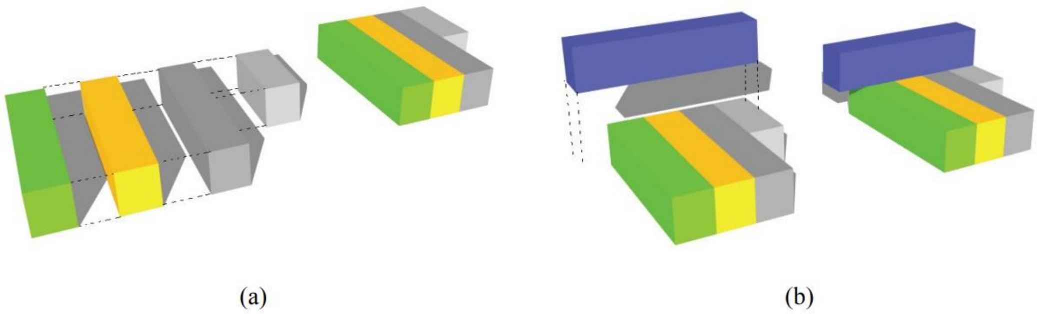


Figure 28 Horizontal and vertical modular coordination of modules. (Luiz , Bernardo, & Araújo, 1-20)

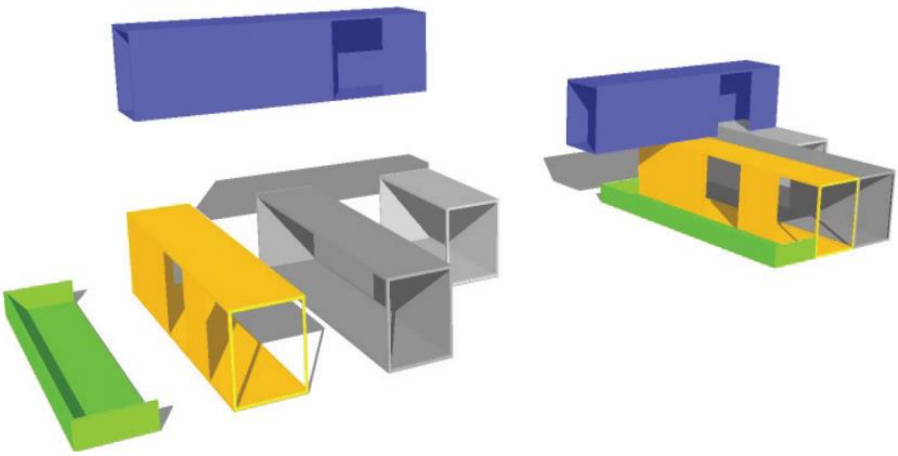


Figure 29 Example of openings and internal connections for a single-family house. (Luiz , Bernardo, & Araújo, 1-20)

d) Space Layout Optimization

Space layout optimization is critical in container architecture, as it directly impacts the functionality and energy performance of the building. Research indicates that the spatial arrangement of different areas within a container can significantly influence energy efficiency, particularly through the coupling of daylight and thermal performance (Du & Jansen, 2019).

Utilizing simulation tools can help architects visualize and assess various layout configurations, ensuring that the design maximizes natural light while minimizing energy consumption. Furthermore, the use of systematic layout planning (SLP) methods can guide the arrangement of spaces within containers, optimizing the flow and accessibility of different functional areas (Li & guo, 2019).

e) Environmental Considerations

The architectural layout must also address environmental factors, such as wind patterns and solar orientation, to enhance the building's sustainability. Studies have shown that the layout of residential spaces can be influenced by wind environment factors, which can affect thermal comfort and energy use (Xiang & Ding, 2021).By strategically positioning containers, architects can harness natural ventilation and reduce reliance on mechanical cooling systems. Additionally, integrating green roofs or vertical gardens can further enhance the environmental performance of container buildings (Faragallah, 2022).

f) User-Centric Design

A user-centric approach is essential in the design of container layouts. Understanding the needs and behaviors of the occupants can inform decisions about spatial organization and functionality. For example, in student housing projects, creating communal spaces that encourage interaction while providing private areas for study and rest can significantly enhance the living experience (Faragallah, 2022) .Engaging potential users in the design process can also yield valuable insights that lead to more effective and satisfying layouts.

g) Aesthetic and Cultural Context

The aesthetic appeal of container architecture should not be overlooked. The exterior and interior design elements must resonate with the cultural context of the location. This can involve the use of color, materials, and architectural styles that reflect local traditions and preferences. Additionally, the layout should facilitate a harmonious relationship between the containers and their surroundings, promoting a sense of place and community. (Faragallah, 2022)

h) Technological Integration

Incorporating technology into the design process can enhance the efficiency and effectiveness of container layouts. Advanced modeling techniques, such as computational design and parametric modeling, allow architects to explore complex spatial arrangements and optimize layouts based on specific criteria (Lobos & Donath, 2010). This technological integration can streamline the design process, enabling rapid prototyping and iteration, which is particularly beneficial in modular construction.

i) The construction site

Following the modifications, the containers are transported to the construction site, where they are assembled according to the pre-designed plans. This assembly process can be relatively quick compared to traditional construction methods, as the containers are prefabricated units that can be stacked or arranged in various configurations (Faragallah, 2022) .The modular nature of container architecture allows for rapid deployment, which is particularly beneficial in emergency housing situations or temporary structures (Bahar, Samudro, & Yulianto, 2021).

Foundations: When adapting shipping containers for construction, the foundation type is crucial for structural integrity. There are three common types of foundations used:

Spread Footings: These are reinforced concrete enlargements at the base of a column. They work well for small to medium-sized structures with moderate to good soil conditions. Spread footings are economical, easy to build, and customizable in shape and size.

Mat Foundations: These are enlarged spread footings that cover the entire area beneath the structure. They are ideal when more than 50% of the building's footprint requires support. They are useful when there's a risk of unpredictable settlement, large uplift forces, or high groundwater tables.

Piles: Piles are long columns made of concrete, steel, or timber that extend deep into the ground (over 20 feet). They are used when surface soils are too weak to support the structure, when larger loads are needed, or when the area is prone to flooding or scouring. They elevate the container structure and provide stability in soft or unstable soils.

In most cases, shipping container structures use either concrete spread footings or mat foundations, especially for lighter loads. Other foundation options include wood beam footings, cinder blocks, and helical piles. (Giriunas, Sezen, & Dupaix, 2012)

Figure 30 : Chipping Container Foundation Concrete Base Mould of 300mm sides by 220mm height (ndooroutdoors.co.uk/products/shipping-container-foundation-concrete-base-mold)

j) Connections

When adapting shipping containers for construction, proper connection methods are critical to ensure structural stability. One common connection method involves attaching a container to a steel base plate using welds. The underside of the base plate includes reinforcing bars (anchor bolts) of varying lengths. These anchor bolts are welded to the base plate and cast into the concrete foundation or grout while it's still wet. Once the concrete or grout hardens, the base plate is securely anchored into the foundation. (Giriunas, Sezen, & Dupaix, 2012). Additionally, there are various connection devices used to lock containers together, either for stacking, transporting, or lifting. These include:

Twist Locks and Latchlocks: These devices secure containers at their corner fittings during stacking, transport, or when lifting empty containers. They provide a secure connection between two containers.

Stacking Fittings or Cones: These devices secure containers horizontally during stacking or transporting and are typically used in conjunction with other securing devices.

The connection devices can handle both lateral and gravity loads under normal shipping operations, with a tensile strength of 150 kN and a compressive strength of 850 kN. However, depending on the specific use of the container structure, modifications to the locking connections might be necessary. Further research is needed to optimize container structure connections for various applications. Additionally, a non-locking connection method, though less common, can be used between two containers, but its structural characteristics are not well-documented. (Giriunas, Sezen, & Dupaix, 2012)

Figure 31a) Welded shipping container to base plate and (b) uncommon connection between shipping containers from Hermann (Giriunas, Sezen, & Dupaix, 2012)

k) Structural Modifications

The conversion of shipping containers into habitable structures requires several structural modifications to ensure safety, stability, and functionality. These modifications primarily involve the creation of openings, the joining of containers, and adjustments for thermal performance in different climates.

- **Openings for Windows and Doors**

Cutting openings in the container walls to accommodate windows and doors can compromise its structural integrity. As highlighted by Bernardo et al., these openings must be reinforced with steel frames or beams around the edges to maintain the container's stability (Bernardo, Oliveira, Nepomuceno, & Andrade, 2013)). In seismic-prone regions, cross-bracing techniques can also be employed to increase rigidity and provide additional support to the structure (Giriunas, Sezen, & Dupaix, 2012).

- **Stacking and Joining Containers**

The modular nature of shipping containers enables architects to create multi-story buildings or expansive layouts by stacking and joining multiple units. Oliveira et al. emphasize that this modular flexibility can be used creatively to design larger spaces, as well as ensure natural ventilation and light (Bernardo, Oliveira, Nepomuceno, & Andrade, 2013). Furthermore, cantilevered designs can be employed to create shaded outdoor areas, enhancing the livability of container-based structures while maintaining structural stability (Giriunas, Sezen, & Dupaix, 2012).

l) The integration of essential utilities and systems

The integration of essential utilities and systems, such as plumbing, electrical, and HVAC, into container structures is a key phase in their adaptation. These systems must be carefully planned and implemented to ensure both functionality and compliance with building codes. Mohamed highlights the importance of teaching architectural students about the modularity and flexibility of container design, which can greatly influence how these systems are integrated (Mohamed E. G., 2017)

Additionally, the structural integrity of the modified containers must be evaluated to ensure they can withstand environmental loads and stresses. Giriunas et al. stress the importance of conducting thorough structural assessments during the design process, including understanding the load-bearing capacities of containers and reinforcing them where necessary (Giriunas, Sezen, & Dupaix, Refurbished shipping containers as architectural module in bandung, 2020). Once the structural modifications and utility integrations are complete, the container is ready for the final finishing touches, transforming it into a livable or usable space.

m) The adaptation of insulation techniques

Insulation is crucial in adapting shipping containers into livable spaces. Given the metal structure, effective insulation ensures thermal performance, energy efficiency, and comfort. Several techniques can be used:

- Spray Foam Insulation: Polyurethane foam expands to fill gaps and creates an airtight seal, improving thermal resistance.
- Rigid Foam Board Insulation: Polystyrene boards, placed on the container's walls, offer excellent thermal resistance and reduce thermal bridging.
- Reflective Insulation: Aluminum foil reflects radiant heat, useful in hot climates, and can be combined with other materials for better efficiency. (Álvarez-Feijoo, Orgeira-Crespo, Suárez-García, Ribas, & Arce, 2020)
- Natural Materials: Sustainable options like cellulose, wool, or bamboo provide good thermal performance.
- Insulated Panels: Prefabricated sandwich panels offer high insulation and easy installation (He, Wang, & Liu, 2022).

II.6 EXAMPLES OF CONTEMPORARY ARCHITECTURE INTEGRATING RECYCLED MATERIALS AND OBJECTS

In recent years, an increasing number of architects and designers have incorporated the use of recycled materials and objects as a key element of sustainable and innovative design. These practices not only respond to urgent environmental concerns but also redefine the aesthetic and functional possibilities of architectural creation. Through the integration of salvaged materials, such as wood, metal, plastic, glass, and industrial objects, architectural projects can significantly reduce their ecological footprint while showcasing a creative reinterpretation of form and function.

Below we present a selection of contemporary architectural projects that exemplify how recycled materials and objects are being successfully incorporated into design. These examples highlight diverse approaches across different contexts, scales, and building types, illustrating the versatility and potential of reuse in both practical and artistic terms.

II.6.1 The Container City

The "Container City" project in London is an example of innovative architectural design that utilises repurposed shipping containers for urban housing and workspace solutions. The project addresses housing shortages and rising property prices in London while emphasising sustainability, adaptability, and community engagement.

Launched in 2001, the Container City project aims to provide affordable housing and workspaces in a city struggling with housing shortages. The use of shipping containers allows for quick construction and flexible designs, making it an ideal solution for urban development.

Figure 32 Container City(source: simon Richards photography)

By reusing shipping containers, the project reduces waste and contributes to sustainability. Containers, known for their durability, can be reused multiple times, which decreases the need for new building materials. Energy-efficient design elements are incorporated into the project to lower carbon footprints compared to conventional construction.

Container City has sparked discussions about gentrification, as it represents a government-driven initiative to revitalize urban areas. Critics argue that such projects might displace lower-income residents. However, the Container City project strives to be inclusive by offering affordable spaces amidst the rising costs of living in London.

Container City encourages collaboration and interaction among local businesses, artists, and residents. It features studios, offices, and communal areas that promote community engagement. The project aims to create an inclusive environment where diverse communities can interact and thrive.

The project highlights the versatility of shipping containers as building materials. The modular nature of containers allows for creative designs that fulfill various functional needs. Container City serves as a case study for the integration of unconventional materials in urban design, showcasing their potential in mainstream architectural practices.

Despite its successes, Container City faces challenges in terms of public perception, with some viewing it as a temporary or inferior building solution. Regulatory challenges and building codes that are not fully suited to container construction can also hinder the project's expansion. Economic factors may also influence the acceptance of such innovative projects.

As London evolves into a smart city, the principles demonstrated by Container City can inform future urban development strategies. The integration of sustainable practices and technology in container architecture aligns with the goals of the Smart London Plan, which promotes innovation, inclusivity, and sustainability in urban planning. Container City serves as a model for future urban projects balancing economic, social, and environmental considerations.

II.6.2 **A temporary office space in Tokyo**

Hiroki Tominaga Atelier's innovative approach to architectural design, particularly through the use of deconstructed pallets to dress a Tokyo office, exemplifies a blend of sustainability, aesthetics, and functionality.

Figure 33 Interior view of the office (dezeen)

The design focuses on the creative reuse of wooden pallets, which are deconstructed and reassembled to form both structural and aesthetic elements. This approach emphasizes sustainability and resourcefulness, aligning with contemporary architectural trends. The use of pallets introduces a tactile connection to the space's material origins and brings a unique quality to the office, reflecting a modern interpretation of traditional timber construction.

The design effectively utilizes vertical space, with pallets being used not only for walls and partitions but also for ceiling treatments and shelving. This innovative use of space maximizes functionality while maintaining an open and airy feel within the office. The strategic arrangement of pallets can also facilitate natural light penetration, enhancing the overall ambiance of the workspace.

The project incorporates biophilique design principles by emphasizing natural materials and textures, which can enhance occupants' connection to nature. The use of wood, a natural material, contributes to a calming environment that can improve productivity and reduce stress levels among employees. This alignment with biophilique design reflects a growing trend in architecture that seeks to create healthier and more sustainable workspaces.

Deconstructed pallets provide a raw, organic aesthetic that contrasts with the typical modern finishes of office spaces. The natural textures and colour variations of the wood create a warm, inviting environment. This choice of material enhances the sensory experience and adds visual dynamism, making the office both a functional and visually engaging space.

The roof is primarily composed of deconstructed pallets, creating a lightweight yet durable roofing system. The modular nature of the pallets allows flexibility in design and efficient load distribution, ensuring stability while minimizing the need for additional structural support. This method aligns with sustainable architecture principles, prioritizing resource efficiency and structural integrity.

II.6.3 **Prahran Hotel**

Prahran Hotel in Victoria, Australia, creatively integrates recycled materials into its design. Despite the name, it's not a hotel but a pub focused on eating and drinking. The building features a striking Art Deco façade and is defined by the unique addition of concrete pipes on the back of the façade, a key element of the renovation.

Figure 34 The hotel prahran (photography by © Peter Clarke)

The concrete pipes are not merely decorative; some are repurposed as cabins with tables and benches for diners. These pipes create a blend of indoor and outdoor experiences, offering an interesting contrast between the enclosed, wood-lined interiors and the open sides that provide diners with views of the street.

The renovation introduces a two-story space with a central courtyard, designed as an informal standing area for drinking. The recycled concrete pipes are strategically placed to create small, open cabins, adding a unique and functional design feature that enhances the dining experience.

II.6.4 **Residence A Docks**

Cité A Docks in Le Havre, France, stands as a pioneering example of sustainable architecture using recycled shipping containers for student housing. The containers themselves are not load-bearing. Instead, a metal framework supports them: This structural independence allowed non-linear stacking, staggering of units, and creation of voids between them. These voids form patios**,** balconies, and corridors**,** breaking up the building mass and adding visual rhythm to the façade. The transverse corridors give a strong sense of public-private transition**,** enhancing circulation and privacy.

Figure 35: Residence A Docks

The building contains 100 studios across four levels, all elevated from the ground to ensure equal privacy and a coherent base. Each unit features large windows at both ends, ensuring cross-ventilation and abundant daylight. Units are oriented toward interior gardens, reinforcing a sense of community and serenity within a dense urban context.

Exterior container walls and inter-unit partitions are covered with 40 cm thick reinforced concrete**.** A rubber layer is embedded to absorb vibrations and sound**.**

Challenges the visual and psychological expectations of container living. Integrates industrial aesthetics with Uses modular construction not just for efficiency, but to generate architectural richness**.** Embeds environmental, acoustic, and social comfort at the heart of the design.

II.6.5 PV14 House

This modern residence in Dallas, Texas, sits across from White Rock Park on one of the city's highest points, about 100 feet above White Rock Lake. The design aims to create a home with a strong identity that responds to its elevated site, captures surrounding views, and makes use of underutilized but readily available construction technologies.

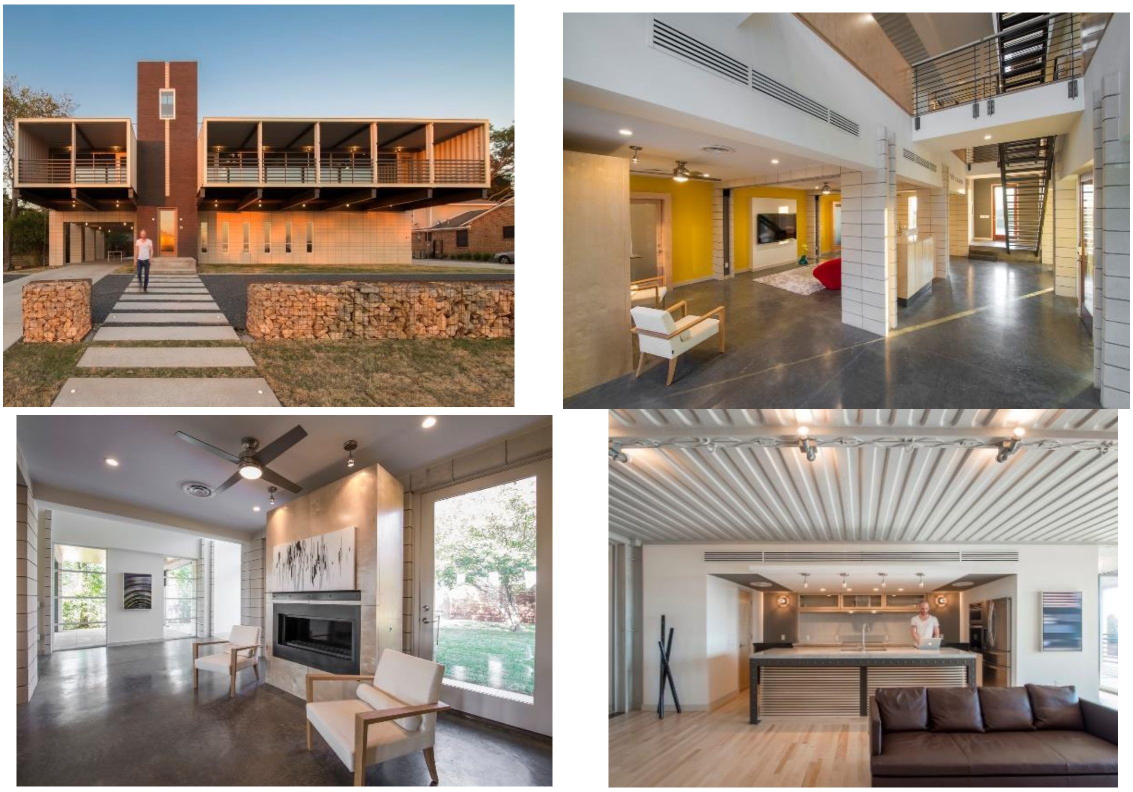


Figure 36 : PV14 House

The house showcases its materials by using exposed steel framing, concrete floors, pre-manufactured steel modules, masonry, and large glass openings. These elements are intentionally left visible, emphasizing an industrial-modern aesthetic and a straightforward expression of structure and material.

Main living areas are elevated to take full advantage of views and to create distance from street activity. The layout is aligned with the city grid, enhancing orientation and sun exposure. A rooftop deck adds an outdoor living space with panoramic views of the lake and city.

The roof deck acts as a solar screen for the insulated membrane roof, reducing heat gain and extending roof life.

The house reflects a modern, material-driven approach that integrates structure and landscape. Its exposed systems and modular construction challenge traditional residential design, offering a sustainable, site-responsive alternative rooted in both form and function.

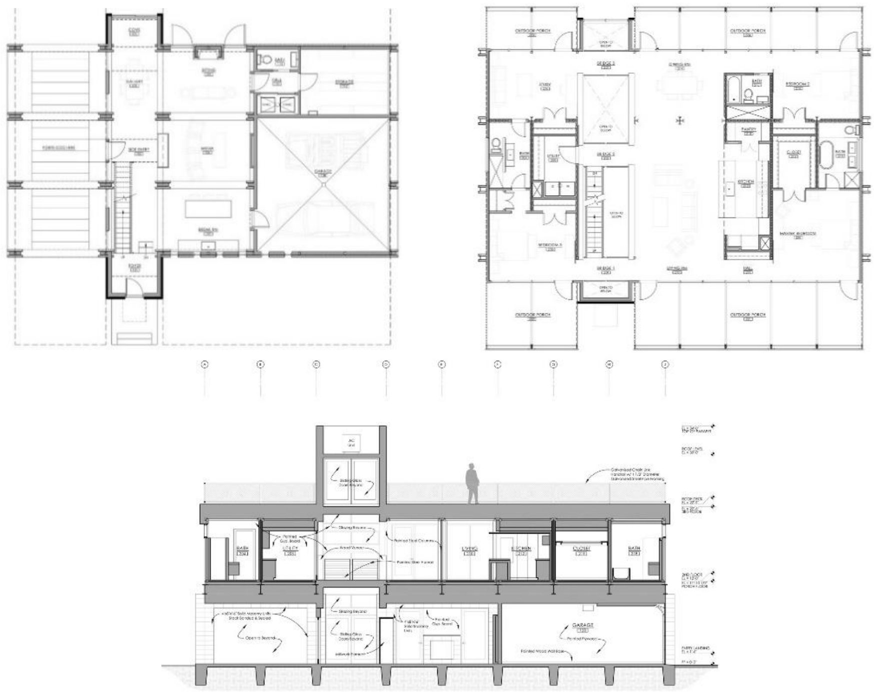


Figure 37PV14 House plan and section

II.6.6 **Container House**

A family residence built from eight re-used, high cube shipping containers (20′ and 40′), located on a steep lot near a lake outside Stockholm. The house is elevated on steel columns due to the terrain’s steep slope and rainwater runoff.

Containers' structural walls support the upper level, which extends beyond the lower level footprint. Careful consideration was given to which container walls to cut, maintaining structural integrity with minimal additional framework. The house is supported by steel columns and concrete plinths, addressing rainwater flow issues.

The entrance level includes a den, guest bedroom, laundry, and master bath. The upper level features a living-dining area with a terrace and bedrooms facing the forest. A top container functions as a mezzanine lookout and light shaft for the living room.

The design maximizes natural light despite the north-facing site, with the living-dining room flooded with sunlight. The bathroom offers views of the canyon rock and a small window that allows natural sounds to enter.

Figure 38 : Container House

The project emphasizes re-use and alteration, with salvaged materials integrated into the design. The house balances the rectilinear form of containers with the natural curves of the site. The final design merges the containers with the landscape, creating a unique building experience.

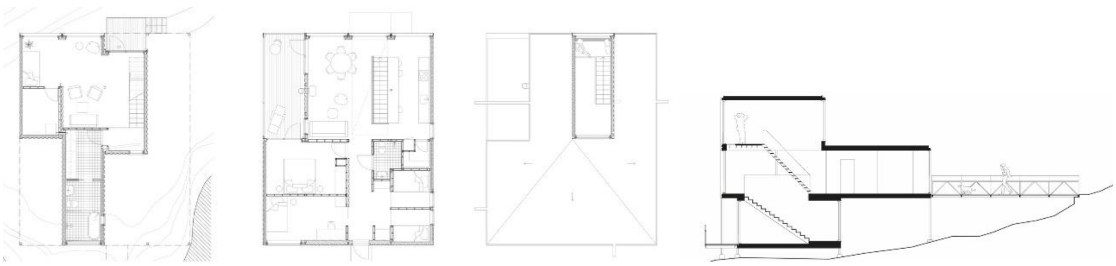


Figure 39 : Container House plans and section

II.7 COMPARISON BETWEEN RECYCLED CONTAINER CONSTRUCTION AND TRADITIONAL CONCRETE CONSTRUCTION

To support the innovative and economic aspect of the project idea, a comparative study was conducted between two architectural units of identical size and usage: one made from a recycled shipping container, and the other built using traditional reinforced concrete. This comparison aims to highlight the differences in terms of cost, construction time, environmental performance, adaptability, and suitability for urban environments.

Table 4 : Basic Comparison Parameters

Item	Shared Value
Function	Multi-use functional unit (urban waiting space, workshop...)
Dimensions	12 m × 2.5 m × 2.8 m
Hypothetical location	Semi-hot urban area (e.g., Biskra)
Duration of use	Medium to long term (5–15 years)

Table 5: General Structure and Materials

Component	Recycled Shipping Container	Traditional Concrete Construction
Structure	Prebuilt, steel, uniform	Concrete columns + brick or block walls
Walls	Steel walls with internal insulation (OSB or gypsum)	Block/brick + concrete + internal insulation
Flooring	Steel floor + insulation + wood	Reinforced concrete slab
Roof	Original container roof or added roof	Reinforced concrete roof
Windows/Doors	Cut into the steel and installed	Conventional wall openings

Table 6: Construction Duration

Phase	Recycled Container	Traditional Construction
Excavation & preparation	1–2 days	4–5 days
Structure installation	Already built	7–10 days (pouring/building)
Insulation & finishes	3–5 days	10–15 days
Total Duration	**7–14 days**	**25–40 days**

Table 7 : Flexibility in Use and Transport

Feature	Container	Traditional Construction
Ease of transport	Very high – fully movable	Not possible
Expandability	High – modular connection	Difficult – requires demolition
Reusability	Possible – can be repurposed	Not practical
Installation in remote areas	Yes	Difficult in harsh terrain

Table 8 : Environmental Performance

Environmental Aspect	Container	Concrete
Carbon emissions in production	Low (recycled unit)	Very high (cement production)

Use of natural resources	Minimal	Significant
Contribution to recycling	Yes	No
Environmental impact at demolition	Minimal	Major (solid waste)

Table 9 : Earthquake and Shock Resistance

Feature	**Container**	**Concrete Building**
Seismic resistance	Excellent due to steel flexibility	Depends on structural quality
Maintenance needs	Low	Regular and sometimes costly

*Table 10 : Quantitative and Estimate Quotation (Quantitative and Estimate Quotation) of normal concrete building 12*2.5*2.8*

N°	Désignations des travaux	U	Qtité	Prix unit	Montant
01 - Terrassements					
1..01	terrassement en grande masse	M3	7,800	600,00	4 680,000
1..02	Fouilles en Puits en terrain toute nature	M3	58,500	500,00	29 250,000
	Sous Total………………… 01				**33 930,00**
02 - Infrastructure					
2..01	Béton de propreté pour fondation, dosé à 250 Kg /m3 en ciment CPA 325, éxécuté sur les fond des semelles, longrines, scaliers et plots…..est) épai 10 cm comprenant fourniture, manutention, mise en oeuvre, talochage de la surface et toutes sujétions.	M3	1,44	800,000	1 152,00
2..02	Béton Armé en fondation (Semelles, Avant Poteaux, Longrines et Poutres de Redressement ...etc), dosé à 350 Kg de ciment CPA 325, comprenant fourniture, manutention, vibration, coffrage, ferraillage et toutes sujestions.	M3	11,41	35000,000	399 350,00
2..05	Hérisson de 0,20 d'épaisseurs moyennes en pierres sèches posées à la main avec remplissage des vides aux cassons de pierres et d'agrégats roulés y compris compactage et toutes sujestions.	M2	39,00	1 200,00	46 800,00
2..06	Dallage sur herrisson épaisseur de 10 cm, avec treillis soudé en rouleau ou en plaque (20x20x5mm), comprenant mise en place, coupes, ligatures, plots, dosé à 250 Kg de ciment CPA 325, comprenant fourniture, manutention et toutes sujétions.	M2	39,00	1 500,00	58 500,00
	Sous Total………………… 02				**505 802,00**
03 - Superstructure					
3..01	Béton armé en elevation (Poteaux, Poutres et Chainages, Rédaisseur, Dalle pleine pour toiture inclineee, Escaliers, Acrotère + Chaperon element arc et element decoratif etc...), dosé à 350 Kg comprenant fourniture, manutention, vibration, ferraillage Y/C Toutes Sujestions	M3	6,85	35000,000	239 820,00
3..02	Linteaux en Béton Armé pour divers dimensions et épaisseurs dosé à 350kg/m3 y compris Toutes Sujestions	ML	5,40	1 200,00	6 480,00
3..03	Plancher en corps creux 16+4 cm y/c Trillé soudé 5mm(15x15) en béton dosé à350 kg/m3 et Toutes Sujestions	M2	39,00	4000,00	156 000,00

3..04	Appuis de fenetre en béton légèrement armé pour divers dimensions dosé à 350 Kg/m3 Épaisseur de 10 cm et toutes sujestions	ML	4,5	1 500,00	6 750,00
3..05	forme de pente sur la dalle inclinee dosé à 350 Kg/m3 Épaisseur de PH 12 cm PB 3cm à 5 cm et toutes sujestions	M2	39	1 200,00	46 800,00
	Sous Total………………… 03				**455 850,00**
04 - Moçonneries et Enduits					
4..01	Maçonnerie Double Parois de 30cm(15+5+10) en brique rouge y compris Toutes Sujestions	M2	70	2 000,00	140 000,00
4..07	Enduit interieur en ciment dosé à 350kg/m3 y comrpis Toutes Sujestions				
	a) Sur Mur	M2	75,40	600,00	45 240,00
	b) Sous Plafond	M2	30,00	800,00	24 000,00
4..08	Enduit extérieur lisse sur murs de facade en ciment dosé à 350kg/m3+ dressage y compris Toutes Sujestions	M2	88,00	600,00	52 800,00
	Sous Total………………… 04				**262 040,00**
	05 - Revetements intèrieurs et Extèreiur				
5..03	F/P et Revetement en Carrelage GRANITO (Dim 33x33cm de 2,5cm d'épais) de bonne et 1ère qualité y/c mortier ,coupes, couche rattrapage niveau en béton d'épaisseur variable, rejointements au ciment blanc colorée, "choix maitre d'ouvrage"et toutes Sujestions	M2	30,00	1 500,00	45 000,00
5..04	F/P Plinthe cuité vernisée de bonne qualité dim GM cm y compris coupes, mortier et Toutes Sujestions	ML	29,00	500,00	14 500,00
	Sous Total………………… 05				**59 500,00**
06 - Etanchiètè					
7..01	F/P Isolation thermique en feuille polystérène épaisseur 4cm ou plaques de liège de qualité y/c Toutes Sujestions	M2	39,00	1000,00	39 000,00
7..02	F/P Film polyane en plastique de qualité dur en deux façes "Doublé au dessous et sus-dessus de l'isolation " y compris fixation toutes sujestions	M2	39,00	400,00	15 600,00
7..03	Forme de pente en béton légèrement dosée à 350kg/m3 épaisseur variable suivant pente et fil d'eau y/c réglettes en béton, polissage et TS	M2	39,00	1500,00	58 500,00
7..04	F/P Etanchiètè en tricouches "03 couches" type nord 36 ST ou 36AS de qualité agrée y/c noirssage et toutes sujestions	M2	39,00	1500,00	58 500,00
7..05	F/P Relevé en pax aluminium auto colant sur acrotères, chappérons, joints sur une hauteurs de 50 cm y/c Toutes Sujestions	ML	30,00	1400,00	42 000,00
7..06	F/P Couche de protection de gravillion roulé ou concassé daim 20/25 sur une épaiss de 6 cm y/c Toutes Sujestions	M2	39,00	1500,00	58 500,00
7..07	F/P Gargouillé crapaudine en tole galvanisé soritie daim 100mm y/c scellement, fixation,picage, jointation et Toute Sujestions	U	02	1200	2 400,00
7..08	F/P Déscente d'eau pluvaile en tube acier daim 110mm y/c scellement, fixation, picage de dalle, jointation, pienture métal et TS	ML	5,60	1500,00	8 400,00
	Sous Total………………… 06				**282 900,00**
07 - Ménuiseries (Bois, Aluminuim, Métal)					
	A _ Menuiserie bois				
9..A01	F/P Porte pleinne en bois rouge du nord cadre en bois 14cm avec imposte fixé y/c scellement, quincailleries et TS (suivants les Détails et conception) pour Dim suiv:				
	a) Dim 0,90x 2,20 h (Porte à 01 vantaux)	U	01	20 000,00	20 000,00

9..A02	F/P fenetre ,chassis , vasistat , en bois du nors cadre en bois 14cm avec imposte fixé y/c scellement,quincailleries et TS (suivants les Détails et conception) pour Dim suiv: verre Stop Sol 5mm et verre armé				
	a) Dim 1,50 x 1,20 h (fenetre à 02 vantaux vitree)	U	03	12 000,00	36 000,00
	Sous Total………………… 06				**56 000,00**
10 - Peinture					
10..02	F/P Peinture intérieure vinylique sur murs et en sous plafonds en 03 couches y compris , 03 couches d' enduit de polissage grattage, finition, rebouchage et Toutes Sujestions (Pour les endroits humides cuisine, SDB, WC…..est)(Couleurs choix maitre d'ouvrage)	M2	75,40	600,00	45 240,00
10..03	F/P Peinture Vinylique extérieure sur murs et plafond de façade en 03 couches y compris , grattage, finition, rebouchage et Toutes Sujestions (Couleurs choix maitre d'ouvrage)	M2	84,56	600,00	50 736,00
10..03	F/P L'isolation mousse de polyuréthane sur murs intérieure y compris , grattage, finition, Toutes Sujestions	M2	75,40	3 500,00	263 900,00
	Sous Total………………… 10				**359 876,00**
	Total Général HT ….………				**2 015 898,00**
	TVA 17 % ....……….....….				**342 702,66**
	Total général en TTC ….…..…				**2 358 600,66**

*Table 11 : Quantitative and Estimate Quotation (Quantitative and Estimate Quotation) of a container building 12*2.5*2.8*

N°	Désignations des travaux	U	Qtité	Prix unit	Montant
01 - Terrassements					
1..01	Fouilles en Puits en terrain toute nature	M3	2,304	500,00	1 152,000
	Sous Total………………… 01				1 152,00
02 - Infrastructure					
2..01	Béton de propreté pour plots, dosé à 250 Kg /m3 en ciment CPA 325, éxécuté sur les fond des semelles, longrines, scaliers et plots…..est) épai 10 cm comprenant fourniture, manutention, mise en oeuvre, talochage de la surface et toutes sujétions.	M3	0,38	800,000	307,20
2..02	Béton Armé en plot , dosé à 350 Kg de ciment CPA 325, comprenant fourniture, manutention, vibration, coffrage, ferraillage et toutes sujestions.	M3	2,30	25000,000	57 600,00

2..03	Dallage épaisseur de 10 cm, avec treillis soudé en rouleau ou en plaque (20x20x5mm), comprenant mise en place, coupes, ligatures, plots, dosé à 250 Kg de ciment CPA 325, comprenant fourniture, manutention et toutes sujétions.	M2	39,00	1 500,00	58 500,00
	Sous Total………………… 02				116 407,20
03 - contenaires					
3..01	D/P Conteneur en acier Corten, dimensions standard 12,19 m x 2,44 m x 2,59 m, structure étanche et résistante à la corrosion. Idéal pour une réutilisation en construction modulaire.	U	1,00	800000,000	800 000,00
	Sous Total………………… 03				800 000,00
	04 - Revetements intèrieurs et Extèreiur				
5..03	F/P et Revetement en Carrelage GRANITO (Dim 33x33cm de 2,5cm d'épais) de bonne et 1ère qualité y/c mortier ,coupes, couche rattrapage niveau en béton d'épaisseur variable, rejointements au ciment blanc colorée, "choix maitre d'ouvrage"et toutes Sujestions	M2	30,00	1 500,00	45 000,00
5..04	F/P Plinthe pvc de bonne qualité dim GM cm y compris coupes, mortier et Toutes Sujestions	ML	29,00	500,00	14 500,00
	Sous Total………………… 05				59 500,00
05 - Ménuiseries					
	A _ Menuiserie METALIQUE				
9..A01	F/P Porte pleinne en Métal avec imposte fixé y/c scellement, quincailleries et TS (suivants les Détails et conception) pour Dim suiv:				
	a) Dim 0,90x 2,20 h (Porte à 01 vantaux)	U	01	20 000,00	20 000,00
9..A02	F/P fenetre ,chassis , vasistat , en Aluminuim avec imposte fixé y/c				

	scellement,quincailleries et TS (suivants les Détails et conception) pour Dim suiv: verre Stop Sol 5mm et verre armé				
	a) Dim 1,50 x 1,20 h (fenetre à 02 vantaux vitree)	U	03	10 000,00	30 000,00
	Sous Total………………… 06				50 000,00
10 - Peinture					
10..02	F/P Peinture intérieure laque sur murs et en sous plafonds en 03 couches y compris , 03 couches d' enduit de polissage grattage, finition, rebouchage et Toutes Sujestions (Pour les endroits humides cuisine, SDB, WC…..est)(Couleurs choix maitre d'ouvrage)	M2	75,40	600,00	45 240,00
10..03	F/P Peinture Vinylique extérieure sur murs et plafond de façade en 03 couches y compris , grattage, finition, rebouchage et Toutes Sujestions (Couleurs choix maitre d'ouvrage)	M2	84,56	600,00	50 736,00
10..03	F/P L'isolation mousse de polyuréthane sur murs intérieure y compris , grattage, finition, Toutes Sujestions	M2	75,40	3 500,00	263 900,00
	Sous Total………………… 10				359 876,00
	Total Général HT …..…….				1 386 935,20
	TVA 17 % ....…………..….				235 778,98
	Total général en TTC ……..….				1 622 714,18

- The analysis shows that container-based construction is approximately 45.35% less expensive than traditional building methods, highlighting a significant cost advantage in favor of innovative and recycled solutions.

II.8 THE THERMAL EFFICIENCY OF THE BUILDING MADE BY CONTAINER IN HOT CLIMAT

The use of recycled shipping containers as building materials in hot climates presents several unique challenges and opportunities regarding thermal efficiency and sustainability. The growing trend toward utilizing refurbished shipping containers emphasizes the need to assess their thermal performance in various climates, particularly hot and humid regions. Research has demonstrated that while shipping containers can be sustainably repurposed, their thermal efficiency largely depends on design modifications such as insulation and ventilation strategies.

A significant study by Elrayies assessed the thermal performance of container-based buildings (CBBs) in hot and humid climates, identifying that these structures often require enhancements to mitigate the high thermal loads associated with such environments (Elrayies, 2017). Containers, due to their metal composition, can exacerbate heat retention; hence, insulation becomes crucial (Zafra, Mayo, & Villareal, 2021). The establishment of adequate thermal resistance through effective insulation can significantly improve indoor conditions, enabling occupants to maintain comfort without excessive reliance on mechanical cooling systems (Jamaludin, Zul , & Abd Al , 2021). Similarly, Jamaludin et al. highlight the necessity of building insulation to improve thermal resistance and reduce dependency on energy-intensive cooling solutions (Jamaludin, Zul , & Abd Al , 2021).

Design principles that prioritize passive ventilation can also be effective. Research indicates that the spatial configuration and design of openings significantly influence indoor thermal environments, making strategic architectural decisions vital to achieving comfort in hot climates. Building envelope performance is paramount; as outlined by Lotfabadi and Hançer, variables including thermal mass, shading, and cross-ventilation can dramatically affect energy efficiency and occupant comfort in such environments (Lotfabadi & Hançer, 2019).

Finally, sustainable strategies that align with vernacular practices provide additional insights for enhancing thermal performance. Traditional architectural designs often incorporate natural cooling techniques that can be adapted to modern shipping container architecture (Salameh & Touqan, 2022). The integration of these strategies can optimize thermal efficiency while ensuring the structures remain functional and sustainable.

II.8.1 Analysis of Thermal Simulation Results in the Study of Container-Based Architecture in Hot and Humid Climates

a) Main Goal of the Article

The study evaluates how well buildings made from reused shipping containers (CBBs) perform in hot and humid climates specifically in Port Said, Egypt and how different thermal insulation materials can improve indoor comfort and energy efficiency.

Simulation software used: Ecotect

Table 12 : Simulated Models

Model	Type	Performance
1	Traditional Brick	Moderate in summer, fair in winter
2	Uninsulated SC	Very poor – overheats in summer, loses heat in winter

3	Rock Wool Insulated SC	Good balance
4	Wool Insulated SC	Similar to rock wool, slightly better
5	ccSPF Insulated SC	Best overall performance
6	Straw Insulated SC	Best cooling, but poor winter insulation

- Hourly Temperature Profile (HTP) for the Hottest Day and the Coldest Day (Average)

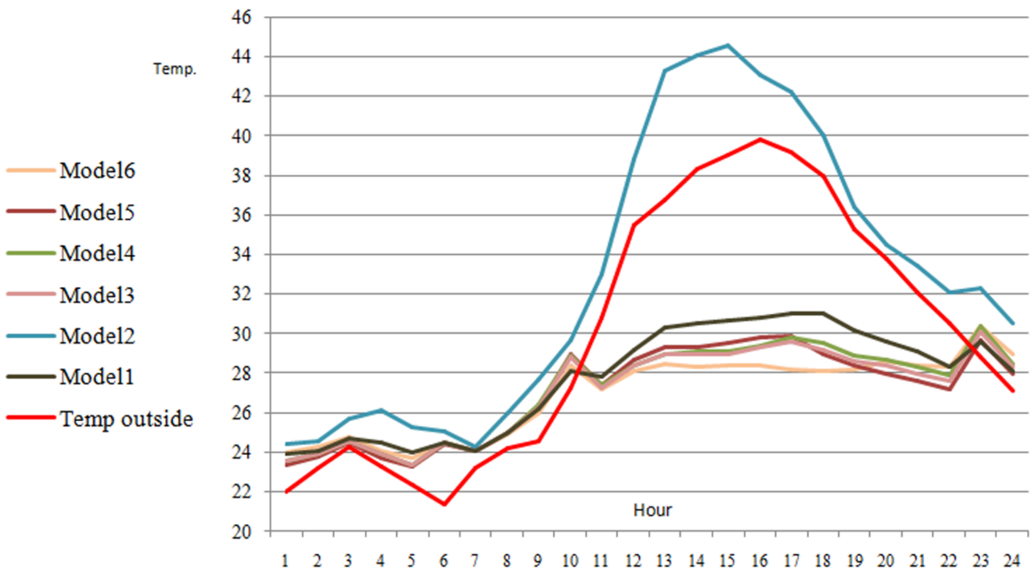


Figure 40 HTP for the hottest day (average), April 30

Table 13 : Comparative analysis of the thermal performance of the six models on the hottest day (average)

Hour	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**Total Weight (hrs)**
Model 1	3	3	3	2	2	2	2	2	4	6	2	2	2	2	2	2	2	2	2	2	2	2	4	5	**62**
Model 2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**24**
Model 3	4	4	4	4	4	2	2	2	3	4	4	3	4	5	5	5	5	4	4	5	5	4	3	4	**93**
Model 4	4	4	4	4	4	2	2	2	2	3	3	3	4	4	4	4	4	3	3	3	4	3	2	3	**78**
Model 5	5	5	5	5	5	3	2	2	3	2	3	2	3	3	3	3	3	5	5	6	6	5	5	6	**93**
Model 6	2	2	2	3	3	2	2	3	5	5	5	4	5	6	6	6	6	6	6	4	3	2	2	2	**92**

On the hottest day, the uninsulated container (Model 2) performed the worst, overheating throughout the day. The brick building (Model 1) offered moderate performance but still heated up. Straw insulation (Model 6) gave the best cooling during the peak hours, while ccSPF (Model 5) provided the most balanced performance with good cooling and less heat gain at night. Rock wool (Model 3) and wool (Model 4) also improved comfort compared to uninsulated models.

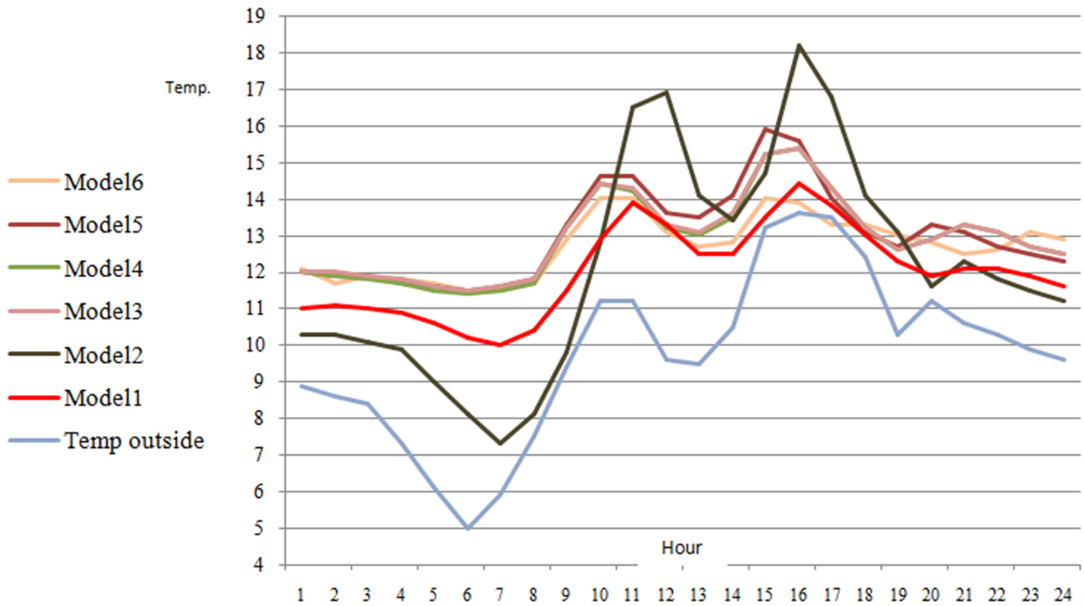


Figure 41 HTP for the coldest day (average), January 12

Table 14 : Comparative analysis of the thermal performance of the six models on the coldest day (average)

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total Weight (hrs)
Model 1	2	2	2	2	2	2	2	2	2	2	1	3	1	1	1	2	2	1	1	2	1	2	2	2	**42**
Model 2	1	1	1	1	1	1	1	1	1	1	6	5	6	3	3	5	5	5	5	1	2	1	1	1	**59**
Model 3	3	5	4	4	4	4	4	4	4	4	4	3	4	5	4	3	4	3	2	4	5	5	4	4	**94**
Model 4	3	4	3	3	3	3	3	3	4	4	3	2	3	4	4	3	4	3	2	4	5	5	4	4	**101**
Model 5	3	4	4	3	4	4	4	4	5	5	5	4	5	6	5	4	3	2	3	5	4	4	3	3	**100**
Model 6	4	3	4	4	5	4	3	3	3	3	2	1	2	2	2	1	1	4	3	4	3	3	5	5	**74**

In cold weather, ccSPF (Model 5) and wool (Model 4) offered the best indoor warmth, while straw (Model 6) was the weakest at night. Surprisingly, Model 2 reached high temperatures during the day due to direct solar gain, but lacked consistency. The brick model underperformed overall. Insulation, especially ccSPF and wool, proved essential for thermal comfort.

CONCLUSION

Recycling materials in architecture is no longer just a sustainable option, it is a necessary response to today's environmental, economic, and social challenges. Through the reuse of materials such as shipping containers, architects can reduce resource consumption, lower construction waste, and promote more adaptable and resilient design solutions. Shipping containers, in particular, offer a unique opportunity due to their structural strength, modularity, and global availability. By giving these containers a second life, architects can create innovative and functional spaces while actively contributing to the circular economy.

This chapter has highlighted the architectural potential of repurposed containers, showing how they can be transformed into vibrant, efficient, and eco-friendly buildings. Beyond their practical advantages, such approaches reflect a shift in architectural thinking, toward more responsible, creative, and future-oriented practices. In embracing recycled materials and container architecture, we not only extend the life of existing resources but also expand the boundaries of architectural imagination.

III. THEMATIC CHAPTER: TOY LIBRARY PROJECT

INTRODUCTION

In recent years, the concept of toy libraries has gained increasing attention as a vital tool in promoting child development, social interaction, and educational inclusion. A toy library, much like a traditional library, offers access, not to books, but to a wide variety of educational and recreational toys, fostering learning through play. This chapter explores the architectural and social dimensions of designing a toy library, with particular emphasis on the needs of children, the importance of creating inclusive and stimulating spaces, and the integration of sustainable and innovative design strategies.

By focusing on the toy library as both a community resource and a pedagogical space, this project aims to highlight how architecture can support playful learning environments that are accessible, engaging, and socially meaningful.

This chapter outlines the design concept, objectives, material choices, spatial organization, and environmental strategies of the project,

III.1 WHY TOY LIBRARY?

The choice of studying a Toy Library as the central focus of this thematic chapter stems from its unique architectural and social value. Unlike conventional educational or recreational buildings, toy libraries offer a multifunctional space where children can learn, play, and grow in a supportive environment. They combine education with fun, creativity with structure, and individual discovery with community engagement. This blend makes them an ideal subject for exploring how architecture can directly influence childhood development.

In today's evolving society, it is crucial to rethink how we design spaces for children. The Toy Library encourages a shift from traditional, rigid structures to more dynamic, inclusive, and imaginative environments. By analysing examples like the Toy and Media Library designed by Philippe Fichet Architectes, we can uncover how architecture can nurture learning through play and adapt to the diverse needs of young users. Such projects remind us of the importance of experimenting with new, creative architectural approaches that prioritise user experience, especially for our youngest generations.

Figure 42 : Gallery of Toy and Media Library (archidaily)

III.2 WHAT IS TOY LIBRARY?

The architecture of a toy library is a specialized field that combines elements of traditional library design with the unique requirements of children's play and learning environments. A toy library serves as a community resource where children can access a variety of toys and educational materials, fostering creativity, social interaction, and cognitive development. The design of such spaces must consider both the physical layout and the psychological needs of children, ensuring that the environment is engaging, safe, and conducive to play.

III.3 SPATIAL ORGANISATION

The organisation of a toy library typically includes designated areas for different types of play and learning activities. For instance, spaces can be divided into sections for quiet reading, active play, and group activities. This zoning is crucial as it allows children to engage in various forms of play while minimizing distractions. The design of public spaces, including libraries, should reflect the everyday culture and practices of the community it serves, which is particularly relevant for toy libraries that cater to diverse groups of children and families (Ewing, 2022).

Moreover, the layout should facilitate easy navigation for both children and caregivers. Clear pathways and visible signage can enhance the user experience, allowing children to explore independently while ensuring safety. The incorporation of flexible furniture that can be rearranged for different activities also supports a dynamic environment that can adapt to various needs (Nicholson, 2019).

Figure 43 : Toy Library

III.4 INTERIOR SPACES

The interior spaces of a toy library should be vibrant and inviting, utilizing colors, textures, and materials that appeal to children. Research indicates that the aesthetics of a space can significantly influence user satisfaction and engagement (Hindagolla & Weerasinghe, 2022). For example, bright colors and playful designs can stimulate creativity and encourage exploration. Additionally, the use of natural light and open spaces can create a welcoming atmosphere that promotes positive interactions among children (Block, 2018).

In terms of functionality, the interior should include storage solutions that are accessible to children, allowing them to take ownership of their play experiences. This aligns with the findings of Matthews and Kitsantas, who emphasize the importance of supportive environments in fostering collaborative and engaging experiences (Matthews & Kitsantas, 2007). Furthermore, incorporating areas for adult supervision, such as comfortable seating for caregivers, ensures that adults can engage with children while maintaining a watchful eye.

III.5 MEETING THE NEEDS OF USERS

Understanding the needs of the library's users is paramount in the design process. Toy libraries must cater not only to the children who use the space but also to their caregivers and the broader community. This includes providing resources that support early childhood development, such as educational toys that promote STEM learning, social skills, and creativity (Ilavonga & Grace, 2023)

Moreover, the library should offer programs and activities that engage families and encourage community involvement. This can include workshops, storytelling sessions, and playgroups, which can enhance the library's role as a community hub. The integration of technology, such as interactive displays or digital resources, can also enrich the user experience and keep pace with the evolving interests of children (Duncan, 2022)

III.6 SAFETY CONSIDERATIONS

Safety is a paramount concern in the design of toy libraries. The layout should minimize hazards by ensuring that spaces are free from sharp edges, tripping hazards, and other potential dangers. The use of soft flooring materials, such as rubber or carpet, can mitigate injury risks during play (Hindagolla & Weerasinghe, 2022).

Moreover, the design should include clear sightlines for caregivers to supervise children effectively. This can be achieved through open layouts and strategically placed furniture that allows for unobstructed views of play areas (Block, 2018). Additionally, safety features such as secure storage for small or hazardous items and child-proof locks on cabinets can further enhance the safety of the environment.

In conclusion, the architecture of a toy library is a multifaceted endeavor that requires careful consideration of spatial organization, interior design, and user needs. By creating an environment that is both functional and engaging, toy libraries can effectively support the developmental needs of children and foster a love for learning and play.

III.7 ARCHITECTURAL NORMS FROM NEUFERT

III.7.1 Design Considerations

- Spaces should promote modularity and be easily adaptable.
- Circulation paths should be intuitive, minimizing unnecessary corridors.
- Rooms like group spaces, changing rooms, and restrooms should be placed logically for ease of supervision.
- Outdoor access is key; facilities should include gardens, shaded play areas, and safe pathways.

III.7.2 Interior and exterior spaces in day-care design

Group Room: This is the main area for daily activities. It should allow for different zones: rest, play, learning, and interaction. Heights of furniture and materials must be adapted to children (e.g., low platforms, visibility). Storage and sanitary access should be integrated into the layout.

Kitchen: If meals are served on-site, the kitchen may be part of a larger shared service or independent, depending on the institution. It must comply with health regulations and be accessible to staff without disturbing children's spaces.

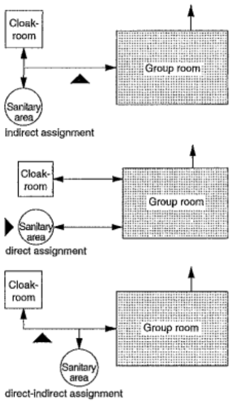
Rest Area: Sleeping or resting zones should be calm and slightly separated from activity spaces. Accessibility and comfort are essential, especially for younger children.

Activity Rooms: Spaces should support creativity—offering areas for drawing, music, physical activities, and quiet play. Flexibility is essential for adapting to children's changing needs.

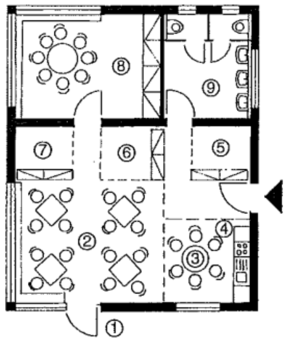
Outdoor Areas: Outdoor spaces are vital for shade, light, and air. Designs should include different natural elements: grass, sand, small hills, and trees. They support development, autonomy, and socialization.

When designing facilities for young children, it is crucial to consider their specific needs, beyond just dimensions or regulations. There are no universal standards; instead, recommendations are based on observed best practices.

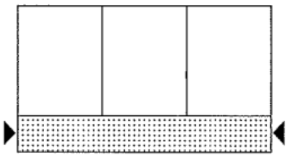
III.7.3 Access and building forms rooms outdoor areas



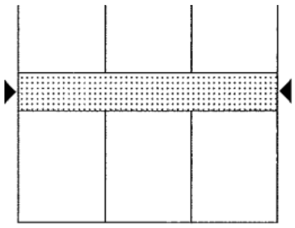
1 Functional arrangement of group room, cloakroom and sanitary facilities



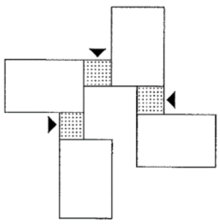
① terrace
② common room 45–48 m²
③ dining
④ kitchen
⑤ role-play 4 m²
⑥ building 4 m²
⑦ bonding 4 m²
⑧ group room 18 m²
⑨ washroom/WC



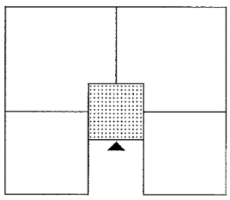
3 Children's daycare centres access types: in a single block



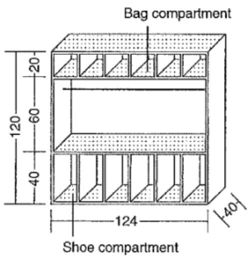
4 In two blocks



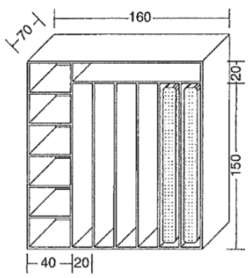
6 Hall access



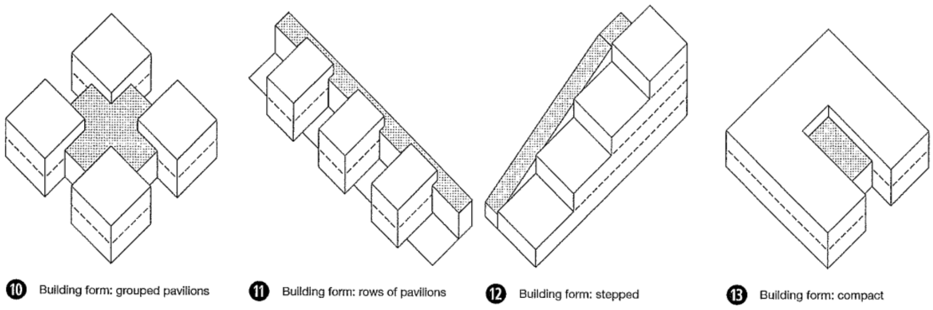
7 Courtyard access



8 Cloakroom cupboard for six children



9 Cupboard for storing children's mattresses (size: 140/70 and 120/60 cm)



III.8 ZONES IN A TOY LIBRARY: LEARNING THROUGH PLAY

The toy library is a fun and educational space where children learn by exploring different themed areas which different activities like:

Agriculture and Insects: Children can learn about different types of plants, practice planting in small pots, observe how seeds grow, and discover the role of insects such as bees and butterflies. These activities aim to build environmental awareness, a sense of responsibility, and an understanding of nature.

Figure 44 : Agriculture and Insects

Engineering and Architecture: Through building blocks, creating models of cities and houses, and experimenting with balance and bridge construction, children develop logical thinking, creativity, and spatial planning abilities.

Figure 45 : Engineering and Architecture

Electronics and Digital Technology: Activities like programming simple robots, engaging in augmented reality games, and exploring educational tech tools help introduce children to technology and computational thinking while encouraging future-oriented learning.

Figure 46 : Electronics and Digital Technology

Reading Area: A cozy library corner with picture books, interactive storytelling sessions, and reading workshops is designed to nurture a love for reading, language skills, and imagination.

Figure 47 : Reading Area

Daily Life Experiences: Children can explore real-life scenarios in playful settings, such as a mini kitchen for cooking, a pretend shop for shopping, and areas to simulate roles like firefighters or doctors. These experiences help develop independence and an understanding of social roles and responsibilities.

Outdoor Play Areas: Spaces for movement games, slides, climbing, cycling, and sand or water play promote physical development, cooperation, and self-confidence.

Figure 48 : Outdoor Play

Additional Fields: Creative areas for **music**, where children can try instruments and make simple composite ns, and spaces for **art** and **design** activities like drawing and clay modeling. Role-playing different professions and participating in **cooperative games** help children explore social dynamics, teamwork, and emotional growth.

III.9 ANALYSIS OF TOY LABRARIES EXAMPLES

III.9.1 Children's toy Library / LAN Architecture

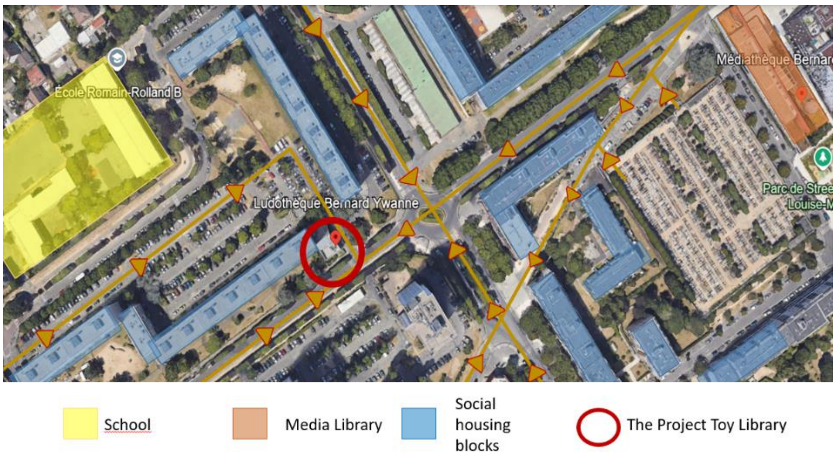
a) Project Overview

The **Children's Toy Library** in Bonneuil-sur-Marne, France, designed by **LAN Architecture** and completed in 2008, serves as both a public facility and a dedicated play space for children. Situated in an area dominated by 1960s social housing, the project addresses the challenges of its context by juxtaposing a monumental exterior with a warm, inviting interior.

Figure 49 : Interior view for Children's toy Library / LAN Architecture (Archidaily)

b) Urban Analysis

- Site Context and **Location** Surrounding Buildings**:** Located in a dense residential area, the library integrates with the surrounding architecture through material continuity while introducing a modern reinterpretation of concrete.
- **Accessibility** : The project is well-connected to the neighborhood via existing streets and pathways. Pedestrian access is emphasized, with safe, direct routes leading to the toy library from nearby residential buildings. Parking for vehicles, including drop-off zones for families, is likely incorporated into the broader urban planning around the site.

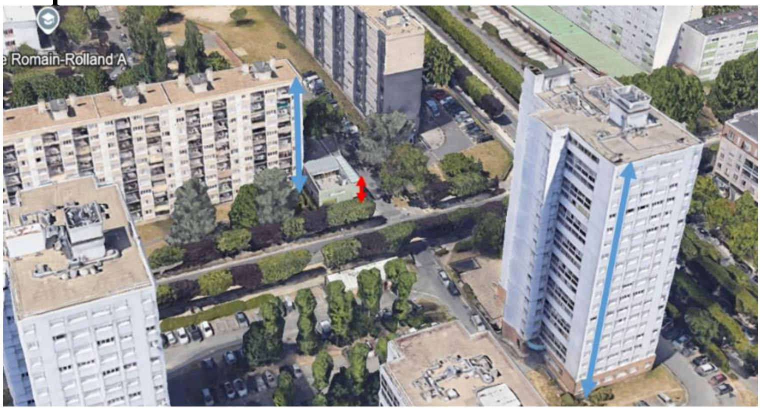


- **Entrance and Orientation:**

The toy library is accessed through a monumental entrance, clearly marked and easily visible from the surrounding area.

- **Scale and Proportions**

The toy library has a modest height, ensuring a child-friendly scale that is welcoming and approachable.



- **Integration with Public Spaces:**

The site is adjacent to small public spaces and courtyards, which serve as transitional zones between the dense residential environment and the public function of the toy library. These spaces allow for informal gathering, outdoor play, or waiting areas for families.

- **Sustainability and Urban Integration** The green-tinted concrete façade minimizes heat absorption and offers a durable, low-maintenance solution. Landscaped areas around the building soften the transition from the dense urban environment and provide opportunities for outdoor activities. The design prioritizes walkability, reflecting sustainable urban planning principles.

Figure 50 : Children's toy Library / LAN Architecture (Archidaily)

c) Architectural analysis

- Concept and Design Philosophy
- Reusing an existing building and adapting it for a new function.
- Creating a dedicated children’s play space with an engaging and protective environment.
- Developing a small-scale public facility in a socially unstable area with large housing complexes.

- Overcoming budget constraints, initially limited to an interior reconfiguration.
- The creation of a new entrance and an open courtyard.

Figure 51 : Children's toy Library (Archidaily)

- **Materiality and Aesthetics**

The exterior features monolithic, green-tinted concrete with a wood-imprinted texture, giving it a timeless, bunker-like quality. The interior is vibrant and colorful, designed to create a warm, cocoon-like atmosphere filled with natural light and playful elements.

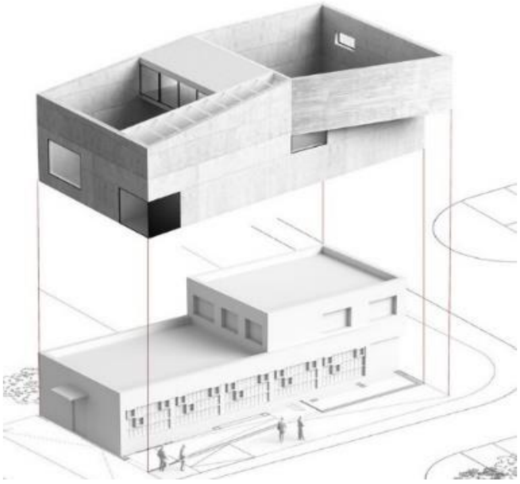


Figure 52: The shape of Children's toy Library (Archidaily)

Figure 53 : Interior view of Children's toy Library (Archidaily)

Our strategy was inspired by a medical logic of intervention. The creation of an additional freestanding skin of allowed us to control the interfaces between exterior spaces, building and interior spaces, as well as meet the need to provide generous volumes.

d) Interior analysis

- **Functionality and Spatial Organization**

The toy library spans two levels, with the interior layout emphasizing openness and adaptability to accommodate various activities. Natural light permeates the space from three sides, enhancing the play areas and contributing to a vibrant environment. The design ensures that the facility is both functional and comfortable, tailored to the needs of its young users.

Figure 54: The floor plan of the Children's toy Library (Archidaily)

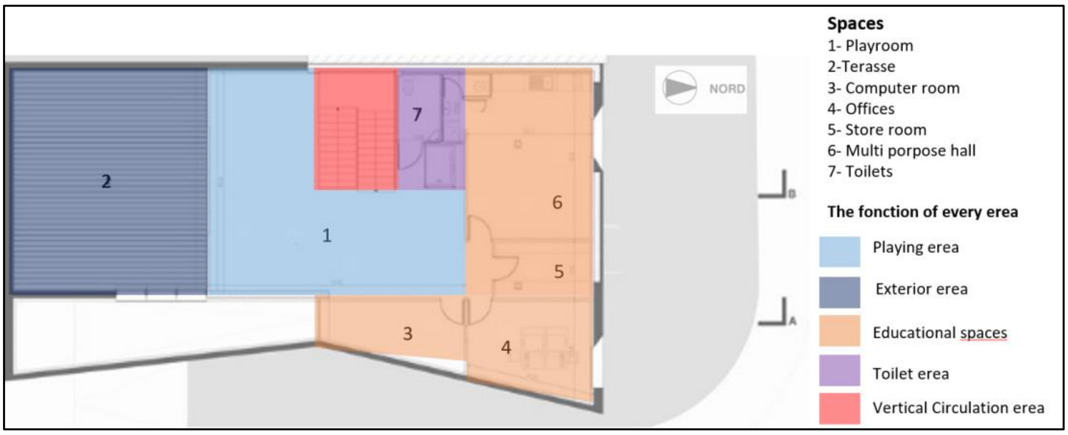


Figure 55 : The 1st floor plan of Children's toy Library (Archidaily)

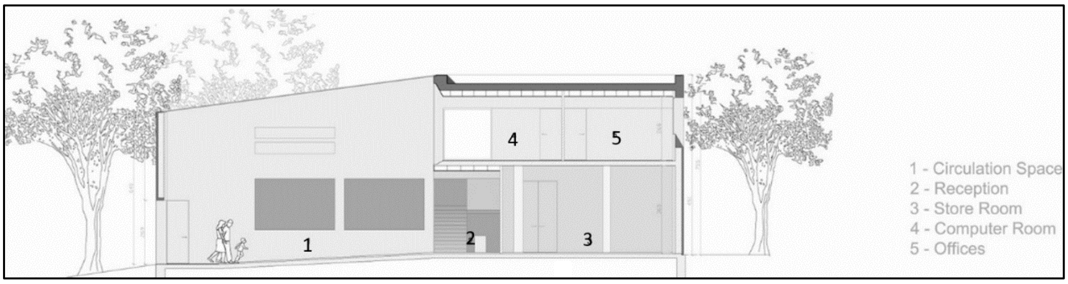


Figure 56 : A section of Children's toy Library (Archidaily)

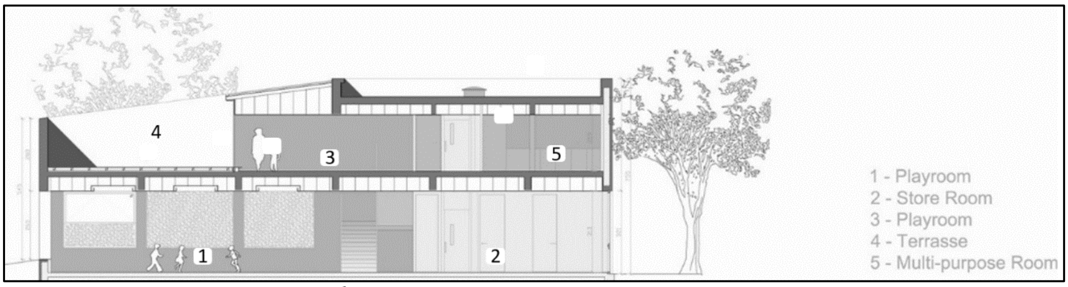


Figure 57 : 2nd section of Children's toy Library (Archidaily)

- **Spatial organization on the ground floor analysis**: The ground floor is organized to optimize circulation, accessibility, and functionality: Entrance /Pushchair /Room /Circulation Space / enabling smooth movement / Reception / Playroom / Store Room /Toilets /Technical Room
  - **Spatial Organization** on the upper Level: The first floor focuses on quieter, educational, and administrative functions:
  - Playroom /Terrace /Computer Room of technology and play /Offices /Store Room /Multi-purpose Hall /Toilets
  - Functionality: The design maximizes the building's utility by separating active play zones (ground floor) from quieter, more educational spaces (first floor).
- Circulation Both levels are connected via central staircases, ensuring smooth movement between floors.

e) Summary of Strengths of this project

The Children's Toy Library by LAN Architecture demonstrates several strengths, particularly in its innovative reuse of an old building, thoughtful spatial organization, and the balance between a vibrant interior and a respectful exterior.

- Reusing an Old Building
- Well-Defined Spatial Distribution
- Colorful Interior Design
- Simple Exterior Respecting the Environment

III.9.2 Toy and Media Library in Philippe Fichet architects

The Toy and Media Library, designed by Philippe Fichet Architectes, is a cultural facility located in La Ferté-Bernard, France, completed in 2014. This 1,300-square-meter building combines a toy library and a media library under one roof, offering a versatile space for education, recreation, and community engagement. Situated at the edge of the historic town center, alongside a picturesque river, the project acts as a bridge between the old and new parts of the city.

a) Urban Analysis

- Site Context and Integration

Positioned at the eastern edge of the old town, the library serves as a transitional space between historical and modern developments. The proximity to the river creates a scenic and inviting public space, enhancing the site’s cultural and recreational value.

- Accessibility

The project is easily accessible from the surrounding urban fabric, with pathways that connect seamlessly to the adjacent public spaces and streets. Wide, open entry points ensure smooth flow for pedestrians, families, and individuals with mobility aids.

Figure 58 : The accessibility

- Urban Role and Connectivity

By merging a toy library and media library, the project caters to diverse age groups and needs, solidifying its position as a cultural hub for the community. The reflective façade allows the building to blend with the urban landscape, adapting to its surroundings by mirroring nearby structures and nature. The site leverages its visibility and connectivity, encouraging engagement between residents and visitors, while also revitalizing the adjacent riverfront area.

Figure 59 : Le plan de masse du projet

- **The entrance**

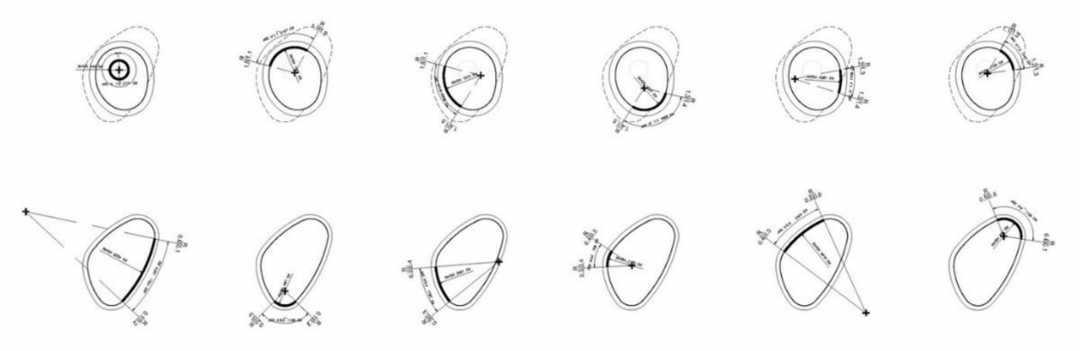
The entrance of the project is a distinctive architectural feature that harmoniously integrates with its urban and natural surroundings. Situated on the edge of the old town and adjacent to a river, the building's forecourt is equipped with a misting system that creates a reflective surface, evoking the nearby water body and enhancing the sensory experience for visitors.

Figure 60: The entrance of the project

b) Architectural Analysis

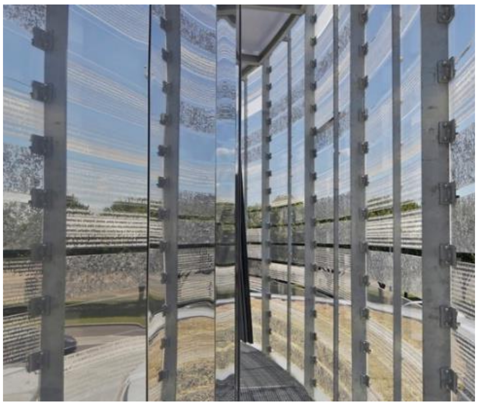
- **Form and Design Concept**

The building adopts a flowing, curvilinear form, reflecting its dynamic cultural purpose and creating an inviting, playful aesthetic. The curvatures evoke a sense of movement and creativity, aligning with the library's dual role as a space for imagination and knowledge.



- **Materiality and Façade**

Polymethyl methacrylate (PMMA) and stainless steel dominate the façade, creating a blurred mirror effect. This reflective treatment integrates the building with its surroundings, responding to light and weather conditions dynamically. The reflective surfaces reduce solar heat gain and establish a balance between aesthetic appeal and functional performance.



- Environmental Considerations

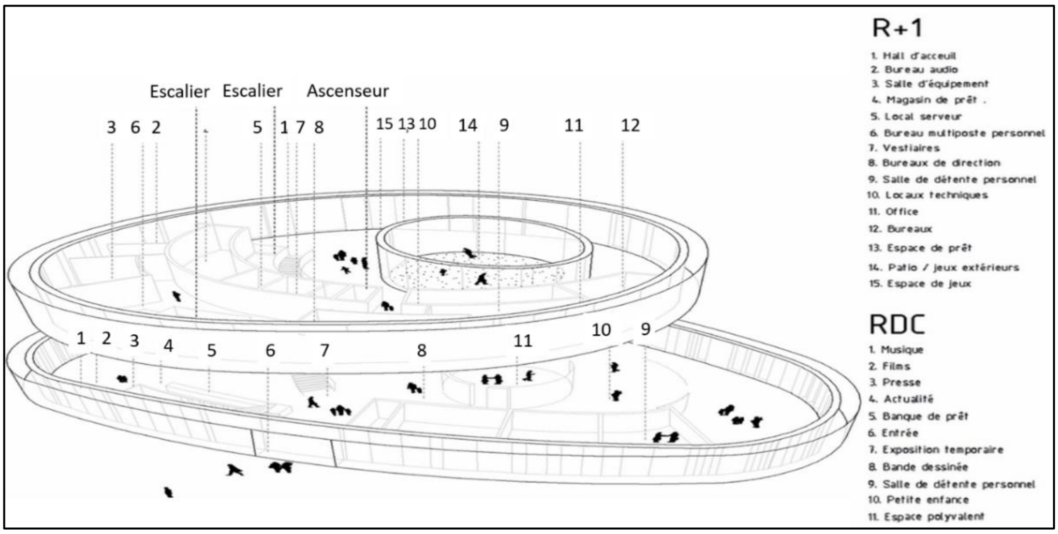
The materials and design focus on sustainability, with natural light and reflective elements reducing energy consumption. The building adheres to passive design principles, using transparency and light modulation to ensure thermal and visual comfort.

c) Interior Analysis

- Program and Spatial Organization

Spaces are organized around central cores, facilitating smooth navigation and flexible use. The public areas are open and interconnected, fostering interaction and collaboration, while private spaces like administrative offices maintain functionality. The program ensures a seamless transition between the toy library and media library, providing intuitive access for all users.

- Spatial Flow and Navigation
- The interior promotes fluid movement, with curved pathways and open layouts reflecting the external form of the building. Central reception areas provide orientation and interaction points, creating a welcoming atmosphere for visitors.



- **Lighting and Ambiance**

Natural light penetrates the building through large glazed areas and a central circular patio, reducing the need for artificial lighting. The interplay of light and shadow enhances the dynamic character of the interiors, aligning with the building's cultural purpose.

- **Material Palette**

The interiors use materials that complement the exterior, such as light-toned finishes and smooth surfaces, emphasizing a sense of openness and modernity. The combination of durable and tactile materials ensures the spaces are both functional and inviting for users of all ages.

Figure 61 Interior space

- **User Experience**

The design prioritizes comfort and engagement, creating a friendly and stimulating environment for children while maintaining the professionalism needed for adults and staff. Flexible furniture and adaptable spaces support various activities, from storytelling sessions to digital media exploration.

- **Functional Zoning**

The layout separates spaces for different user groups, with areas dedicated to children, adults, and staff. Open reading spaces and play zones in the toy library encourage interaction and creativity, while quieter areas in the media library offer focused study opportunities.

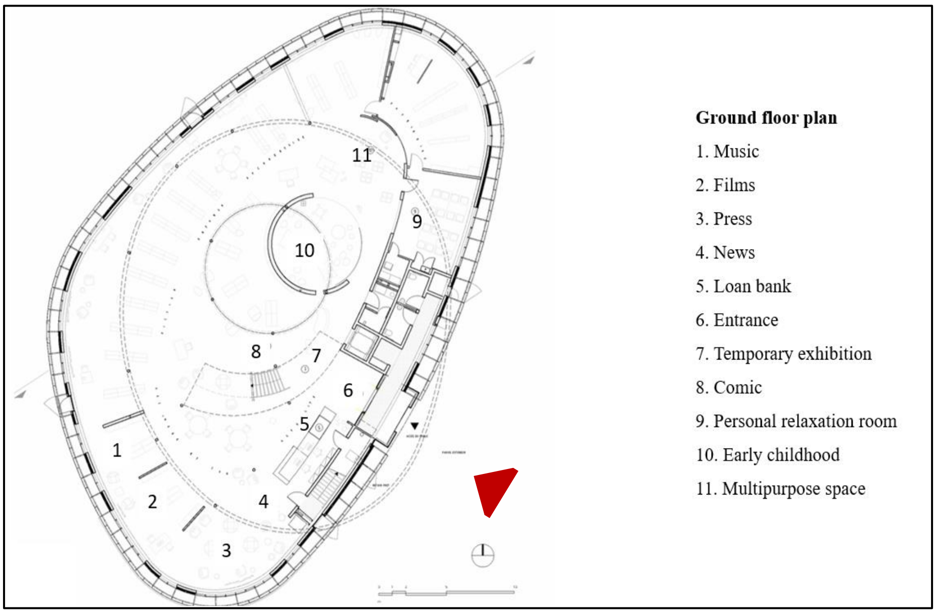


Figure 62 : Ground floor plan

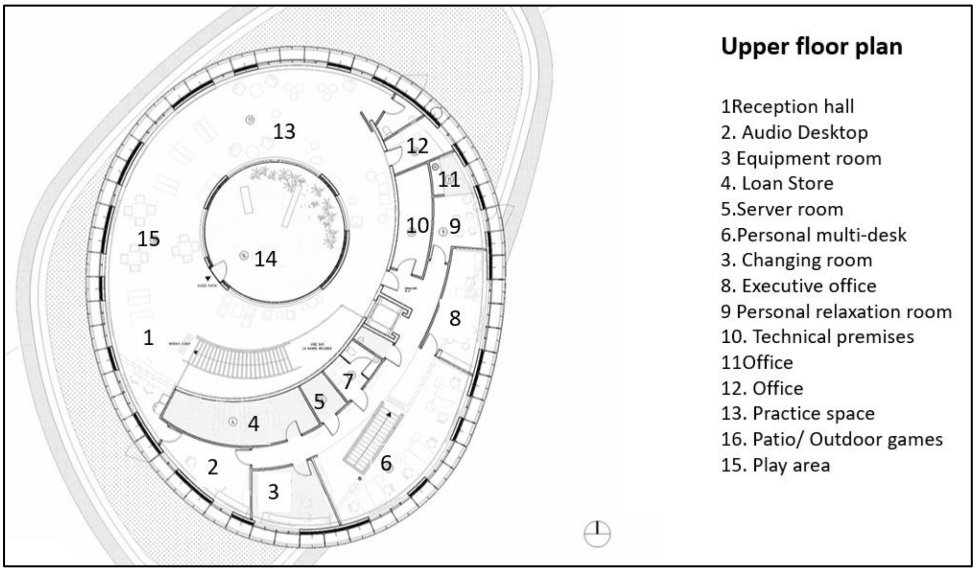


Figure 63 : Upper floor plan

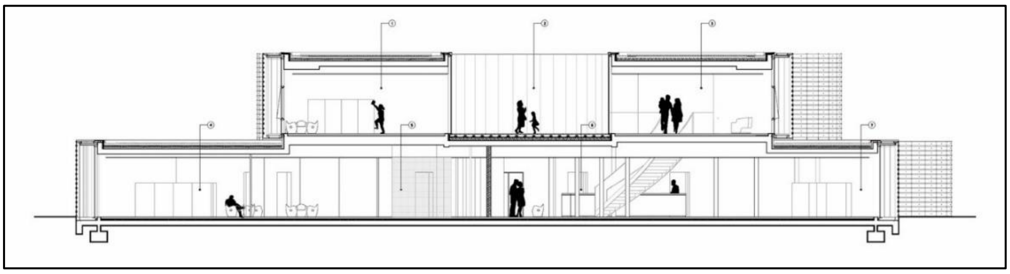


Figure 64 : Section

d) Summary of Strengths of this project

- Urban Integration: Strategically located to connect the historic town center and modern urban developments. Enhances pedestrian and urban connectivity, while revitalizing the adjacent riverfront.
- Environmental Considerations Designed with energy efficiency in mind, the **wooden** Architectural Design: The curvilinear, flowing form reflects its dynamic cultural role and creates an inviting, playful aesthetic. The reflective façade interacts with the environment, blending the building with its surroundings while maintaining a striking visual presence.
- Functionality and Accessibility: Combines a toy library and media library, catering to diverse age groups and needs. Offers a well-organized layout with open, flexible spaces that encourage creativity and community engagement. Universal design principles ensure physical, visual, and functional accessibility for all users.
- Interior Design: Maximizes natural light through large glazed areas and a central courtyard, creating bright and welcoming interiors. Offers diverse, adaptable spaces for various activities, from quiet study to playful interactions.

III.9.3 Day Nursery and Toy LIBRARY / a+samueldelmas architects

The Day Nursery and Toy Library, designed by a+samueldelmas architectes, is a notable example of sustainable and context-sensitive architecture in Vélizy, France. This project exemplifies a harmonious blend of urban integration, architectural innovation, functional design, and thoughtful interior spaces.

a) Urban analysis

- Urban Context and Integration

The 9.3 Day Nursery and Toy Library is located in the Louvois district of Vélizy-Villacoublay, France, an area undergoing urban renewal. The project is situated at the base of a 1960s residential tower, utilizing previously underutilized basement spaces. The surrounding environment includes collective housing, commercial spaces, and newly created pedestrian areas, providing a mix of residential and public functions.

- **Accessibility from the City Center**

The site is well-connected to the city center through a network of roads and public transportation. The urban renewal plan has enhanced accessibility by improving pedestrian pathways and integrating the area with the broader urban landscape. The removal of old commercial slabs has opened up new circulation routes, making the site more accessible for families and children.

Figure 65 Accessibility from the City Center

- **Scale and Proportions with Other Buildings**

The project is positioned at the base of a high-rise residential building, which creates a contrast in scale and proportion.

- **Nearby environment**

It is bordered to the west, north and south by a highway, and to the east by a green area. It has a parking next to the southern entrance.

- Entrance and Orientation

A welcoming entrance faces pedestrian pathways, while the building's orientation maximizes natural light and integration with its surroundings.

Figure 66 Integration with Public Spaces

- Integration with Public Spaces

New green spaces and pedestrian routes connect the nursery to the community, enhancing accessibility and public engagement.

b) Architectural Analysis

- Form and Design Concept

The project revitalizes an underused basement space, integrating it into an evolving urban environment. The project is integrated into an existing urban setting, revitalizing a previously underused basement space. The rectilinear form and modular layout create open, flexible spaces for children. A wooden grid façade balances privacy and openness while enhancing urban integration.

The use of outdoor spaces throughout the building gives a sense of comfort, nature and natural lighting.

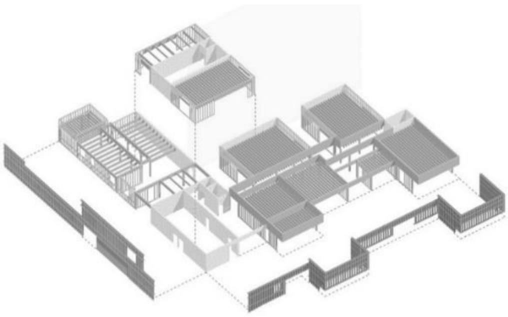
The work on the 5th facade has enabled us to create a new, living 'soil' in front of the flats above, with soil complexes of up to one meter and real trees to come

Figure 67the 5th facade

- Materiality and Façade

Sustainability is at the core of the project, with the structure built entirely from **wood and bio-based reclaimed materials**. The **façade consists of vertical poplar slats** spaced uniformly, combined with **coppery zinc sheets**, adding depth and texture while maintaining durability.

Structure provides excellent thermal insulation, reducing the need for artificial heating and cooling. Large windows and skylights allow ample natural daylight, minimizing reliance on artificial lighting. Furthermore, the inclusion of patios and green spaces improves ventilation and natural shading, creating a comfortable microclimate for users.



- **Environmental Considerations**
  - The wooden structure improves thermal efficiency, reducing energy consumption.
  - Patios and green spaces enhance ventilation and natural shading.

Large windows and skylights maximize daylight, lowering the need for artificial lighting.

c) Interior Analysis

- **Spatial Organization**

The interior is designed with an open and flexible layout, ensuring a safe and engaging environment for children. Spaces are divided into activity areas, rest zones, and service areas, with seamless transitions between them.

- **Circulation**

The layout promotes fluid movement, with wide hallways and clear sightlines for easy supervision. Natural light and visual connections between spaces enhance spatial continuity and user experience.

The children's sections are soft and flow between intimate patios and play gardens

- Functionality Each space is designed for efficiency, catering to the needs of both children and caregivers. Natural materials, soft lighting, and acoustic treatments create a comfortable atmosphere, while storage solutions enhance organization.

Figure 68 : The ground floor plan

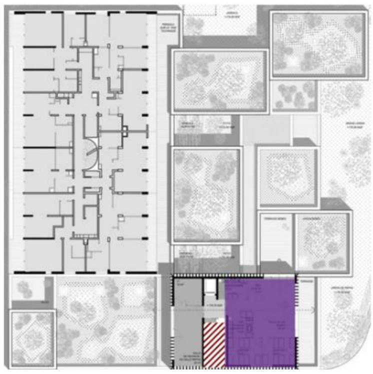


Figure 69: The 1 st floor plan

CONCLUSION

The exploration of the Toy Library's architecture highlights the growing importance of creating spaces that are not only functional and playful but also culturally and environmentally responsive. Through the analysis of Philippe Fichet Architectes' Toy and Media Library in La Ferté-Bernard, it is evident that thoughtful design can successfully merge pedagogical goals with architectural innovation. The project demonstrates how architecture can support child development by offering spaces where learning and education occur through play and discovery, an essential principle for toy libraries.

Such environments must go beyond storage or recreational use; they should be immersive, stimulating, and educational, enabling children to grow intellectually, socially, and creatively in a fun and engaging way. This calls for architectural projects that prioritize user-centered, flexible, and inclusive designs, spaces that adapt to the needs of children and encourage learning through interaction. By examining these case studies, we gain valuable insights into how toy libraries can become dynamic cultural landmarks, enriching the urban fabric while promoting the holistic development of young users.

IV. ARCHITECTURAL CHAPTER

IV.1 SITE ANALYSIS

From the beginning, I wanted my toy library to be located in a place that is not isolated, but rather in the heart of the city, a space that is accessible, welcoming, and already loved by children.

That's why I chose a site located behind a public garden in the northern part of Biskra. This space is currently empty and unused, but its calm and green environment makes it perfect for children.

IV.1.1 Site location and relation with the city

The plot is located near the city center of Biskra, making it easily accessible and well-connected. It is directly linked to the central area through a main road, which facilitates smooth transportation to and from the site. Being in a familiar and popular part of the city, the location is known by most residents.

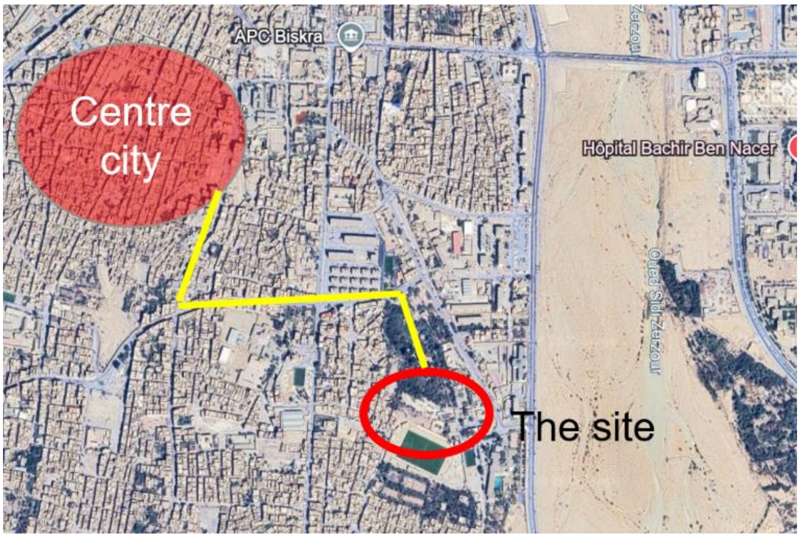


Figure 70 : The site

The site is not far from the city center and has a direct connection via a main road. It's a well-known location familiar to everyone in the city. The site is located in the south of Lando Garden on the middle of Biskra city behind 8 Mars road.

Figure 71 : The site

IV.1.2 Environment and Landmarks near the site

The site is strategically positioned in close proximity to primary and middle schools, as well as both social and private residential areas, ensuring optimal accessibility and strong community integration.

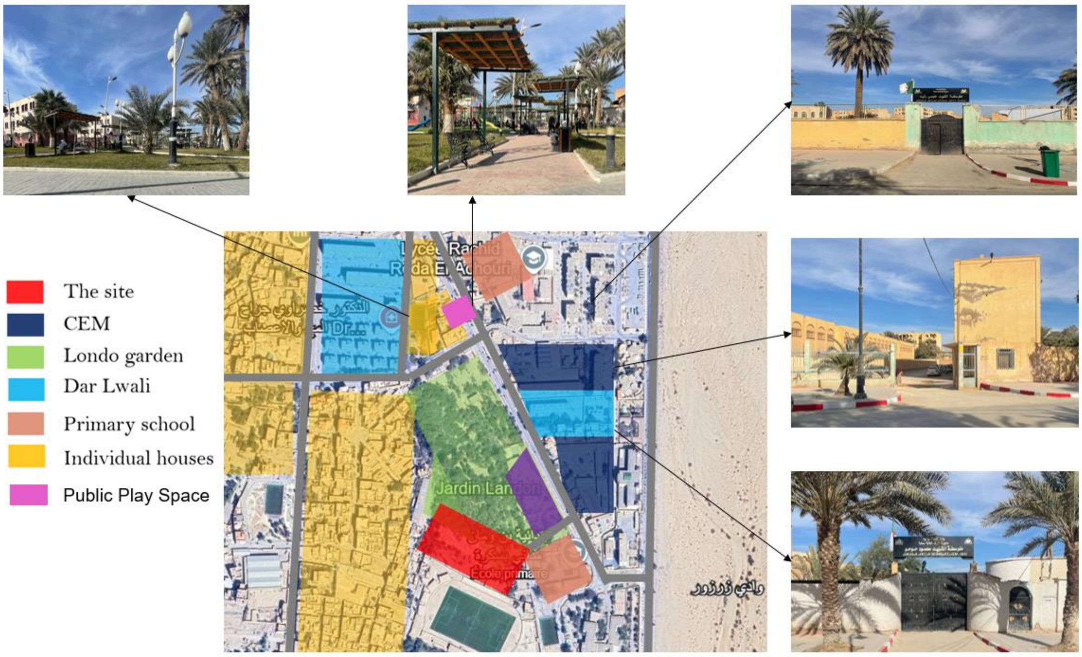


Figure 72 The environment of the site

IV.1.3 Roads and accessibility

The site offers excellent accessibility, with well-connected roads and pedestrian pathways ensuring easy access for residents, students, and visitors. There is two ways to get to the site:

- From Gouassemi Mohamed road enter from the main door of the garden so we pass from all the garden to get to it.
- From 8 Mars road direct entrance by a small road.

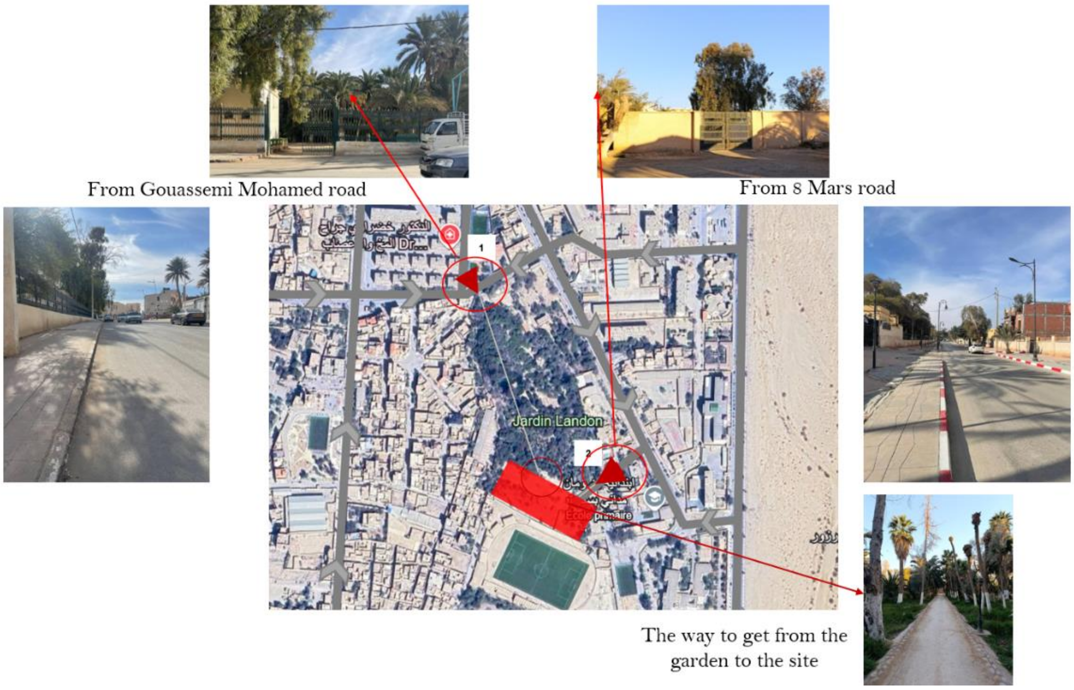


Figure 73 The entrances of the site

IV.1.4**Site morphology**

The site is located next to a garden and still has some trees and palm trees, which can be incorporated into the design. It covers an area of 5 972,52 m².

Borders: It is bordered by Lando Park to the north, a sports field to the south, a primary school to the east, and a road to the west.

Figure 74 : Site morphology

IV.1.5**Built and unbuilt system**

The ratio of built-up areas surrounding this plot is roughly equal to the non-built areas, as the site is located in a park and near a sports field, both of which are non-built spaces. Additionally, it is situated in a residential area with houses, schools, etc., making the built and non-built ratios approximately balanced.

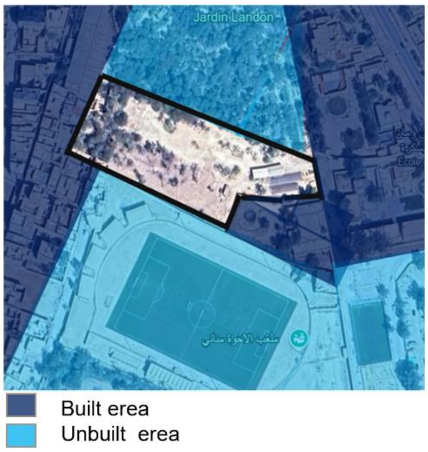


Figure 75 : Build and unbuild erea

IV.1.6 Effect of the sun's path

Additionally, it is notable that the southern side of the plot is not covered by any buildings or trees, with only a wall present. This allows direct sunlight to reach the area. On the western side, trees and buildings block the western sunlight.

Figure 76 : Sun path

IV.1.7 Effect of the Wind

The cold wind coming from the north is effectively blocked by the trees located on the northern side of the plot, near the adjacent park. This provides excellent protection from these cold winds, especially during winter.

Figure 77 Effect of the Wind

IV.1.8 **Reason of choice**

The site selected for the toy library is a vacant area located at the edge of a public garden, right in the center of the city. This location was chosen for its strong emotional and functional connection to the community.

The garden is already a cherished destination for children and families, making it a naturally attractive setting for a child-focused project. Its central urban position ensures excellent accessibility from all directions, especially from the nearby residential neighborhoods, encouraging regular visits and community engagement.



In addition, the site benefits from its direct proximity to nature, offering a calm, green environment that complements the project's aim to provide both playful and educational experiences. This combination of accessibility, emotional value, and connection to nature makes the site an ideal foundation for a toy library that is open, welcoming, and integrated into the daily life of the city.

IV.2 THE PROJECT

IV.2.1 The program of the project

Block	Space	Function / Activity	Floor	Area (m²)
Reception & Administration	Reception	Welcoming visitors, orientation, and basic inquiries	Ground	15
	Waiting Area	Seating area for visitors and parents	Ground	11
	Multi-purpose Room	Flexible space for meetings, workshops, or temporary activities	Ground	25
	Archive	Storage of administrative records and materials	Ground	15
	Staff Break Room	Relaxation and refreshment space for staff	Ground	15
	Meeting Room	Formal meetings, coordination, and planning	First	60
	Toilet	Toilet	Ground	15
	Total	**Total surface of the block**		**156**
Toy Lending & Library	Reception & Waiting Area	Welcoming children and parents, waiting before borrowing	Ground	12
	Toy Library	Toy lending and return area	Ground	28
	Play space	Playing in tables	Ground	40
	Sterilization Room	Cleaning and disinfecting toys before return	Ground	11
	Library	Shelving and reading space for children	First	90
	Total	**Total surface of the block**		**181**

Arts & Architecture	Reception & Waiting Area	Welcoming and holding children before activities	Ground	16
	Drawing & Crafts Room	Artistic activities: drawing, painting, and handcrafts	Ground	60
	Architecture & Construction Room	Building activities using games, LEGO, and models	First	60
	Total	**Total surface of the block**		**136**
Future Professions	Reception & Waiting Area	Orientation and waiting before entering mini spaces	Ground	15
	Mini Market	Role-play shopping and cashier activities	Ground	23
	Mini Chef Zone	Role-play cooking activities	Ground	18
	Mini Police Station	Role-play law enforcement activities	Ground	8
	Doctor Space	Role-play medical practice and care	First	23
	Firefighter Space	Role-play emergency response	First	23
	Pilot Space	Role-play flying simulation	First	23
	Astronaut Space	Space exploration play and learning	First	30
	Teacher Space	Role-play teaching and school activities	First	20
	Toilet	Toilet	Ground	2.5
	Total	**Total surface of the block**		**185.5**
Sports Block	Reception & Waiting Area	Welcoming area for kids before entering changing or sports zones	Ground	23
	Changing Rooms	Changing clothes before swimming or sports	Ground	20

	Table Tennis Zone	Table tennis activity	First	30
	Darts Zone	Dart throwing and coordination activity	First	30
	Free Play Area	Open play space with flexible uses	Second	60
	Toilet	Toilet	Ground	5
	Total	**Total surface of the block**		**168**
Digital & Science Exploration	Reception & Waiting Area	Orientation area before digital or science activities	Ground	12
	Programming Space	Learning coding and logic skills	Ground	30
	Digital descovery	Learning inforamtiques	Ground	31
	Virtual Reality Zone	Immersive VR games and educational simulations	Ground	47.5
	Physics	Experiments and scientific learning	First	30
	Chemistry Space	Experiments and scientific learning	First	30
	Light & Optics Exploration	Hands-on exploration of light and vision	First	17
	Total	**Total surface of the block**		**197.5**
Music & Performance	Reception & Waiting Area	Welcoming and waiting area for children and parents	Ground	14.5
	Dance Room	Movement, rhythm, and dance activities	Ground	30
	Instruments Room	Learning and playing musical instruments	Ground	30
	Mini Performance Theater	Small shows, storytelling, and performances	First	46
	Total	**Total surface of the block**		**120.5**
Nature, Farming & Biology	Reception & Waiting Area	Gathering space before activities	Ground	9.5

	Farming & Insects Area	Learning about plants, gardening, and insect life	Ground	36
	Human Body & Biology Room	Learning about anatomy and biological systems	First	17
	Toilet	Toilet	Ground	9.5
	Total	Total surface of the block		72
Overall	**Total**	**Total surface of the entire project**		**1216.5**
Overall with circulation	**Total**	**Total surface with the circulation 15%**		**1431.33 m²**

- By adding the long connecting corridor, which measures **158 m²,** along with the estimated internal circulation within the blocks, the total circulation accounts for approximately 15% of the project's surface. Therefore, the total surface area, including circulation, reaches **1431.33 m².**
- Driving Simulation Yard Outdoor space for driving mini cars and traffic awareness **400 m².**
- Swimming Pool (Exterior)Outdoor water play and swimming **81 m².**

IV.2.2 **Design Intentions**

Modular Design Inspired by LEGO: To develop a modular architectural language using shipping containers that reflects the playful, constructive spirit of LEGO, allowing for flexible composition, stacking, and rearrangement.

Adaptive Reuse of Shipping Containers: To creatively repurpose used shipping containers as structural and spatial units, promoting sustainability, cost-efficiency, and rapid construction.

Integration with the Natural Environment: To design in harmony with the surrounding public garden by maintaining visual and physical connections with greenery, sunlight, and open space.

Functional Zoning and Spatial Clarity: To organize the program into clearly defined blocks, where each zone (art, science, robotics, movement, music, etc.) is spatially identifiable yet connected through circulation and theme.

Human-Scaled, Child-Friendly Architecture: To design spaces with proportions, colors, furniture, and elements adapted to children's scale and perception, creating environments that are inviting and intuitive to explore.

Indoor-Outdoor Continuity: To blur the boundaries between indoor and outdoor play through terraces, open courtyards, transparent façades, and accessible green zones.

Efficient Circulation and Wayfinding: To create simple, safe, and engaging circulation paths that encourage exploration without confusion, using color, signage, and container arrangement to guide movement.

Natural Lighting and Ventilation: To maximize the use of daylight and natural airflow within containers by incorporating openings, skylights, louvers, and strategic orientation.

Safety and Comfort in Design: To ensure all architectural elements are designed with child safety in mind, including soft edges, non-toxic materials, adequate supervision points, and comfortable microclimates.

Playful Aesthetic Expression: To reflect the spirit of play in the architecture itself through bright colors, creative forms, varied textures, and interactive surfaces.

IV.2.3 Toy Library Concept Inspired by LEGO and Recycled Architecture

This project is a toy library designed as a playful, modular architectural composition using recycled shipping containers. The design draws direct inspiration from the LEGO game, where simple, standardized units are creatively combined to form complex structures. Similarly, the project employs container units as modular building blocks that are assembled, stacked, and arranged in various orientations to create a dynamic and adaptable architectural composition.

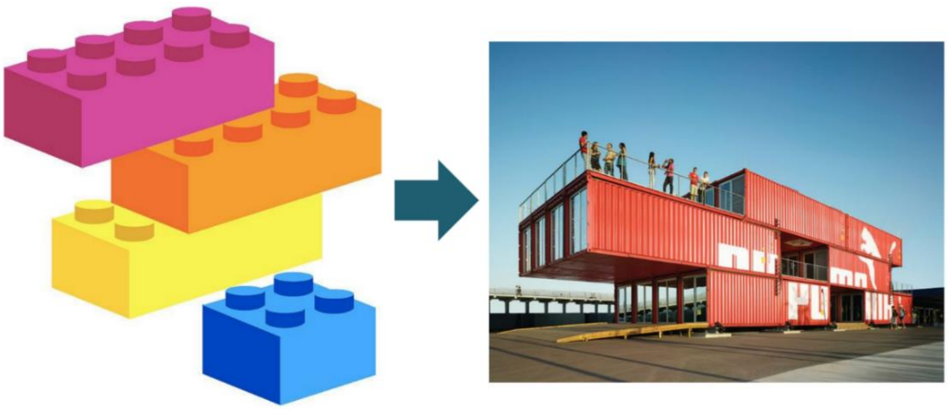


Figure 78 : Project Idea (by author)

Each block or unit group in the project represents a specific functional zone dedicated to children's activities such as art, science, movement, music, architecture, and digital play. These zones are distributed throughout the site like LEGO pieces, emphasizing playfulness, and flexibility, and imagination— key principles of both child development and the LEGO philosophy.

By using shipping containers, the project promotes sustainability, reuse, and cost-efficiency, while their modular nature allows for easy expansion, rearrangement, and customization of the toy library over time.

- **General Organization Strategy Quiet/Noisy**
  - Zones arranged by function and noise level.
  - Smooth circulation for children and staff.

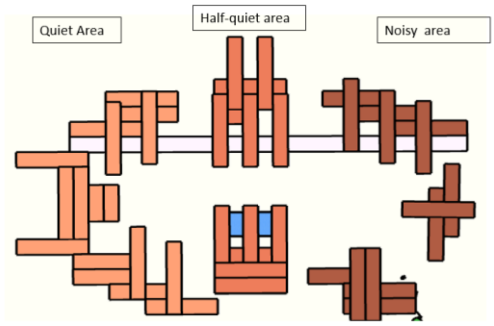


Figure 79 Areas separation quiet/noisy(by author)

- **Leisure/Educational**
  - **Northern Zone**: Leisure and artistic expression
  - **Southern Zone**: Educational and discovery-based activities

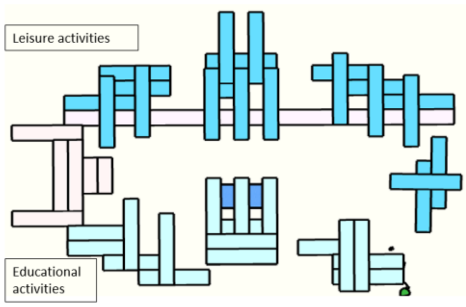


Figure 80Areas separation Leisure/ Educational(by author)

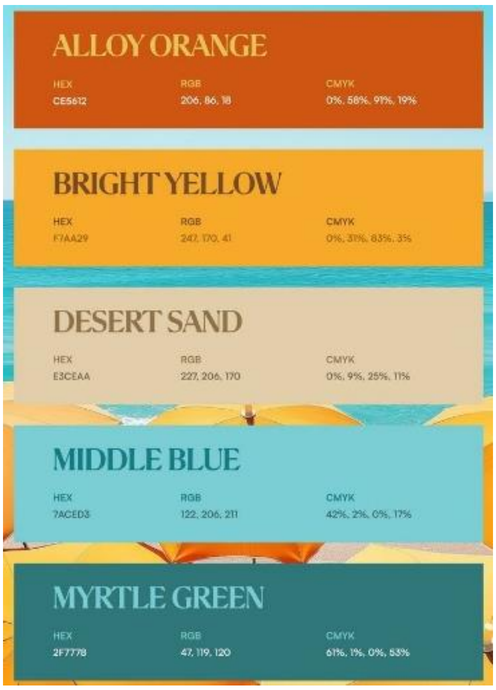


Figure 81 : Choice of colors

IV.2.4The blocks function/plan

Table 15 : Reception and administration/ Library and Toy Lending / Art and Creative Design Block

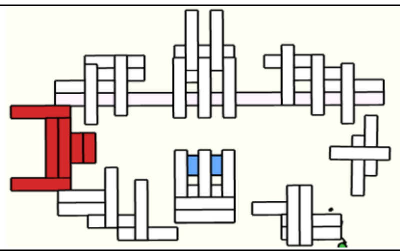
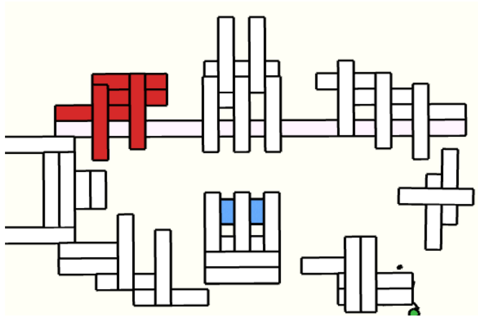
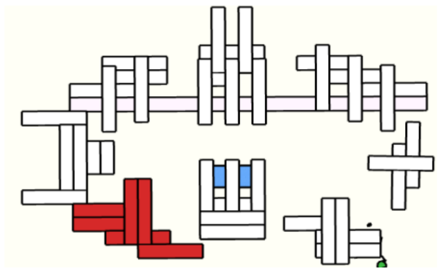
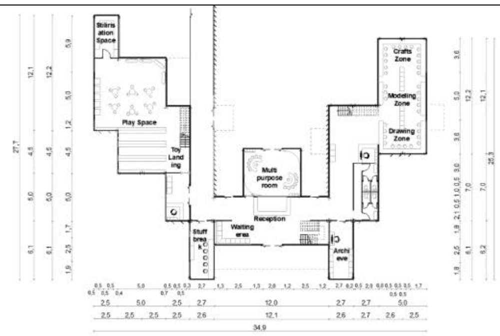
BLOCK FONCTION	Position
Reception and administration: This block functions as the main entry and management center of the Toy Library. • **Ground Floor:** Includes the reception area for welcoming visitors, an archive space for document storage, and a small breakfast area for staff and multipurpose room. • **First Floor:** Contains a meeting room for team discussions and planning.	
Library and Toy Lending Block • This block is dedicated to organizing toy borrowing and ensuring a safe and structured circulation of toys among children. • **Ground Floor:** Includes a designated toy lending area with shelves displaying the toys. Children can borrow and later return the toys. A toy sanitization space is also provided to maintain hygiene and safety. **First Floor:** Reserved for the staff office to manage the lending system and maintain records.	
• This block focuses on developing children's creative and visual skills through art and architectural activities. • **Ground Floor:** Dedicated to drawing and sculpting activities, allowing children to express themselves using various tools and materials. • **First Floor:** Features architectural and construction-based activities where children use building blocks and assembly toys to bring their ideas to life.	
GROUND FLOOR PLAN	**1ST FLOOR PLAN**
	

Table 16 : Sports Block

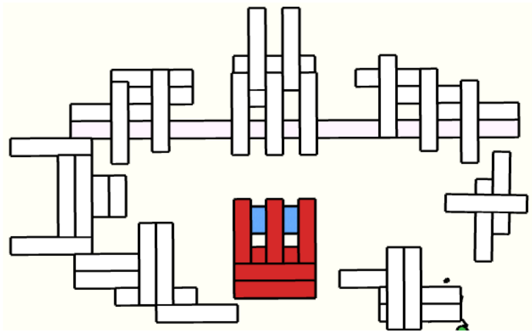
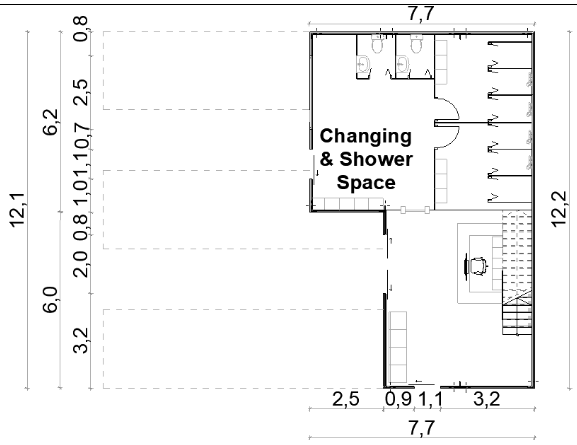
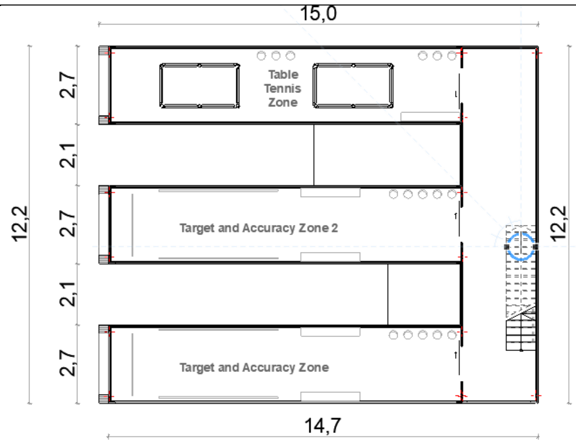
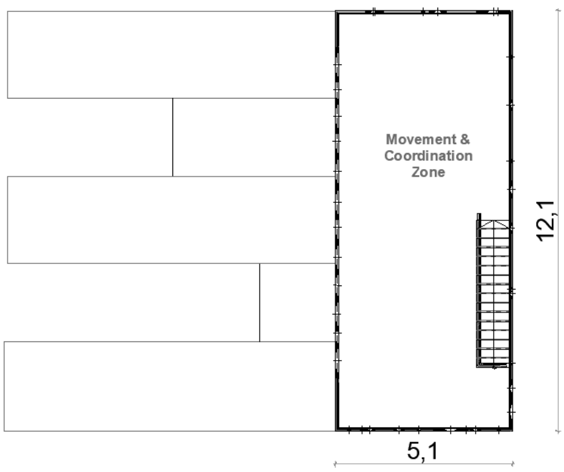
BLOCK FONCTION	**Position**
• This block provides various spaces for physical activities . • Ground Floor: Includes changing rooms for children heading to the outdoor swimming pool. • First Floor: Offers a designated area for table tennis and another for darts, encouraging friendly competition and motor coordination. • Second Floor: Dedicated to free play, allowing children to move and play freely in a safe and open environment.	
GROUND FLOOR PLAN	**1ST FLOOR PLAN**
	
2nd floor plan 	

Table 17 : Future Professions Block

<table>
<tr><th>BLOCK FONCTION</th><th>Position</th></tr>
<tr><td>

- This block introduces children to future careers through realistic and interactive role-play experiences that spark curiosity and imagination.
- **Ground Floor:** Features a mini kitchen and supermarket where children can engage in cooking, selling, and shopping activities. It also includes a police station connected to an outdoor road simulation, allowing kids to experience roles such as drivers and police officers.
- **First Floor:** Dedicated to professions like medicine, aviation, firefighting, space exploration, and teaching, each represented through immersive, child-friendly environments.

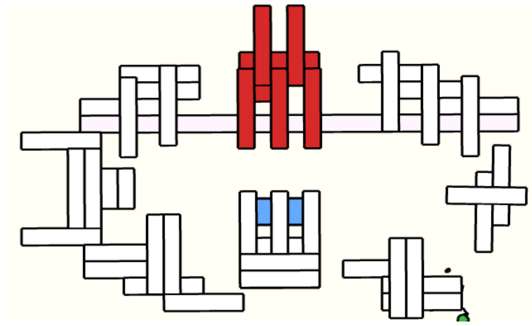
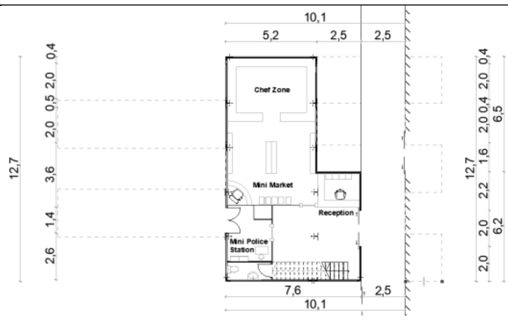
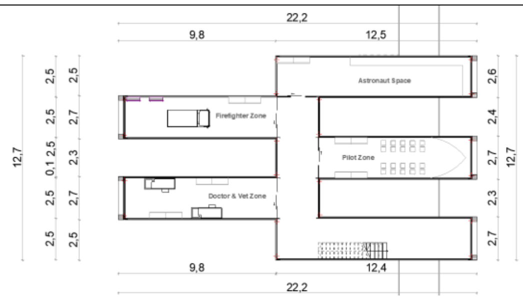
</td><td></td></tr>
<tr><td>GROUND FLOOR PLAN</td><td>1ST FLOOR PLAN</td></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Table 18 : Digital Play and Scientific Exploration Block

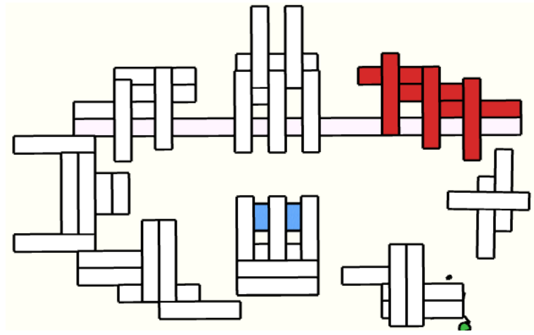
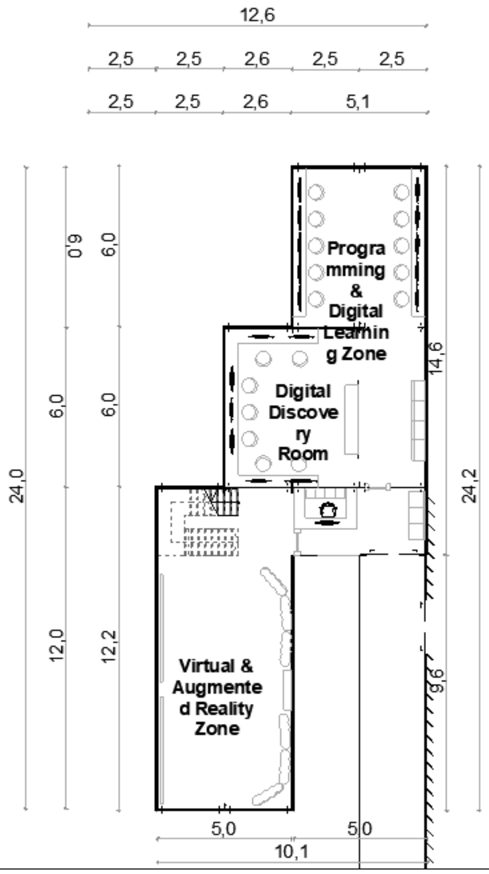
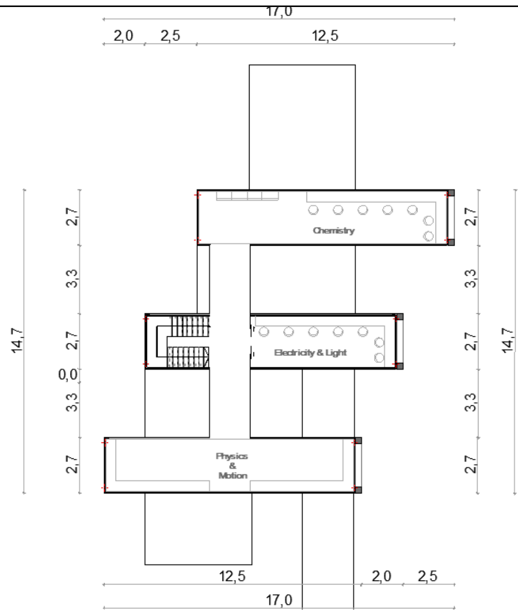
BLOCK FONCTION	Position
• This block combines technology and learning through engaging digital experiences and hands-on scientific experiments. • **Ground Floor:** Features a space for AI-enhanced games, immersive digital experiences, and programming activities that promote logical thinking. • **Upper Floor:** Dedicated to science experiments, allowing children to explore basic concepts in physics and chemistry through interactive and safe activities.	
GROUND FLOOR PLAN	**1ST FLOOR PLAN**
	

Table 19 : Music and Performing Arts Block

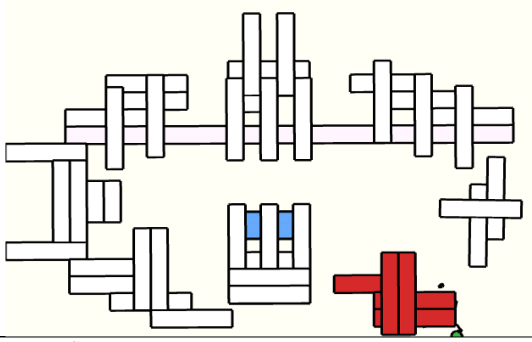
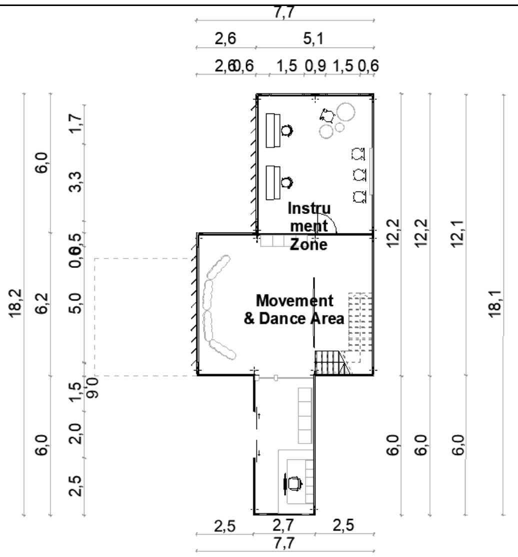
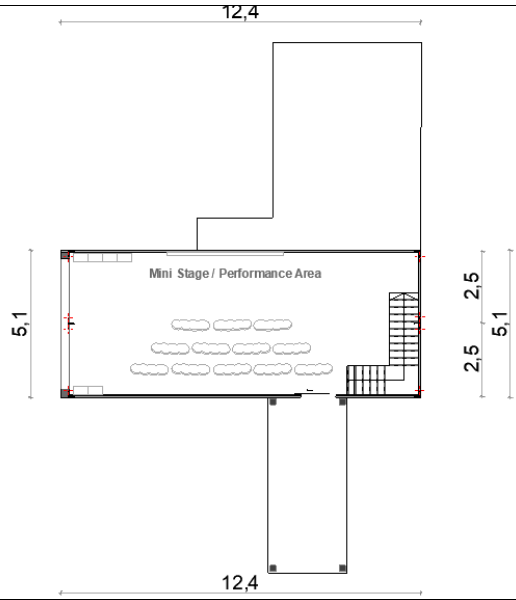
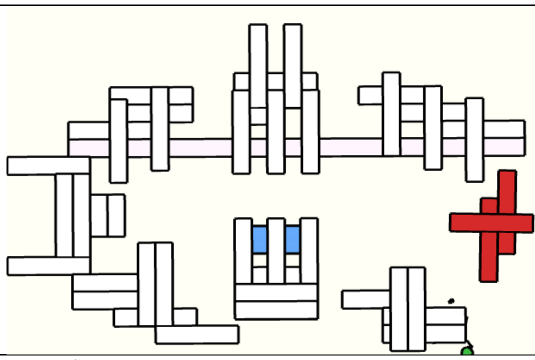
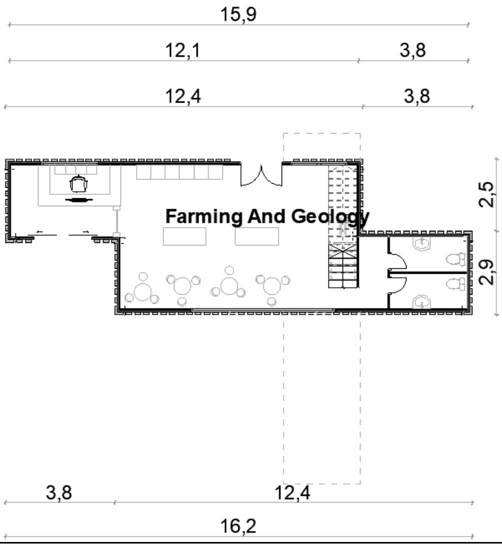
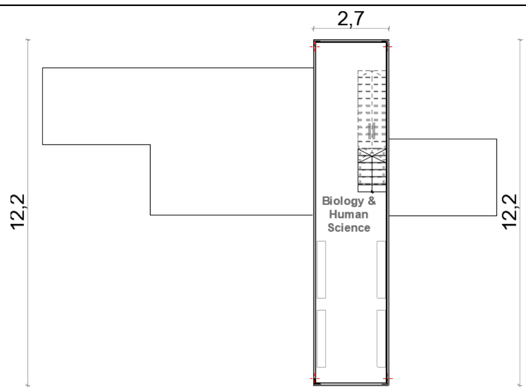
<table>
<tr><th>BLOCK FONCTION</th><th>Position</th></tr>
<tr><td>This block nurtures children's artistic expression through music, dance, and theater.
• Ground Floor: Includes a dance area and a space for exploring and playing musical instruments.
• Upper Floor: Features a small stage where children can perform plays, songs, and other artistic presentations in an encouraging setting.</td><td></td></tr>
<tr><td>GROUND FLOOR PLAN</td><td>1ST FLOOR PLAN</td></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Table 20 : Biology block

BLOCK FONCTION	**Position**
This block nurtures children's artistic expression through music, dance, and theater. • **Ground Floor:** Includes a dance area and a space for exploring and playing musical instruments. • **Upper Floor:** Features a small stage where children can perform plays, songs, and other artistic presentations in an encouraging setting.	
GROUND FLOOR PLAN	**1ST FLOOR PLAN**
	

IV.2.5**Mass plan**

Figure 82 mass plan (by author)

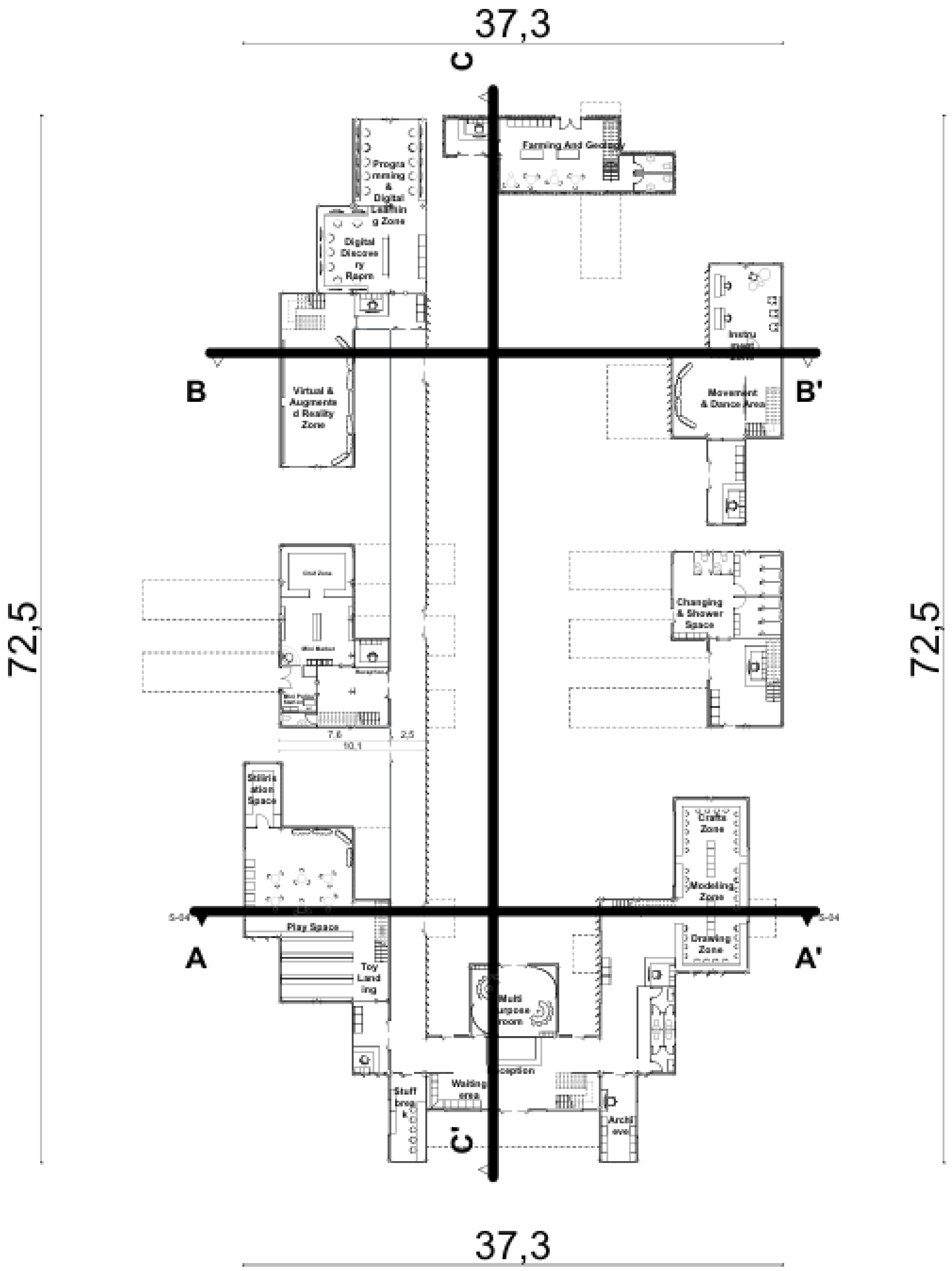


Figure 83 : Ground floor plan(by author)

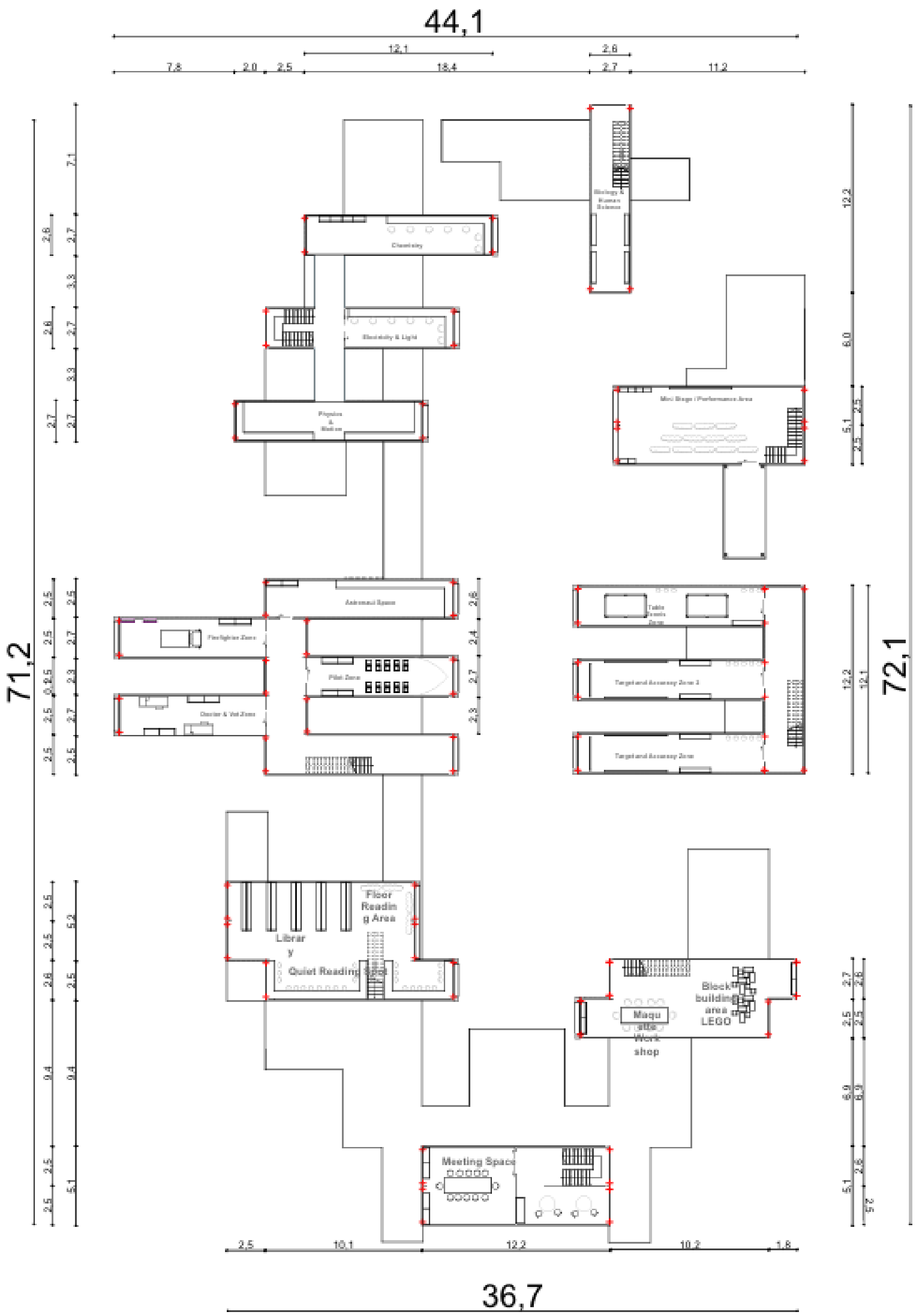


Figure 84 : 1st floor plan (by author)

IV.2.6**The elevations**

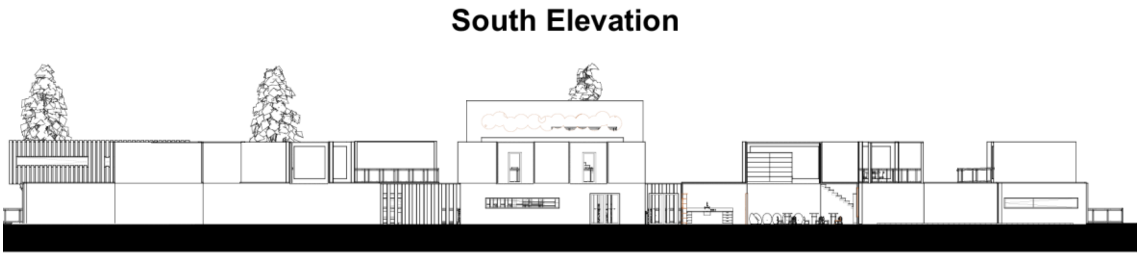


Figure 85 : South Elevation(by author)

Figure 86 : South Elevation colorfull(by author)

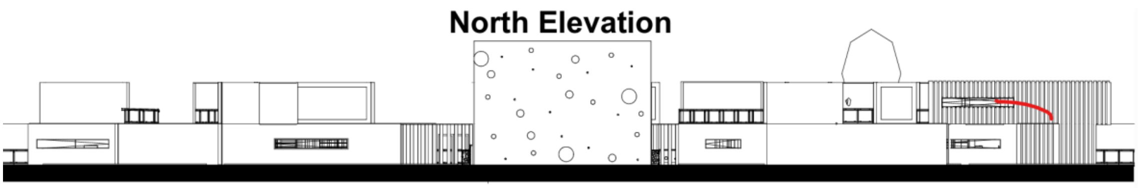


Figure 87 : North elevation(by author)

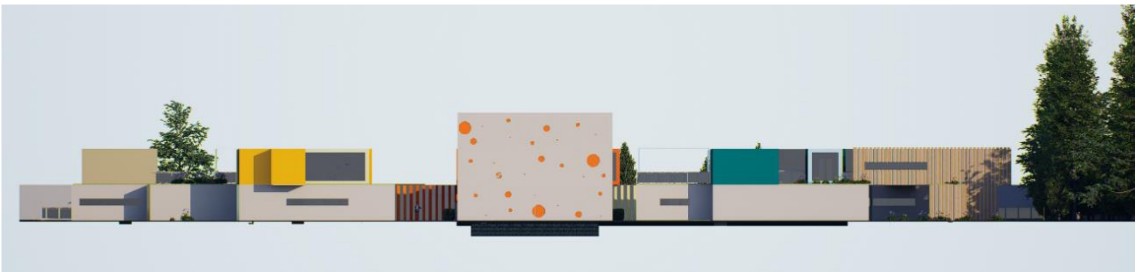


Figure 88: North elevation colorfull(by author)

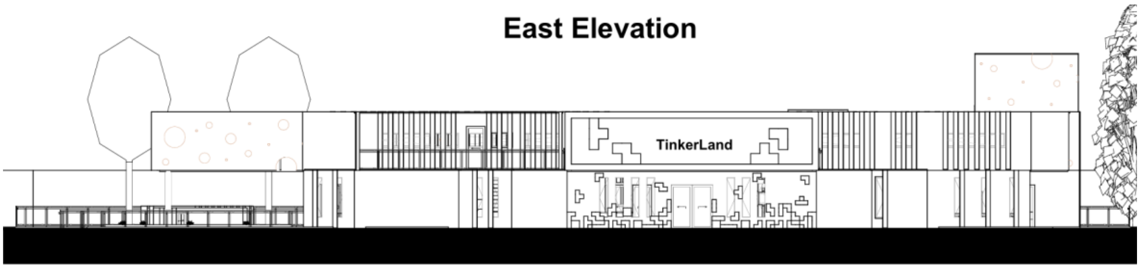


Figure 89: East elevation (the entrance) (by author)

Figure 90 : East elevation colorfull(by author)

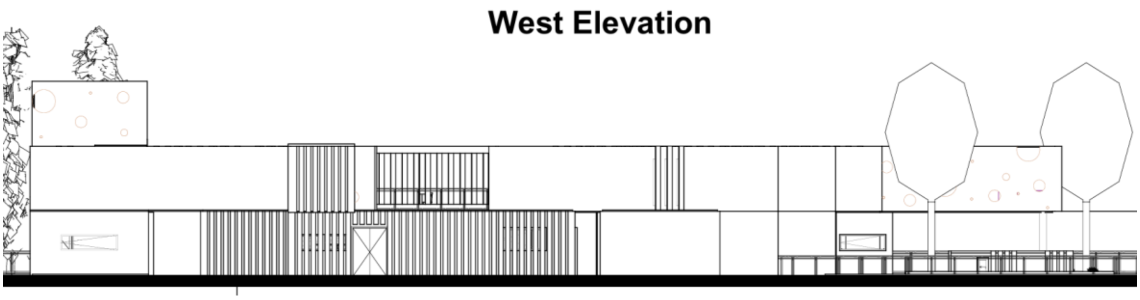


Figure 91 :West elavation(by author)

Figure 92 : West elavation colorfull(by author)

IV.2.7**The sections**

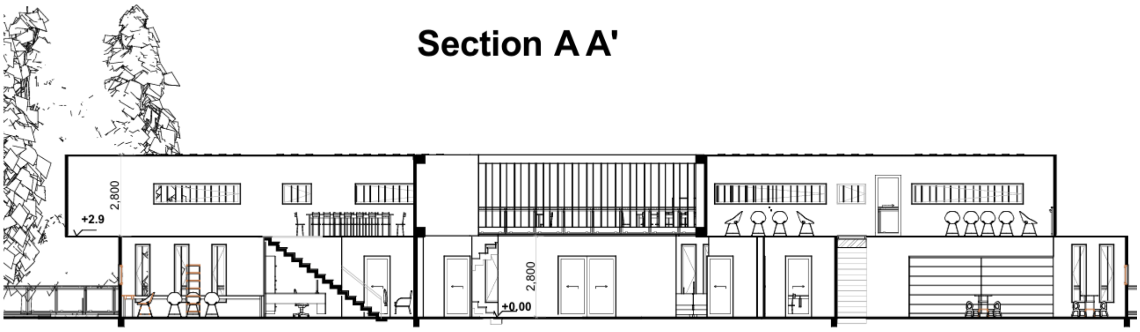


Figure 93 : Section 1(by author)

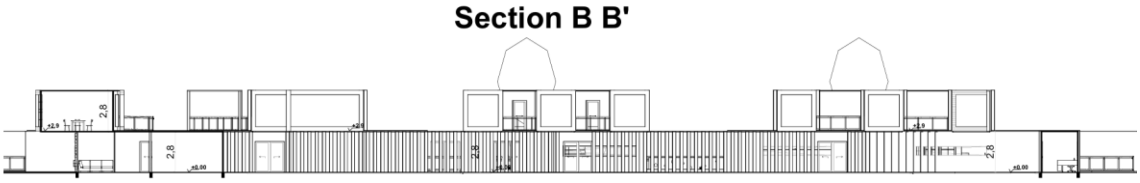


Figure 94 : Section 2(by author)

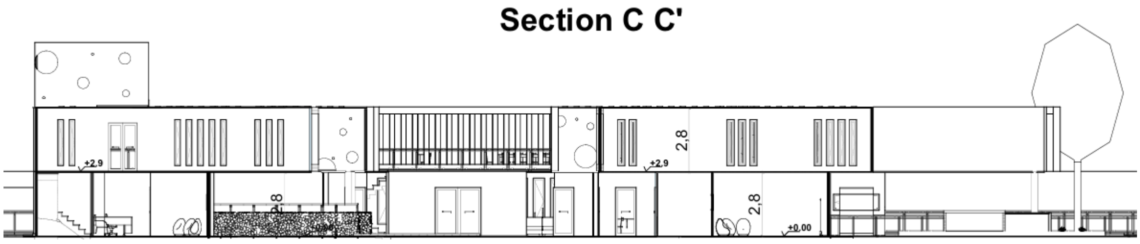


Figure 95 : Section 3(by author)

IV.2.8**Details**

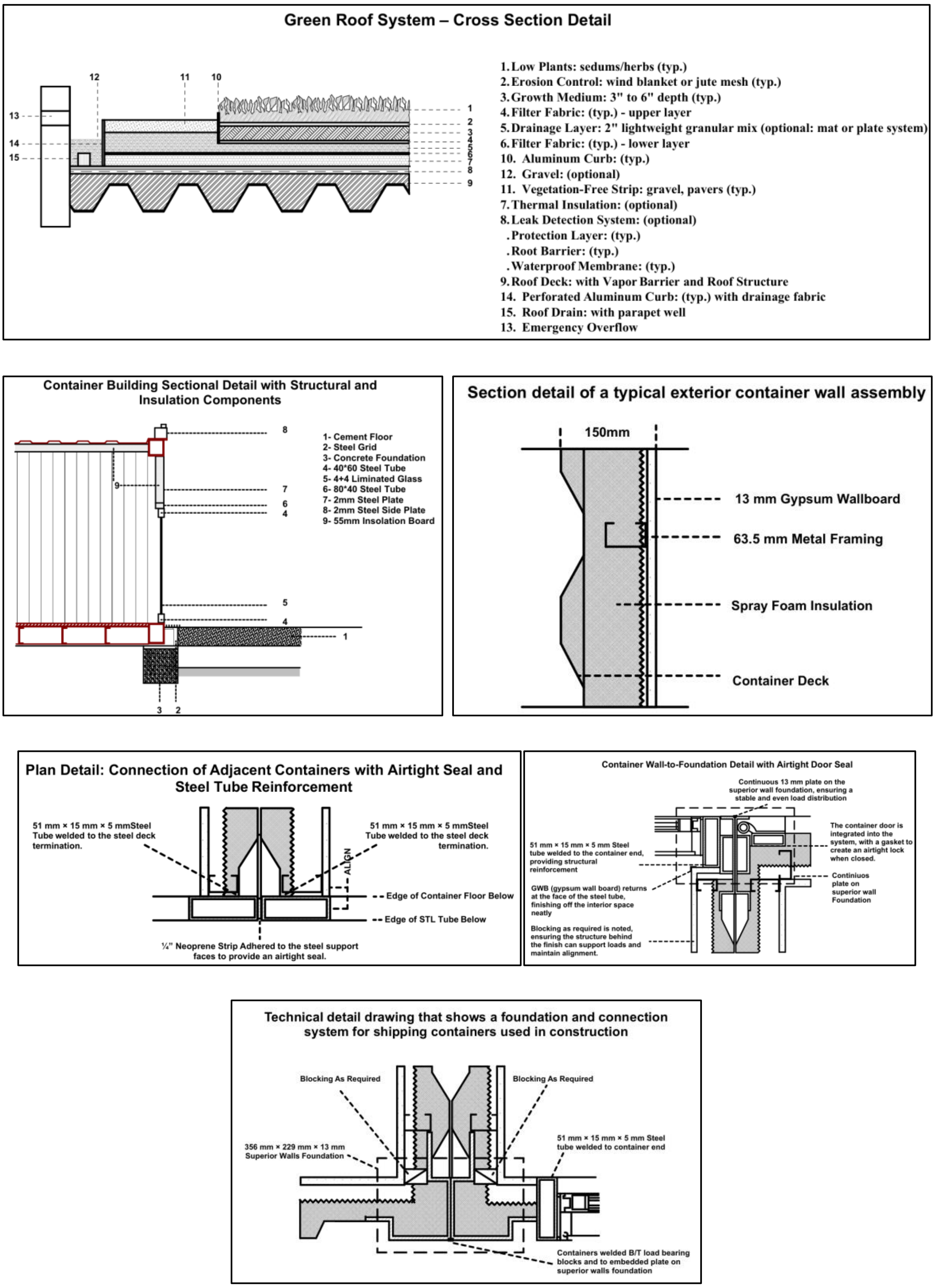


Figure 96 Details (by author)

IV.2.9Environmental Solutions for Heat Reduction

In the project, there is several environmental strategies to reduce heat impact. One of the main solutions was the use of green roofs, which help lower temperatures and improve air quality. Also using wooden roof layers made from recycled wood, installed 30 cm above the main roof, creating an air gap that acts as a thermal buffer and reduces heat absorption.

In addition, using sun breakers to block direct sunlight and reduce glare and indoor heat. Thermal insulation materials were also applied to the walls and roofs to maintain indoor comfort and reduce energy consumption.

Figure 97wooden roof layers made from recycled wood, installed 30 cm above the main roof(by autor)

Figure 98sun breakers(by author)

Figure 99green roofs (by author)

IV.2.10 **3D pictures**

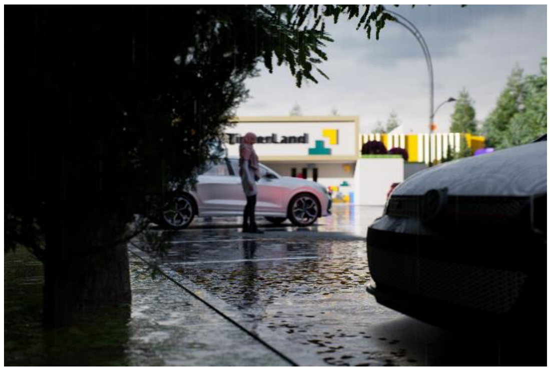








TinkerLand



CONCLUSION

This study reflects a strong belief that architecture is not merely about building structures it is a tool for protecting the environment and shaping more conscious, sustainable communities. Based on this vision, the thesis adopts recycling as a core design principle that aims to reduce resource consumption and revive discarded materials within a new architectural logic that bridges economy and ecology.

Among the most effective applications of this principle is the reuse of shipping containers, which offers a smart and practical solution for constructing architectural spaces at a low cost and with fast assembly—without sacrificing comfort or quality. Containers today have become a symbol of adaptable and flexible architecture, ideal for various functions, especially in educational and community-based projects.

The Toy Library (Ludothèque) project was designed from this environmental perspective to offer a playful educational space for children, where discovery and learning are driven by interactive play. The project is divided into several independent blocks that represent different development areas such as art, science, architecture, music, and real-life role play. Sustainable solutions were also implemented, such as green roofs, raised wooden surfaces made from recycled wood, sun breakers, and thermal insulation, to ensure indoor comfort suited to the local climate.

This project represents an intersection between sustainable architecture and modern educational programming, through the adoption of the Edutec concept, which merges education, technology, and entertainment to offer a holistic experience that supports children's growth. Through this approach, the thesis affirms that innovation in design goes hand in hand with environmental awareness and social responsibility, and that the future belongs to architecture that rethinks its materials, its role, and its message.

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ANNEXE

الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي والبحث العلمي

جامعة محمد خيضر - بسكرة

حاضنة أعمال جامعة بسكرة

رقم 69/ الحاضنة /2025

شهـــادة توطيـــن / تحضيـــن "مشروع مبتكر ضمن قرار 1275"

انا الممضي أسفله، السيد (ة): **محمد جلاب**

مسير(ة) حاضنة الأعمال: **جامعة محمد خيضر – بسكرة-**

المقر الاجتماعي / العنوان: **المجمع الإداري المقابل لكلية العلوم الاقتصادية، الطابق الثاني، جامعة بسكرة 07000**

رقم علامة الحاضنة : **2311223051**

تاريخ تسليم العلامة : **23 نوفمبر2022**

أشهد أن الطالب / الطلبة التالية أسمائهم :

الاسم و اللقب	الطور الدراسي	التخصص	الكلية
كبايري ملاك	ماستر 2	هندسة معمارية	الهندسة المعمارية و العمران و الهندسة المدنية و الري

تحت إشراف الاستاذ/الاساتذة التالية أسمائهم :

الاسم و اللقب	الرتبة	التخصص	الكلية
مقري الواجري سحر	أستاذ محاضر- ب-	هندسة معمارية	الهندسة المعمارية و العمران و الهندسة المدنية و الري

تم احتضانه على مستوى *حاضنة أعمال* جامعة محمد خيضر - بسكرة بمشروع تحت اسم :

شركة ناشئة مختصة في إعادة تدوير الحاويات و استخدامها في بناء مرافق حضرية كحلول اقتصادية

خلال السنة الجامعية 2024 / 2025.

سلمت هذه الشهادة بطلب من المعني للإدلاء بها في حدود ما يسمح به القانون .

حرر في بسكرة بتاريخ : 2025/07/08

مدير الحاضنة

مسؤول حاضنة المؤسسات الناشئة

د/ محمد جلاب

Start Up Incubator

MOHAMED KHIDER UNIVERSITY OF BISKRA

START UP

الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي والبحث العلمي جامعة محمد خيضر – بسكرة

جامعة محمد خيضر – بسكرة

عنوان المشروع:

استغلال الحاويات المعاد تدويرها لتوفير فضاءات حضرية اقتصادية ومبتكرة

مشروع لنيل شهادة مؤسسة ناشئة في إطار القرار الوزاري 1275

صورة العلامة التجارية

الاسم التجاري

ReCON

KEBAIRI Malak

بطاقة معلومات:

حول فريق الاشراف وفريق العمل

1- فريق الاشراف:

فريق الاشراف	
المشرف الرئيسي: ماجري الواجري سحر	التخصص:هندسة معماريلة

2- فريق العمل:

فريق المشروع	التخصص	الكلية
الطالبة: كبايري ملاك	هندسة معمارية	العلوم والتكنولوجيا

فهرس المحتويات

المحور الرابع: خطة الإنتاج والتنظيم

1. مراحل الإنتاج
2. فريق العمل
3. فضاء الإنتاج
2. خطة التوصيل والتركيب

المحور الخامس: الخطة المالية

1. توقعات مالية للمبيعات
2. العنوان مصفوفة الابتكار
3. ميزانية المؤسسة الناشئة
4. حسابات النتائج المتوقعة

حسابات الخزينة

المحور السادس : النموذج الاولي التجريبي

مقدمة عامة

تفرض التحوّلات البيئية والاقتصادية المتسارعة في العالم المعاصر واقعًا جديدًا على ممارسات الهندسة المعمارية والتخطيط الحضري، حيث أصبحت هذه المجالات تواجه تحديات متزايدة ترتبط بندرة الموارد الطبيعية، وارتفاع تكاليف البناء، إضافة إلى الحاجة الملحّة إلى حلول سريعة وفعّالة في مواجهة الأزمات والكوارث. كما تُلقي الضغوط الناتجة عن تزايد النفايات الصناعية وتدهور النُظم البيئية بظلالها على آفاق التنمية المستدامة في المجال العمراني.

في هذا السياق، جاءت فكرة هذا المشروع المبتكر، الذي يهدف إلى إنشاء مؤسسة ناشئة متخصصة في إعادة تدوير حاويات الشحن القديمة وتحويلها إلى فضاءات حضرية مهيأة، اقتصادية، ومستدامة، مثل: أكشاك خدمات عامة، أماكن انتظار، مساحات مغطاة، أو وحدات مخصصة حسب الطلب (مثل وحدات سياحية، تجارية أو اجتماعية).

هذا التوجه لا يستجيب فقط للمتطلبات البيئية، بل يقدم حلولًا فعلية للتحديات العمرانية والاجتماعية التي تعاني منها المدن الجزائرية، خاصة في المناطق التي تشهد ضغطًا حضريًا أو نقصًا في الفضاءات العمومية المنظمة.

يطمح هذا العمل الأكاديمي إلى الجمع بين التكوين المعماري والفكر المقاولاتي، من خلال تقديم مشروع متكامل لمؤسسة ناشئة (Startup) تنبع من تخصص الهندسة المعمارية، وتوظف المهارات التقنية والمعرفية لتقديم خدمة ذات بعد بيئي، اجتماعي، واقتصادي.

ويتناول هذا المشروع بالدراسة مختلف المحاور المرتبطة به، من تحديد الفكرة وشرحها، مرورًا بتحليل السوق وتحديد الفئة المستهدفة، إلى وضع خطة إنتاج وتنظيم وخطة مالية مستقبلية، وصولًا إلى تسليط الضوء على الجوانب الابتكارية لهذا النموذج المقاولاتي.

I. المحور الأول: تقديم المشروع

1. فكرة المشروع (الحل المقترح)

في ظل التحديات البيئية والاقتصادية التي يواجهها العالم اليوم، بات من الضروري البحث عن حلول مبتكرة ومستدامة في مجال التصميم المعماري وتخطيط الفضاءات الحضرية. ومن بين الموارد المهملة التي تحمل إمكانات هائلة، تبرز حاويات الشحن المعدنية، حيث يوجد أكثر من 20 مليون حاوية مستخدمة عالميًا، ويتم إخراج ما يقارب 700,000 حاوية سنويًا من الخدمة بعد بلوغ عمرها الافتراضي.

ينطلق هذا المشروع من فكرة إنشاء مؤسسة ناشئة متخصصة في إعادة تدوير حاويات النقل القديمة وتحويلها إلى وحدات معمارية قابلة للاستعمال في الوسط الحضري، مثل: محطات انتظار الحافلات، أماكن جلوس مغطاة، فضاءات ترفيهية صغيرة، مآوي سياحية مدمجة في الطبيعة، أو كمرافق خدمية أو حتى مشاريع مخصصة حسب الطلب. وتهدف هذه المؤسسة إلى تقديم بدائل تصميمية مبتكرة تستجيب لحاجات المجتمع المعاصر، من خلال اعتماد مقاربة بيئية، اقتصادية، واجتماعية تقوم على الاستدامة، التكيف، وإعادة الاستخدام.

تعتمد المؤسسة في عملها على مبادئ التصميم المرن والبناء المعياري، وتسعى إلى الجمع بين الوظيفة والجمالية، مع التركيز على قابلية النقل، التركيب السريع، والانفتاح على التخصيص وفقًا لخصوصية كل فضاء أو فئة مستهدفة.

إحصائيات وتقديرات حول انخفاض التكلفة عند استخدام الحاويات في البناء

- **انخفاض التكلفة الإجمالية بنسبة 20% إلى 40%**: وفقًا لمشاريع متعددة منشورة في أوروبا وأمريكا، يمكن أن يكون بناء منزل أو مشروع باستخدام الحاويات أقل تكلفة بنسبة تتراوح بين 20% إلى 40% مقارنة بالبناء التقليدي الخرساني أو الطوبي، خاصةً في المناطق ذات اليد العاملة المرتفعة.
- **تكلفة الوحدة أقل بكثير: تكلفة** حاوية مستعملة (20 قدمًا): بين 1500 و3500 دولار. بينما البناء التقليدي للمساحة نفسها يمكن أن يكلف من 5000 إلى 8000 دولار (أو أكثر) اعتمادًا على الموقع والمواد.
- **سرعة البناء توفر في اليد العاملة والتكلفة: البناء** باستخدام الحاويات يستغرق في المتوسط من 30% إلى 50% وقتًا أقل من البناء العادي. هذا يعني تقليل التكاليف المرتبطة باليد العاملة، الإيجار المؤقت، والتصاريح المؤقتة
- **إعادة استخدام المواد توفر حتى 60% من مواد البناء: وفقًا** لتقرير من UN Habitat، استخدام الحاويات يقلل الحاجة إلى الأسمنت، الطوب، والحديد، ويوفر حتى 60% من المواد التقليدية المستخدمة في الهيكل.
- **تكاليف تجهيز الموقع أقل:** الحاويات تأتي كوحدات جاهزة التركيب، ما يقلل الحاجة إلى أعمال الحفر والتسليح، وبالتالي تقليل التكاليف المرتبطة بتجهيز الموقع بنسبة تصل إلى 25%.

- **مصدرميداني (أمثلة و اقعية):** مشروع "Tempohousing" الهولندي: أسكن أكثر من 1000 طالب في وحدات حاويات معاد تدويرها بتكلفة كانت أقل بـ 35% من نظيرتها الخرسانية.

مؤسسة في نيروبي: أظهرت دراسة محلية أن بناء حضانة أطفال باستخدام الحاويات وفر أكثر من 40% من الميزانية مقارنة بالبناء التقليدي.

- أظهرت المقارنة بين مشروعين متطابقين من حيث الأبعاد، أحدهما بالحاويات المعاد تدويرها والآخر بالبناء التقليدي، أن البناء بالحاويات يحقق وفراً في التكلفة بنسبة تقارب 45,35%، مما يؤكد جدوى هذا الحل من الناحية الاقتصادية.

Tableau 1 الكميات والتسعير التقديري لمبنى من الحاويات (12×2.5×2.8 م)

N°	Désignations des travaux	U	Qtité	Prix unit	Montant
	01 - Terrassements				
1..01	Fouilles en Puits en terrain toute nature	M3	2,304	500,00	1 152,000
	Sous Total...................... 01				**1 152,00**
	02 - Infrastructure				
2..01	Béton de propreté pour plots, dosé à 250 Kg /m3 en ciment CPA 325, éxécuté sur les fond des semelles, longrines, scaliers et plots.....est) épai 10 cm comprenant fourniture, manutention, mise en oeuvre, talochage de la surface et toutes sujétions.	M3	0,38	800,000	307,20
2..02	Béton Armé en plot , dosé à 350 Kg de ciment CPA 325, comprenant fourniture, manutention, vibration, coffrage, ferraillage et toutes sujestions.	M3	2,30	25000,000	57 600,00
2..03	Dallage épaisseur de 10 cm, avec treillis soudé en rouleau ou en plaque (20x20x5mm), comprenant mise en place, coupes, ligatures, plots, dosé à 250 Kg de ciment CPA 325, comprenant fourniture, manutention et toutes sujétions.	M2	39,00	1 500,00	58 500,00
	Sous Total...................... 02				**116 407,20**
	03 - contenaires				
3..01	D/P Conteneur en acier Corten, dimensions standard 12,19 m x 2,44 m x 2,59 m, structure étanche et résistante à la corrosion. Idéal pour une réutilisation en construction modulaire.	U	1,00	800000,000	800 000,00
	Sous Total...................... 03				**800 000,00**

	04 - Revetements intèrieurs et Extèreiur				
5..03	F/P et Revetement en Carrelage GRANITO (Dim 33x33cm de 2,5cm d'épais) de bonne et 1ère qualité y/c mortier ,coupes, couche rattrapage niveau en béton d'épaisseur variable, rejointements au ciment blanc colorée, "choix maitre d'ouvrage"et toutes Sujestions	M2	30,00	1 500,00	45 000,00
5..04	F/P Plinthe pvc de bonne qualité dim GM cm y compris coupes, mortier et Toutes Sujestions	ML	29,00	500,00	14 500,00
	Sous Total…………………. 05				**59 500,00**
05 - Ménuiseries					
	A _ Menuiserie METALIQUE				
9..A01	F/P Porte pleinne en Métal avec imposte fixé y/c scellement, quincailleries et TS (suivants les Détails et conception) pour Dim suiv:				
	a) Dim 0,90x 2,20 h (Porte à 01 vantaux)	U	01	20 000,00	20 000,00
9..A02	F/P fenetre ,chassis , vasistat , en Aluminuim avec imposte fixé y/c scellement,quincailleries et TS (suivants les Détails et conception) pour Dim suiv: verre Stop Sol 5mm et verre armé				
	a) Dim 1,50 x 1,20 h (fenetre à 02 vantaux vitree)	U	03	10 000,00	30 000,00
	Sous Total…………………. 06				**50 000,00**
10 - Peinture					
10..02	F/P Peinture intérieure laque sur murs et en sous plafonds en 03 couches y compris , 03 couches d' enduit de polissage grattage, finition, rebouchage et Toutes Sujestions (Pour les endroits humides cuisine, SDB, WC…..est)(Couleurs choix maitre d'ouvrage)	M2	75,40	600,00	45 240,00
10..03	F/P Peinture Vinylique extérieure sur murs et plafond de façade en 03 couches y compris , grattage, finition, rebouchage et Toutes Sujestions (Couleurs choix maitre d'ouvrage)	M2	84,56	600,00	50 736,00
10..03	F/P L'isolation mousse de polyuréthane sur murs intérieure y compris , grattage, finition, Toutes Sujestions	M2	75,40	3 500,00	263 900,00
	Sous Total…………………. 10				**359 876,00**
	Total Général HT				**1 386 935,20**
	TVA 17 %				**235 778,98**

	Total général en TTC		**1 622 714,18**

Tableau 2(تقدير الكميات والأسعار لمبنى خرساني تقليدي (12×2.5×2.8 م

N°	Désignations des travaux	U	Qtité	Prix unit	Montant
	01 - Terrassements				
1..01	terrassement en grande masse	M3	7,800	600,00	4 680,000
1..02	Fouilles en Puits en terrain toute nature	M3	58,500	500,00	29 250,000
	Sous Total..................... 01				**33 930,00**
	02 - Infrastructure				
2..01	Béton de propreté pour fondation, dosé à 250 Kg /m3 en ciment CPA 325, éxécuté sur les fond des semelles, longrines, scaliers et plots.....est) épai 10 cm comprenant fourniture, manutention, mise en oeuvre, talochage de la surface et toutes sujétions.	M3	1,44	800,000	1 152,00
2..02	Béton Armé en fondation (Semelles, Avant Poteaux, Longrines et Poutres de Redressement ...etc), dosé à 350 Kg de ciment CPA 325, comprenant fourniture, manutention, vibration, coffrage, ferraillage et toutes sujestions.	M3	11,41	35000,000	399 350,00
2..05	Hérisson de 0,20 d'épaisseurs moyennes en pierres sèches posées à la main avec remplissage des vides aux cassons de pierres et d'agrégats roulés y compris compactage et toutes sujestions.	M2	39,00	1 200,00	46 800,00
2..06	Dallage sur herrisson épaisseur de 10 cm, avec treillis soudé en rouleau ou en plaque (20x20x5mm), comprenant mise en place, coupes, ligatures, plots, dosé à 250 Kg de ciment CPA 325, comprenant fourniture, manutention et toutes sujétions.	M2	39,00	1 500,00	58 500,00
	Sous Total..................... 02				**505 802,00**
	03 - Superstructure				
3..01	Béton armé en elevation (Poteaux, Poutres et Chainages, Rédaisseur, Dalle pleine pour toiture inclineee, Escaliers, Acrotère + Chaperon element arc et element decoratif etc...), dosé à 350 Kg comprenant fourniture, manutention, vibration, ferraillage Y/C Toutes Sujestions	M3	6,85	35000,000	239 820,00
3..02	Linteaux en Béton Armé pour divers dimensions et épaisseurs dosé à 350kg/m3 y compris Toutes Sujestions	ML	5,40	1 200,00	6 480,00
3..03	Plancher en corps creux 16+4 cm y/c Trillé soudé 5mm(15x15) en béton dosé à350 kg/m3 et Toutes Sujestions	M2	39,00	4000,00	156 000,00
3..04	Appuis de fenetre en béton légèrement armé pour divers dimensions dosé à 350 Kg/m3 Épaisseur de 10 cm et toutes sujestions	ML	4,5	1 500,00	6 750,00

3..05	forme de pente sur la dalle inclinee dosé à 350 Kg/m3 Épaisseur de PH 12 cm PB 3cm à 5 cm et toutes sujestions	M2	39	1 200,00	46 800,00
	Sous Total…………………. 03				**455 850,00**
	04 - Moçonneries et Enduits				
4..01	Maçonnerie Double Parois de 30cm(15+5+10) en brique rouge y compris Toutes Sujestions	M2	70	2 000,00	140 000,00
4..07	Enduit interieur en ciment dosé à 350kg/m3 y comrpis Toutes Sujestions				
	a) Sur Mur	M2	75,40	600,00	45 240,00
	b) Sous Plafond	M2	30,00	800,00	24 000,00
4..08	Enduit extérieur lisse sur murs de facade en ciment dosé à 350kg/m3+ dressage y compris Toutes Sujestions	M2	88,00	600,00	52 800,00
	Sous Total…………………. 04				**262 040,00**
	05 - Revetements intèrieurs et Extèreiur				
5..03	F/P et Revetement en Carrelage GRANITO (Dim 33x33cm de 2,5cm d'épais) de bonne et 1ère qualité y/c mortier ,coupes, couche rattrapage niveau en béton d'épaisseur variable, rejointements au ciment blanc colorée, "choix maitre d'ouvrage"et toutes Sujestions	M2	30,00	1 500,00	45 000,00
5..04	F/P Plinthe cuité vernisée de bonne qualité dim GM cm y compris coupes, mortier et Toutes Sujestions	ML	29,00	500,00	14 500,00
	Sous Total…………………. 05				**59 500,00**
	06 - Etanchiété				
7..01	F/P Isolation thermique en feuille polystérène épaisseur 4cm ou plaques de liège de qualité y/c Toutes Sujestions	M2	39,00	1000,00	39 000,00
7..02	F/P Film polyane en plastique de qualité dur en deux façes "Doublé au dessous et sus-dessus de l'isolation " y compris fixation toutes sujestions	M2	39,00	400,00	15 600,00
7..03	Forme de pente en béton légèrement dosée à 350kg/m3 épaisseur variable suivant pente et fil d'eau y/c réglettes en béton, polissage et TS	M2	39,00	1500,00	58 500,00
7..04	F/P Etanchiété en tricouches "03 couches" type nord 36 ST ou 36AS de qualité agrée y/c noirssage et toutes sujestions	M2	39,00	1500,00	58 500,00
7..05	F/P Relevé en pax aluminium auto colant sur acrotères, chappérons, joints sur une hauteurs de 50 cm y/c Toutes Sujestions	ML	30,00	1400,00	42 000,00
7..06	F/P Couche de protection de gravillion roulé ou concassé daim 20/25 sur une épaiss de 6 cm y/c Toutes Sujestions	M2	39,00	1500,00	58 500,00
7..07	F/P Gargouillé crapaudine en tole galvanisé soritie daim 100mm y/c scellement, fixation,picage, jointation et Toute Sujestions	U	02	1200	2 400,00
7..08	F/P Déscente d'eau pluvaile en tube acier daim 110mm y/c scellement,	ML	5,60	1500,00	8 400,00

	fixation, picage de dalle, jointation, pienture métal et TS				
	Sous Total...................... 06				**282 900,00**
	07 - Ménuiseries (Bois, Aluminuim, Métal)				
	A _ Menuiserie bois				
9..A01	F/P Porte pleinne en bois rouge du nord cadre en bois 14cm avec imposte fixé y/c scellement, quincailleries et TS (suivants les Détails et conception) pour Dim suiv:				
	a) Dim 0,90x 2,20 h (Porte à 01 vantaux)	U	01	20 000,00	20 000,00
9..A02	F/P fenetre ,chassis , vasistat , en bois du nors cadre en bois 14cm avec imposte fixé y/c scellement,quincailleries et TS (suivants les Détails et conception) pour Dim suiv: verre Stop Sol 5mm et verre armé				
	a) Dim 1,50 x 1,20 h (fenetre à 02 vantaux vitree)	U	03	12 000,00	36 000,00
	Sous Total...................... 06				**56 000,00**
	10 - Peinture				
10..02	F/P Peinture intérieure vinylique sur murs et en sous plafonds en 03 couches y compris , 03 couches d' enduit de polissage grattage, finition, rebouchage et Toutes Sujestions (Pour les endroits humides cuisine, SDB, WC.....est)(Couleurs choix maitre d'ouvrage)	M2	75,40	600,00	45 240,00
10..03	F/P Peinture Vinylique extérieure sur murs et plafond de façade en 03 couches y compris , grattage, finition, rebouchage et Toutes Sujestions (Couleurs choix maitre d'ouvrage)	M2	84,56	600,00	50 736,00
10..03	F/P L'isolation mousse de polyuréthane sur murs intérieure y compris , grattage, finition, Toutes Sujestions	M2	75,40	3 500,00	263 900,00
	Sous Total...................... 10				**359 876,00**
	Total Général HT				**2 015 898,00**
	TVA 17 %				**342 702,66**
	Total général en TTC				**2 358 600,66**

2. القيم المقترحة:

تسعى المؤسسة الناشئة إلى تقديم مجموعة من القيم المضافة التي تميزها في السوق وتُبرز مساهمتها في المجال الحضري والمعماري، ومن أبرز هذه القيم:

a. **الاستدامة البيئية:** إعادة استعمال حاويات الشحن يساهم في الحد من النفايات الصناعية ويشجع على إعادة التدوير، مما ينعكس إيجابًا على البيئة.

b. **المرونة والتكيّف:** تتميز الحاويات بسهولة تعديلها وتشكيلها لتتناسب مع مختلف الاستخدامات، مما يتيح توفير فضاءات متنوعة ومخصصة حسب احتياجات كل فئة أو موقع.

c. **السرعة في الإنجاز:** بفضل الطابع الجاهز والمعياري للحاويات، يمكن تنفيذ المشاريع في وقت قياسي مقارنة بالبناء التقليدي.

d. **انخفاض التكاليف: يُعد** استعمال الحاويات بديلاً اقتصاديًا مقارنة بالمواد وطرق البناء التقليدية، مما يسمح بتوفير خدمات معمارية في متناول فئات أوسع.

e. **الجمالية المعاصرة:** تقدم الحاويات طابعًا عصريًا وصناعيًا يواكب توجهات التصميم الحديث، مع إمكانية التلاعب بالشكل والواجهة والداخلية لخلق بيئة جذابة ومريحة.

f. **إمكانية النقل وإعادة التوظيف:** يمكن تفكيك أو نقل الفضاءات بسهولة إلى مواقع جديدة ، مما يجعلها مثالية للبيئات المتغيرة أو المؤقتة.

g. **الاستجابة لحاجات محددة:** تقدم المؤسسة حلولًا مخصصة حسب الطلب، سواء لمرافق حضرية، أو فضاءات عامة، أو وحدات تعليمية أو ترفيهية متنقلة.

h. **الجاهزية في حالات الأزمات والكوارث:** بفضل صلابتها وقدرتها على التحمل، يمكن استعمال الحاويات كوحدات سكنية أو وظيفية مؤقتة في حالات الطوارئ مثل الزلازل أو الكوارث الطبيعية، حيث توفر مأوى سريع وآمن للمتضررين. كما أن بعض أنواع الحاويات توفر مقاومة جيدة للزلازل، ما يجعلها خيارًا موثوقًا في البيئات الهشة.

3. فريق العمل

يعتمد نجاح هذا المشروع على فريق عمل متكامل يضم كفاءات متعددة التخصصات، تعمل بشكل منسجم لتحقيق أهداف المؤسسة الناشئة. ويتكون الفريق من مجموعة من الأعضاء، يضطلع كل واحد منهم بدور محدد يساهم في تطوير المشروع وتنفيذه بكفاءة:

a. **المهندس المعماري (المؤسس):** يتولى الإشراف على التصميم العام للمشاريع، وضمان مطابقتها للمعايير الجمالية والوظيفية، إضافة إلى الابتكار في تحويل الحاويات إلى فضاءات حضرية مناسبة.

b. **مهندس مدني أو تقني في البناء المعدني:** مسؤول عن دراسة الجوانب التقنية والإنشائية للحاويات، وضمان سلامتها الهيكلية واستقرارها عند تحويلها إلى وحدات معمارية قابلة للاستخدام.

c. **مصمم داخلي (Designer d'intérieur):** يساهم في تنظيم الفضاء الداخلي للحاويات بطريقة تتلاءم مع الاستخدامات المختلفة (جلوس، انتظار، خدمات حضرية...) مع مراعاة الراحة وسهولة الاستخدام.

d. **عامل في التهيئة الداخلية:** تركيب الأرضيات والجدران الداخلية، تركيب العزل الحراري والصوتي، تنفيذ أعمال التشطيب (دهان، تجهيزات...).

e. **مسؤول النقل والتركيب** نقل الحاويات من الموردين إلى الورشة، ثم من الورشة إلى موقع الزبون، المساعدة في التركيب في الموقع.

f. **تقني كهرباء وسباكة** تركيب الشبكة الكهربائية والإنارة داخل الوحدة, تنفيذ توصيلات الماء والصرف حسب الطلب

g. **تقني في التلحيم والهيكلة المعدنية** تنفيذ عمليات القص والفتح وتدعيم الهيكل, تركيب الأبواب والنوافذ والهياكل المعدنية الإضافية.

h. **عامل في التهيئة الداخلية** تركيب الأرضيات والجدران الداخلية، تركيب العزل الحراري والصوتي , تنفيذ أعمال التشطيب (دهان، تجهيزات...).

i. **مسؤول إداري ومالي:** مكلف بتسيير الشؤون الإدارية، إعداد الميزانيات، إدارة الموارد، والتواصل مع الجهات الرسمية والممولين.

j. **خبير في التسويق والتواصل:** يعمل على التعريف بالمؤسسة وخدماتها، ووضع استراتيجية تواصل فعالة لجذب العملاء والترويج للفكرة على المستوى المحلي وربما الدولي.

k. **فنيون وعمال متخصصون:** يتكفلون بعمليات التحويل والتجهيز والتركيب في الميدان، وفق المخططات التي يضعها الفريق الهندسي.

l. **مستشار قانوني أو مكلّف بالعلاقات مع الإدارة:** يهتم بالإجراءات القانونية لتأسيس المؤسسة، وتسجيل المنتجات، والحصول على التراخيص، والتعامل مع الجهات الرسمية.

m. **منسق لوجستي للنقل والتوصيل:** يشرف على تنظيم عمليات نقل الحاويات من موقع التخزين إلى موقع التركيب، والتعامل مع الشركات المتخصصة في النقل والتفريغ.

وتجدر الإشارة إلى أن تركيبة الفريق قابلة للتوسيع مستقبلًا، وذلك حسب تطور نشاط المؤسسة واحتياجات المشاريع، حيث يمكن إدماج اختصاصات جديدة مثل: خبراء في الطاقة الشمسية، متخصصين في التصميم الرقمي، أو مشرفين ميدانيين إضافيين حسب طبيعة الفضاءات المنجزة والمناطق المستهدفة.

4. أهداف المشروع

يهدف هذا المشروع إلى تحقيق مجموعة من الأهداف المتكاملة، التي تجمع بين الجوانب المعمارية، البيئية، الاقتصادية والاجتماعية، ومن أبرزها:

a. **ابتكار حلول معمارية حضرية بديلة ومستدامة:** عبر تحويل حاويات الشحن المستعملة إلى فضاءات وظيفية مخصصة، تخدم حاجات السكان في الفضاء العام.

b. **تشجيع ممارسات إعادة التدوير في مجال البناء:** من خلال تثمين المواد المهملة والحد من استخدام الموارد الجديدة، وبالتالي تقليل البصمة البيئية للمشاريع

c. **توفير فضاءات حضرية منخفضة التكلفة وسريعة الإنجاز:** تكون في متناول البلديات، الجمعيات، أو المستخدمين الأفراد، وتساهم في حل مشكلات نقص الفضاءات المهيأة في الأحياء.

d. **تعزيز المرونة الحضرية من خلال حلول قابلة للنقل والتعديل:** بحيث يمكن تكييف هذه الفضاءات حسب تغيّر الحاجات والمواقع، أو حتى استخدامها في حالات الطوارئ.

e. **المساهمة في تحسين جودة الحياة في الأوساط الحضرية:** عبر إنشاء أماكن انتظار، جلوس، لعب، أو خدمات، تكون مريحة، آمنة، وجذابة بصريًا.

f. **دعم ريادة الأعمال والابتكار في المجال المعماري:** من خلال إنشاء مؤسسة ناشئة تمثل نموذجًا جديدًا في توظيف الحاويات بشكل موجه ومدروس.

g. **خلق فرص عمل لشباب متعدد التخصصات: مثل** المهندسين، المصممين، الفنيين، والحرفيين، مما يعزز الديناميكية الاقتصادية المحلية.

h. **الاستعداد لمواجهة الكوارث الطبيعية أو الأزمات الإنسانية: عبر** تقديم وحدات معمارية سريعة التركيب تصلح كملاجئ مؤقتة أو مراكز خدمات متنقلة.

5. جدول زمني لتحقيق المشروع:

المرحلة الزمنية	النشاطات الأساسية	الشهر 1-3	الشهر 4-6	الشهر 7-9	الشهر 18-10	الشهر 24-19
دراسة المشروع والتحضير	دراسة السوق، إعداد نموذج العمل، البحث عن تمويل	X				
التأسيس والتجهيز	التأسيس القانوني، تكوين الفريق، إعداد النماذج الأولية		X			
الإطلاق الأولي	تنفيذ أول مشروع، الترويج، تقييم النموذج			X		
التوسع التدريجي	تنفيذ مشاريع جديدة، تنويع المنتجات، بناء شراكات				X	
التقييم وإعادة التوجيه	تقييم الأداء، إدخال تحسينات، توسعة النشاط					X

II. المحور الثاني: الجوانب الابتكارية

يُعتبر مشروع إعادة تدوير حاويات الشحن في المجال الحضري واحدًا من الحلول المعمارية البديلة التي تجمع بين الوظيفة، البساطة، والاستدامة. ويمتاز المشروع بعدد من الجوانب الابتكارية التي تمنحه طابعًا فريدًا مقارنةً بالحلول التقليدية:

6. **إعادة توظيف مورد صناعي مهمَل كعنصر معماري وظيفي**

حيث يتم تحويل الحاويات من وسائل نقل إلى وحدات معمارية حضرية متكاملة.

7. **الدمج بين الاستدامة والمرونة في تصميم الفضاءات**

من خلال حلول قابلة للتعديل، التفكيك، والنقل.

8. **نموذج إنتاج معماري سريع ومنخفض التكلفة**

يضمن تسليم المشاريع في فترات قصيرة وبتكاليف مناسبة

9. **إمكانية تخصيص التصميم حسب الطلب (SUR-MESURE)**

لتتناسب كل وحدة مع استعمال خاص أو فئة مستهدفة معينة.

10. **مقاربة حضرية تعتمد التصغير والفعالية**

تتماشى مع تحديات الاكتظاظ الحضري.

11. **القابلية للإدماج مع تقنيات حديثة**

مثل الطاقة الشمسية، الأنظمة الذكية، والتهوية الطبيعية.

12. **البعد الإنساني والوظيفي في حالات الطوارئ**

كوحدات جاهزة وسريعة التركيب لخدمة المتضررين في الكوارث أو الأزمات.

13. انعدام وجود مشاريع مماثلة على المستوى الوطني

يُعد المشروع ابتكارًا رائدًا في السياق الجزائري، حيث لا توجد مؤسسات ناشئة معمارية قائمة على تحويل الحاويات إلى فضاءات حضرية موجهة للعموم. هذا الانفراد يعطي للمؤسسة فرصة للريادة والتميّز في السوق المحلي، ويمكّنها من بناء هوية قوية تُلبي حاجة لم تُشبَع بعد.

III. المحور الثالث: التحليل الاستراتيجي للسوق

1. الوضع العام للسوق الجزائري

يُعتبر السوق الجزائري في الوقت الحالي بيئة خصبة للأفكار الجديدة والمبتكرة، خاصة في ظل التوجه الحكومي لتشجيع المؤسسات الناشئة والمشاريع ذات الطابع البيئي والاستدامي. ومع ذلك، ما يزال مفهوم إعادة تدوير الحاويات في البناء الحضري غير مستغل تقريبًا، مما يفتح المجال أمام مشاريع ريادية رائدة في هذا المجال.

2. الفئة المستهدفة

تشمل الفئة المستفيدة من خدمات المؤسسة عدة أطراف متنوعة باختلاف حاجاتهم وطبيعة مشاريعهم، ومن أبرزهم:

a. **البلديات والمجالس المحلية:** من أجل تجهيز الفضاءات العامة (محطات انتظار، أماكن جلوس، نقاط خدمات حضرية...).

b. **الجمعيات الثقافية أو البيئية: التي** تحتاج إلى فضاءات مؤقتة أو قابلة للنقل لتنظيم فعاليات أو حملات توعية.

c. **المؤسسات التربوية والتعليمية:** لإنشاء فضاءات تعلم بديلة ومبدعة، خاصة في المناطق الريفية أو التي تعاني من نقص في الهياكل.

d. **الأفراد أو الحرفيون:** الباحثون عن وحدات قابلة للاستعمال كأكشاك، فضاءات حرفية، أو مساحات تجارية بسيطة.

e. **الجهات الفاعلة في المجال الإنساني:** مثل الحماية المدنية أو الهلال الأحمر، التي تحتاج لحلول إيواء أو خدمات متنقلة في حالات الطوارئ.

f. **الفاعلون في القطاع السياحي والاستثماري :**يُمثّل المشروع فرصة مثالية للمستثمرين في السياحة البيئية والبديلة، خاصةً في المناطق الطبيعية أو الجبلية أو الساحلية، حيث يمكن استخدام الحاويات كمآوي سياحية مدمجة في الطبيعة، أو كمرافق خدمية (استقبال، استراحة، مقهى صغير...) بتكلفة أقل وبمرونة أعلى من البناء التقليدي.

دور المشروع في تلبيتها	نوع الحاجة / الاستخدام	الفئة المستهدفة	الرقم
توفير وحدات جاهزة، منخفضة التكلفة وسهلة التركيب	تجهيز الفضاءات العامة (جلوس، انتظار، ظل، خدمات)	البلديات والمجالس المحلية	1
تصميم فضاءات مبدعة قابلة للنقل وإعادة التوظيف	فضاءات مؤقتة للنشاطات (معارض، حملات، ورشات...)	الجمعيات البيئية والثقافية	2
تصميم وحدات تعليمية متنقلة أو ثابتة	حجرات إضافية أو فضاءات بديلة للتعليم	المؤسسات التربوية (مدارس، مراكز تكوين...)	3
توفير وحدات قابلة للتخصيص بأسعار مناسبة	أكشاك، ورشات مصغرة، مكاتب صغيرة	الحرفيون أو الأفراد	4
تجهيز وحدات سريعة التركيب وآمنة للاستعمال المؤقت	فضاءات طارئة في الكوارث (إيواء، إسعاف، توزيع...)	المنظمات الإنسانية (الحماية المدنية، الهلال الأحمر)	5
تصميم وحدات سياحية مدمجة في الطبيعة، قابلة للتنقل والتخصيص	فضاءات ضيافة بيئية، أكواخ، استقبال سياحي	المستثمرون في المجال السياحي	6

3. تحليل المنافسة

في الجزائر، لا توجد مؤسسات ناشئة تنشط حاليًا بنفس المفهوم أو بنفس التخصص (إعادة تدوير الحاويات لأغراض حضرية موجهة للمجتمع). ومع ذلك، هناك منافسة غير مباشرة قد تأتي من:

g. **شركات البناء التقليدي.**

h. **ورشات النجارة المعدنية أو شركات الهياكل الجاهزة.**

i. **مبادرات فردية لصناعة أكشاك متنقلة.**

ما يُميز المشروع هنا هو تقديم خدمة متكاملة: من التصميم إلى التوصيل، عبر إعادة تدوير حاوية مهملة لتصبح منتجًا معماريا وظيفيًا وجذابًا.

4. الفرص

a. غياب المنافسة المباشرة، مما يتيح التميز والريادة.

b. دعم الدولة للمؤسسات الناشئة (الحاضنات، تمويل ANSEJ، FONAREF...).

c. ارتفاع الوعي المجتمعي بأهمية البيئة وإعادة التدوير.

d. إمكانية استخدام الفكرة في الأحداث الكبرى (معارض، احتفالات، تظاهرات...).

e. سهولة توسيع الفكرة عبر نسخها في مدن وولايات مختلفة.

5. التهديدات أو التحديات

a. صعوبة تغيير الذهنيات فيما يتعلق بالتصميم البديل.

b. العقبات القانونية أو البيروقراطية في إدخال وحدات غير تقليدية في الأماكن العامة.

c. إمكانية صعوبة الوصول إلى الحاويات المستعملة الجيدة النوعية.

d. محدودية التمويل في بداية المشروع إذا لم تُرافقه حاضنة أو دعم رسمي.

IV. المحور الرابع: خطة الإنتاج والتنظيم

تقوم خطة الإنتاج والتنظيم على تحويل حاويات الشحن المعدنية المستعملة إلى فضاءات وظيفية قابلة للاستعمال الحضري، وذلك وفق خطوات مدروسة، وفريق تقني متكامل، ضمن ورشة إنتاج محلية قابلة للتوسعة لاحقًا.

1. مراحل الإنتاج

تمر عملية تحويل الحاويات إلى وحدات معمارية جاهزة بالمراحل التالية:

a. **اقتناء الحاويات المستعملة** :من الموانئ أو الموردين المحليين، مع التأكد من حالتها الهيكلية وسلامتها.

b. **النقل إلى الورشة** :يتم نقل الحاويات إلى ورشة مخصصة للتصنيع وإعادة التأهيل.

c. **القص والفتح** :يتم تعديل الهيكل الخارجي حسب التصميم: فتح نوافذ، أبواب، تهوية...

d. **التدعيم والعزل** :دعم الهيكل إذا لزم، ثم وضع طبقات عزل حراري وصوتي (مواد صديقة للبيئة).

e. **التهيئة الداخلية والخارجية** :تركيب الأرضيات، الجدران الداخلية، الكهرباء، الإضاءة، التهوية، وأي تجهيزات خاصة.

f. **الطلاء والتشطيب الخارجي** :لإعطاء الطابع الجمالي النهائي والوحدة البصرية.

g. **التجهيز النهائي والنقل للزبون** :وضع الأثاث أو التجهيزات الخاصة ثم نقل الوحدة إلى موقع الاستخدام.

2. فريق العمل

يتكوّن الفريق الإنتاجي في المرحلة الأولى من:

a. مهندس معماري (تصميم وإشراف تقني).

b. تقني في التلحيم والهيكلة المعدنية.

c. تقني كهرباء/سباكة.

3. فضاء الإنتاج

يتم اختيار ورشة صغيرة للإنتاج في منطقة صناعية أو شبه حضرية، بمساحة كافية تسمح:

a. باستقبال حاويتين إلى أربع حاويات في الوقت نفسه،

b. وجود فضاء للتخزين المؤقت للمواد،

c. مع إمكانية التوسعة المستقبلية أو الشراكة مع ورش أخرى.

4. خطة التوصيل والتركيب

يشمل المشروع أيضًا:

a. خدمة نقل الوحدات إلى موقع الزبون،

b. خدمة تركيب نهائي أو مرافقة فنية في الموقع،

c. ويمكن تقديم ضمان وصيانة لمدة معينة حسب نوع الاستخدام.

V. المحور الخامس: الخطة المالية PLAN FINANCIER

الجداول والأشكال

- الملحق رقم 01: توقعات مالية للمبيعات
- Business Plan

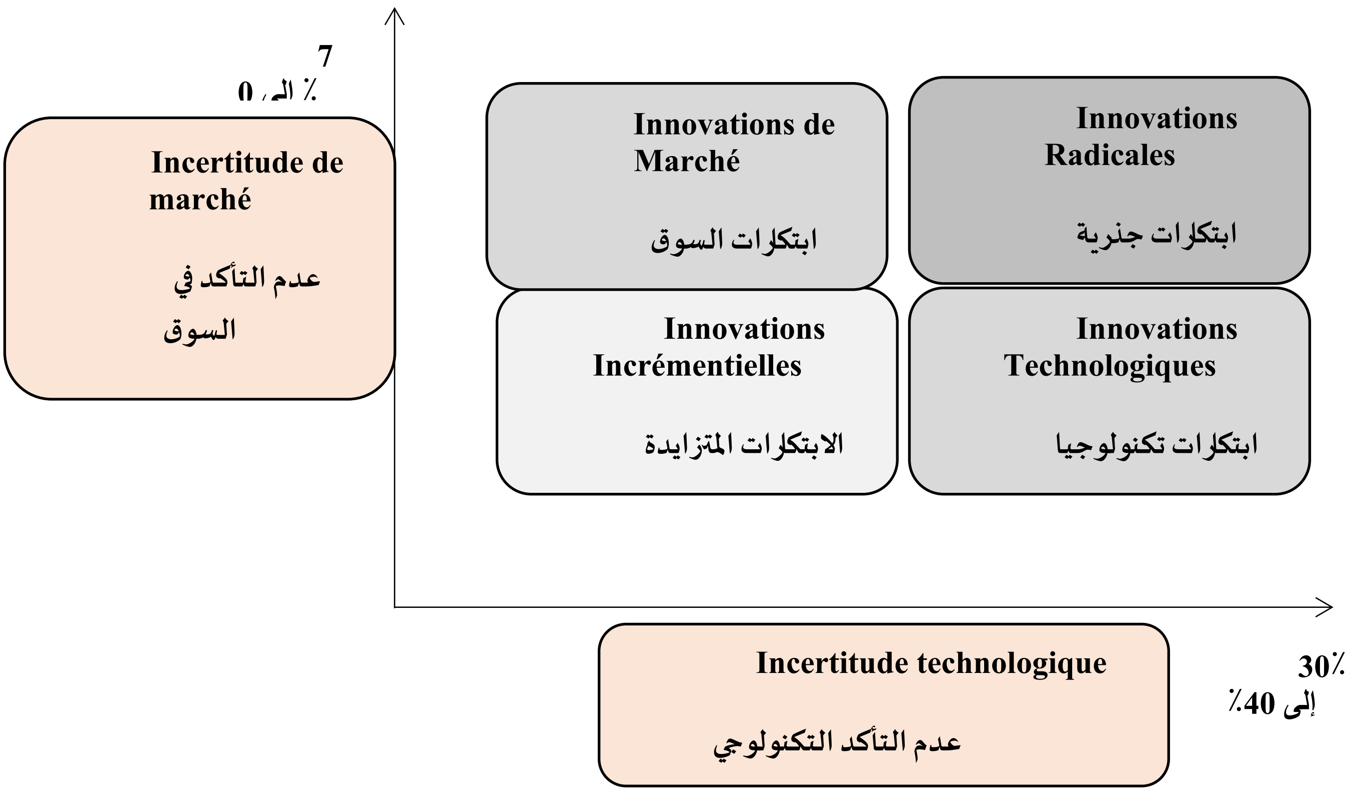
STARTUP :Entreprise qui utilise des conteneurs recyclés pour offrir des espaces urbains économiques et innovants

	REALISATION			PREVISION				
Produit A destiné Client	-2	-1		N+1	N+2	N+3	N+4	N+5
Quantité produit A				5	10	15	20	25
Prix HT produit A				600000	600000	600000	600000	600000
Ventes produit A				3,000,000	6,000,000	9,000,000	12,000,000	15,000,000
CHIFFRE D'AFFAIRES GLOBAL				3,000,000	6,000,000	9,000,000	12,000,000	15,000,000

- السعر المتوسط لكل وحدة جاهزة من الحاوية 600,000 :**دج**.
- في السنة الأولى(N+1) ، سيتم بيع **5وحدات** فقط كنموذج أولي.
- بعدها ستزيد القدرة الإنتاجية تدريجيًا.

الشكل (01): العنـوان مصفوفة الابتكار

Innovation Matrix



قائمة الملاحق :

الملحق رقم 01: ميزانية المؤسسة الناشئة

BILANS DE

STARTUP : Entreprise qui utilise des conteneurs recyclés pour offrir des espaces urbains économiques et innovants

ACTIF								
	REALISATION			PREVISION				
En milliers DZD	N -2	N -1	N	N+1	N+2	N+3	N+4	N+5
Immobilistation Incorporelles	0	0	**150**	**0**	**0**	**0**	**0**	**0**
Immobilisation Corporelles	0	0	**400**	**250**	**300**	**350**	**400**	**450**
Terrain	0		**0**	**0**	**0**	**0**	**0**	**0**
Bâtiment	0	0	**0**	**0**	**0**	**0**	**0**	**0**
Autres Immobilisations Corporelles	0	0	200	150	180	200	200	200
Immobilisations en concession	0	0	50	70	100	120	150	180
Immobilisation en cours	0	0	0	0	0	0	0	0
Immobilisations Financières	0	0	800	470	580	670	750	830
Titres mis en équivalence	0	0	0	0	0	0	0	0
Autres participations et créances rattachées	0	0	0	0	0	0	0	0
Autres Titres immobilisés	0	0	0	0	0	0	0	0
Prets et autres titres financiers non courants	0	0	0	0	0	0	0	0
Impôts différés actif	0	0	0	0	0	0	0	0
ACTIF NON COURANT	0	0	800	470	580	670	750	830
Stocks et encours	0	0	50	80	120	150	180	200
Créances et emplois assimilés	0	0	**0**	**0**	**0**	**0**	**0**	**0**
Clients	0	0	0	300	500	800	1,200	1,500
Autres débiteurs	0	0	0	0	0	0	0	0
Impôts et assimilés	0	0	0	0	0	0	0	0
Autres créances et emplois assimilés	0	0	30	50	80	100	100	100
Disponibilités et assimilés	0	0	120	250	400	700	1,000	1,500

Placements et autres actifs financiers courants	0	0	0	0	0	0	0	0
Trésorerie	0	0	0	0	0	0	0	0
ACTIF COURANT	0	0	200	680	1,100	1,750	2,480	3,300
TOTAL ACTIF	0	0	1,000	1,150	1,680	2,420	3,230	4,130
PASSIF								
	REALISATION			PREVISION				
En milliers DZD	N -2	N -1	N	N+1	N+2	N+3	N+4	N+5
CAPITAUX PROPRES	0	0	**0**	**0**	**0**	**0**	**0**	**0**
Capital émis	0	0	700	700	700	700	700	700
Capital non appelé	0	0	**0**	**0**	**0**	**0**	**0**	**0**
Ecart de réevaluation	0	0	**0**	**0**	**0**	**0**	**0**	**0**
Primes et réserves-Réserves Consolidées	0	0	**0**	**0**	**0**	**0**	**0**	**0**
Résultat net- RN part du groupe	0	0	0	100	250	600	1,000	1,500
Autres capitaux propores-report à nouveau	0	0	**0**	**0**	**0**	**0**	**0**	**0**
Part de la société consolidante (1)	0	0	**0**	**0**	**0**	**0**	**0**	**0**
CAPITAUX PROPRES	0	0	700	800	950	1,300	1,700	2,200
PASSIFS NON-COURANTS	0	0	0	0	**0**	**0**	**0**	**0**
Emprunts et dettes financières	0	0	200	200	180	150	130	100
impôt différé passif	0	0	0	0	**0**	**0**	**0**	**0**
Autres dettes non courantes	0	0	0	0	**0**	**0**	**0**	**0**
Provisions et produits constatés d'avance	0	0	0	0	**0**	**0**	**0**	**0**
PASSIFS NON-COURANTS	-	-	-	-	-	-	-	-
PASSIFS COURNATS	0	0	0	0	**0**	**0**	**0**	**0**
Fournisseurs et comptes rattachés	0	0	100	120	150	170	200	230
Impôts	0	0	0	0	**0**	**0**	**0**	**0**
Autres dettes	0	0	0	0	**0**	**0**	**0**	**0**
Trésorerie passif	0	0	0	0	**0**	**0**	**0**	**0**
PASSIFS COURANTS	-	-	-	-	-	-	-	-
TOTAL PASSIF	0	0	1,000	1,150	1,680	2,420	3,230	4,130
Verification de l'équilibre Actif/Passif	0	0	1,000	1,150	1,680	2,420	3,230	4,130

الملحق رقم 02: جدول حسابات النتائج المتوقعة

COMPTE DE RUSULTAT PREVISIONNELDE

STARTUP : Entreprise qui utilise des conteneurs recyclés pour offrir des espaces urbains économiques et innovants

	REALISATION			PREVISION				
En Milliers DZD	N -2	N -1	N	N+1	N+2	N+3	N+4	N+5
Vente et produits annexes	0	0	800	1500	2300	3000	3800	4500
Variation des stocks produits finis et en cours	0	0	50	80	100	150	200	250
Production immobilisée	0	0	0	0	0	0	0	0
Subvention d'exploitation	0	0	200	100	0	0	0	0
Production de l'exercice	0	0	1050	1680	2400	3150	4000	4750
Achats consommés	0	0	400	700	1000	1200	1400	1600
Services Extèrieurs et autres consommations	0	0	150	250	300	350	400	450
Consommation de l'exercice	0	0	550	950	1300	1550	1800	2050
Valeur ajoutée d'exploitation	0	0	500	730	1100	1600	2200	2700
Charges de personnel	0	0	180	250	300	350	400	450
Impôts et taxes et versement assimilés	0	0	20	40	60	80	100	120
Excédent Brut d'Exploitation	0	0	300	440	740	1170	1700	2130
Autres produits opérationnels	0	0	0	0	0	0	0	0
Autres charges opérationnelles	0	0	0	0	0	0	0	0
Dotations aux amortissements, Provisions	0	0	80	100	120	140	150	150
Reprise sur pertes de valeurs et provisions	0	0	0	0	0	0	0	0
Résultat opérationnel	0	0	220	340	620	1030	1550	1980
Produits Financiers	0	0	0	0	0	0	0	0
Charges financières	0	0	20	30	40	50	50	50
Résultat financier	0	0	-20	-30	-40	-50	-50	-50
Résultat Ordinaire avant impôt	0	0	200	310	580	980	1500	1930
Impôt exigible sur résultat ordinaire	0	0	0	31	58	98	150	193
Impôt différé (variation) sur résultat ordinaire	0	0	0	0	0	0	0	0

TOTAL DES PRODUITS DES ACTIVITES ORDINAIRES	0	0	1050	1680	2400	3150	4000	4750
TOTAL DES CHARGES DES ACTIVITES ORDINAIRES	0	0	850	1401	1878	2270	2650	3013
RESULTA NET DES ACTIVITES ORDINAIRES	0	0	200	279	522	880	1350	1737
Eléments extraordinaire (produits)	0	0	0	0	0	0	0	0
Eléments extraordinaire (charges)	0	0	0	0	0	0	0	0
Résultat extraordinaire	0	0	0	0	0	0	0	0
RESULTAT NET DE L'EXERCICE	0	0	200	279	522	880	1350	1737

الملحق رقم 03: حسابات الخزينة

TABLEAUX DE FLUX DE TRESORERIE

STARTUP : Entreprise qui utilise des conteneurs recyclés pour offrir des espaces urbains économiques et innovants

	REALISATION			PREVISION				
En Milliers DZD	N -2	N -1	N	N+1	N+2	N+3	N+4	N+5
Flux de trésorerie d'exploitation								
Encaissements des ventes			800	1500	2300	3000	3800	4500
Décaissements des charges d'exploitation			850	1401	1878	2270	2650	3013
Flux net d'exploitation			-50	99	422	730	1150	1487
🔷 Flux de trésorerie d'investissement								
Achat matériel & aménagement			-400	-200	-100	-100	-100	-100
Flux net d'investissement			-400	-200	-100	-100	-100	-100
🔷 Flux de trésorerie de financement								
Apports en capital ou subventions			500	100	0	0	0	0
Remboursements d'emprunts			0	0	0	0	0	0
Flux net de financement			500	100	0	0	0	0
💰 Variation nette de la trésorerie			50	-1	322	630	1050	1387
Trésorerie initiale			0	50	49	371	1001	2051
Trésorerie finale			50	49	371	1001	2051	3438

<table>
<tr>
<td rowspan="2">شرائح العملاء
•بلديات ومؤسسات عمومية محلية
•مستثمرون في القطاع السياحي والبيئي
•جمعيات ثقافية وتربوية
•المدارس الخاصة والحضانات
•رواد الأعمال الباحثون عن حلول معمارية مبتكرة
•الأفراد الراغبون في وحدات جاهزة (استراحة، مكتب، محل...)</td>
<td>العلاقات مع العملاء
•لقاءات مباشرة مع الزبائن المحتملين
•تقديم عروض تصميم حسب الطلب
•خدمات ما بعد البيع والتعديل
•ورشات تعريفية لفائدة الجهات المعنية</td>
<td rowspan="2">القيم المقترحة
•حلول معمارية جاهزة، مرنة وقابلة للنقل
•تكلفة منخفضة مقارنة بالبناء التقليدي
•سرعة الإنجاز والتركيب
•احترام المعايير البيئية والاستدامة
•استغلال موارد مهدورة وتحويلها لقيمة
•إمكانيات تصميم حسب الطلب (تصميم داخلي وخارجي)
•دعم المشاريع التربوية والاجتماعية (مثلاً :مكتبات ألعاب، حضانات...)</td>
<td>الأنشطة الرئيسية
•جمع وفرز الحاويات القابلة لإعادة الاستخدام
•تصميم معماري داخلي وخارجي حسب النشاط
•تجهيز بالعزل، التهوية، الكهرباء، وغيرها
•تصنيع وتجميع الوحدات
•التسويق والتواصل مع الشركاء
•خدمات ما بعد البيع والصيانة</td>
<td rowspan="2">الشركات الرئيسية
•شركات شحن وبيع الحاويات المستعملة
•مؤسسات بيع معدات البناء
•مزوّدو أنظمة الطاقة الشمسية أو العزل
•حرفيون ومزوّدو خدمات داخلية
•شركاء بيئيون (جمعيات إعادة التدوير)</td>
</tr>
<tr>
<td>القنوات
•موقع إلكتروني تفاعلي
•وسائل التواصل الاجتماعي (فيسبوك، إنستغرام، يوتيوب)
•معارض البناء والاستدامة
•حملات توعية في المؤسسات
•شراكات مع بلديات وجهات محلية</td>
<td>الموارد الرئيسية
•حاويات بحرية معاد استخدامها
•فريق معماري وتقني متعدد الاختصاصات
•آلات وأدوات ورشة التحويل
•عقار صناعي أو أرض لتخزين وتجهيز الوحدات
•شبكة شراكات لشراء مواد مستدامة (عزل، نوافذ...)</td>
</tr>
<tr>
<td colspan="3">المصادر والإيرادات
•بيع الوحدات الجاهزة (حسب نوع النشاط والمساحة)
•عقود مع البلديات أو المؤسسات
•خدمات التصميم حسب الطلب
•شراكات ودعم من مؤسسات بيئية
•ورشات أو تدريب مدفوع</td>
<td colspan="2">هيكل التكاليف
•تكاليف شراء الحاويات الخام
•أجور العاملين (مصممين، حرفيين...)
•تكاليف معدات الورشة والتحويل
•نفقات تسويق واتصال
•نفقات النقل والتركيب</td>
</tr>
</table>

المحور السادس : النموذج الاولي التجريبي

في عالم يتغيّر بسرعة، يصبح من الضروري أن نعيد التفكير في طريقة تصميم الفضاءات العمومية.مشروعنا الناشئ جاء ليقترح حلاً مختلفًا، عمليًا، ومستدامًا، يعتمد على إعادة توظيف الحاويات البحرية وتحويلها إلى فضاءات حضرية متكاملة. ولكي ننقل رؤيتنا من الفكرة إلى الواقع، قمنا بتطوير بروتوتيب (نموذج أولي) عبارة عن مجموعة من الأمثلة المعمارية، كل واحدة منها تمثّل نوعًا من المرافق العمومية التي يمكن تجسيدها فعليًا، بتصميم ثلاثي الأبعاد، ومخططات كاملة، توضح جودة التنفيذ وسهولة التكيّف مع متطلبات كل مشروع.

🚌 1. محطة حافلات صغيرة وعصرية

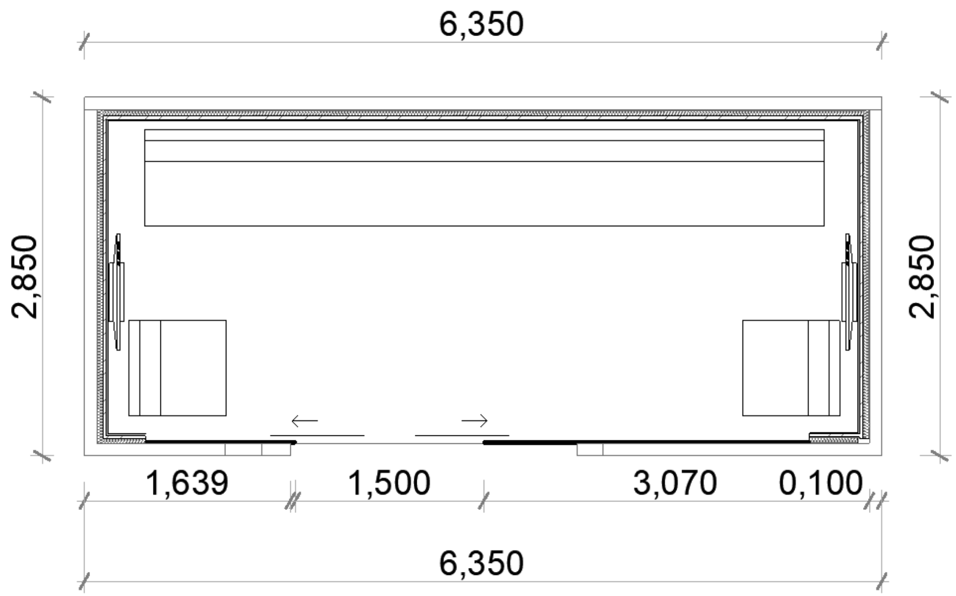
تم تصميم محطة حافلات حضرية مصغّرة باستخدام حاوية واحدة، بلمسة حديثة تحترم الجانب الوظيفي والجمالي:

مساحة انتظار مريحة

تصميم مدمج يلائم الفضاءات الحضرية

نموذج ثلاثي الأبعاد (D3) واضح ومحترف



رسم توضيحي 1 لمخطط لمساحة الانتظار

2. مراحيض عمومية متنقلة

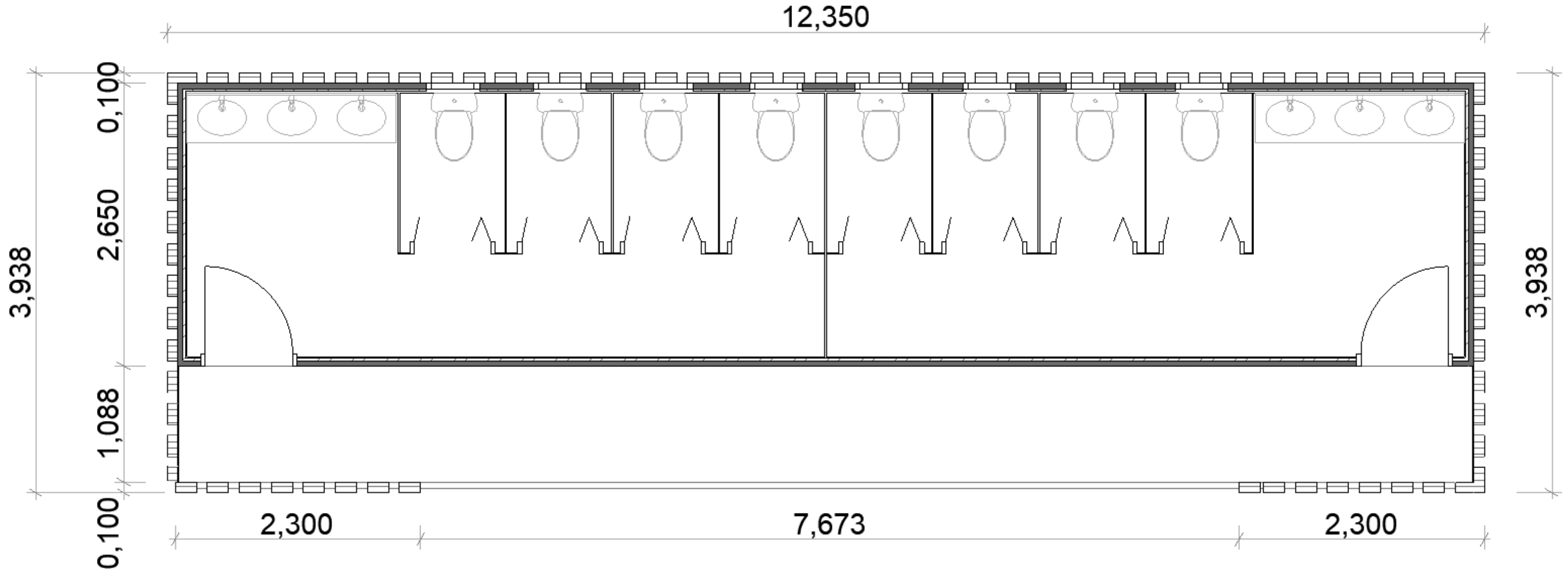
مثال آخر ضمن البروتوتيب هو مرفق مراحيض عمومية متنقل تم تصميمه بنفس الفلسفة:

استعمال حاويات معاد تدويرها

توزيع داخلي عملي ونظيف

مخططات معمارية مفصلة

نموذج ثلاثي الأبعاد يعكس الشكل النهائي



رسم توضيحي 2 محطط المراحيض العمومية

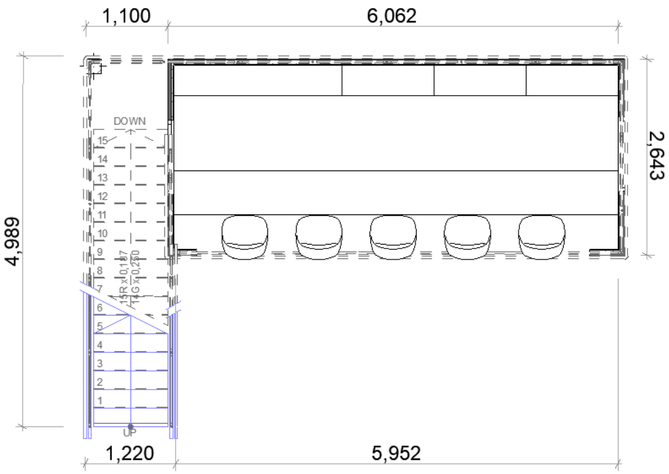
3. كافيتيريا بالحاويات

كما يشمل البروتوتيب تصميم كافيتيريا عصرية مصنوعة بالكامل من الحاويات، تحتوي على:

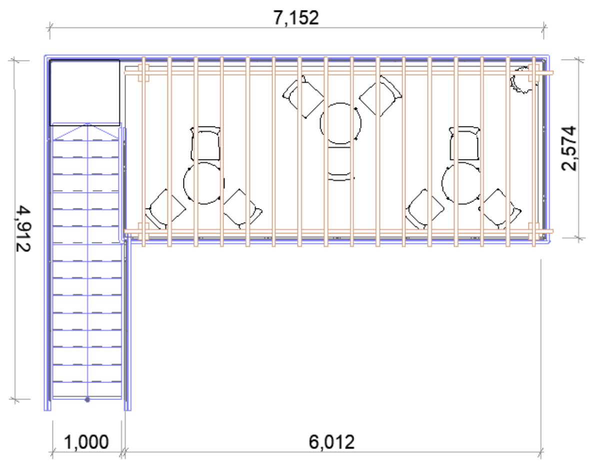
مساحة خدمة داخلية وخارجية

واجهات حديثة

نماذج D3 تساعد على تصور التجربة النهائية



رسم توضيحي 3 مخطط الطابق الارضي



رسم توضيحي 4 مخطط الطابق الاو