MEF University
Graduate School of Science and Engineering
Master of Science in Architectural Design

Mining the Buildings: Urban Mining Projections on İstanbul, Türkiye

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to my beloved parents, Hülya & Kasım Çakacı...

I would like to thank my thesis advisors Esra Sert and Tomris Akın for their ongoing support, guidance and encouragement to express my enthusiasm while owning my voice throughout the process. I would like to thank also the dearest jury members, Aktan Acar, Elif Kendir Beraha and Şebnem Yücel for their constructive critisisim and valuable contrubutions to this thesis.

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Abstract

This study investigates the urban mining approach as a potential circular economy strategy to cope with construction and demolition waste in Istanbul. Through a combination of theoretical analysis, practical case studies, and comparative research, the study investigates the factors influencing the implementation of urban mining practices and their implications for the built environment. By offering an understanding of the conceptual framework of circulation and circularity in transforming nature into anthropogenic stocks, this study highlights the potentials and the constraints of Istanbul for contributing to the creation of a more sustainable, economically accessible, economically independent, and resilient built environment. This study brings together global precedents for improving the built environment while closing the loop with the urban mining approach in Istanbul. It aims to lay the groundwork for urban mining in Istanbul's built environment by highlighting opportunities and limitations of the urban mining approach in this city by considering the working and non-working aspects of global examples.

Key Words: urban mining, built environment, circular economy, Yoo, Bence Güzel Pavillion, İstanbul, construction and demolition waste.

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Özet

Bu araştırma, İstanbul'da inşaat ve yıkım atıklarıyla başa çıkmak için potansiyel bir döngüsel ekonomi stratejisi olarak kentsel madencilik yaklaşımını araştırmaktadır. Teorik analiz, pratik vaka çalışmaları ve karşılaştırmalı araştırmaların birleşimiyle çalışma, kentsel madencilik uygulamalarının uygulanmasını etkileyen faktörleri ve inşa edilmiş çevre üzerindeki etkilerini incelemektedir.
Bu nedenle, doğayı antropojenik stoklara dönüştürmeye yönelik dolaşım ve döngüsellik kavramsal çerçevesinin anlaşılması; İstanbul'un daha sürdürülebilir, ekonomik açıdan erişilebilir, ekonomik açıdan bağımsız ve dirençli bir inşa edilmiş çevre oluşturmaya katkıda bulunma potansiyellerini ve kısıtlamalarını vurgulamaktadır. Böylece, bu çalışma, İstanbul'da döngüyü kapatırken inşa edilmiş çevreyi iyileştirmek için küresel örnekleri bir araya getirmektedir.İstanbul'un kentsel madencilik yaklaşımı için potansiyellerini ve kısıtlarını Dünya'daki örneklerin işleyen ve işlemeyen yönleri aracılığıyla öne çıkararak İstanbul'un yapılı çevresinin kentsel madenciliği için altlık oluşturmayı amaçlamaktadır.

Anahtar Kelimeler: kentsel madencilik, yapılı çevre, döngüsel ekonomi, Yoo, Bence Güzel Pavilyon, İstanbul, inşaat ve yıkıntı atığı.

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Introduction

The built environment, together with the structural and organisational systems developed for transportation, communication, energy, and water supply, consists of both material and immaterial components. Consequently, humankind has a highly significant role in transforming nature to anthropogenic material stocks and spaces. Within the context of the massive material flows in and between cities, humanity has an interconnected relationship with Earth. The capacity for organising as groups has become a source of both struggle and power for the human presence on Earth. It is powerful because it has allowed us to shape the environment we live in in a way that would not be possible on an individual basis. However, the consequences of this power have become a threat not only to our kind but to all living and non-living beings of Earth.
Rapid urbanisation, industrialisation, economic growth, and rising living standards have led to significant accumulations of raw resources into products, infrastructures, and waste streams.[1]

As a major industrial output, construction and demolition (C&D) waste has an average share of 30% in solid waste generation worldwide[2] (Figure 1) The escalating global waste crisis, intensified by the construction industry's substantial contribution to solid waste, necessitates innovative solutions for sustainable resource management. Thus, architects, as key actors of the construction industry, have a shared responsibility in this search for solutions. Moreover, architects and designers can play crucial roles in promoting sustainable construction practices by considering the disassembly and assembly of structural elements during both the design phase and the lifecycle of a building. By incorporating design features that facilitate material reuse and reduce waste, architects can significantly contribute to a more circular economy in the construction industry.

In this scope, urban mining, a key concept of the circular economy, offers a valuable approach for sustainable construction. Through the recovery of valuable materials from existing buildings, urban mining can help reduce the depletion of natural resources, minimise the pressure on the environment, and create new economic opportunities. Moreover, it can significantly reduce the ecological and climatic footprint of the construction industry.

1. Joakim Krook and Leenard Baas, Getting Serious about Mining the Technosphere: A Review of Recent Landfill Mining and Urban Mining Research (Journal of Cleaner Production 55, 2013), 1–9.

2. Papargyropoulou et al, Sustainable Construction Waste Management in Malaysia: A Contractor's Perspective (Management and Innovation for a Sustainable Built Environment MISBE 2011), 20–23.

Figure 1: Demolition debris, Mileyha Wetland, Hatay, Türkiye 2023 Source: Haber Global

Figure 2: Making of Yoo,Bence Güzel Pavillion, 2022
Source: AAP MEF

3. Tim Radford, Two-Thirds of World's Resources 'Used Up.', The Guardian, 2005

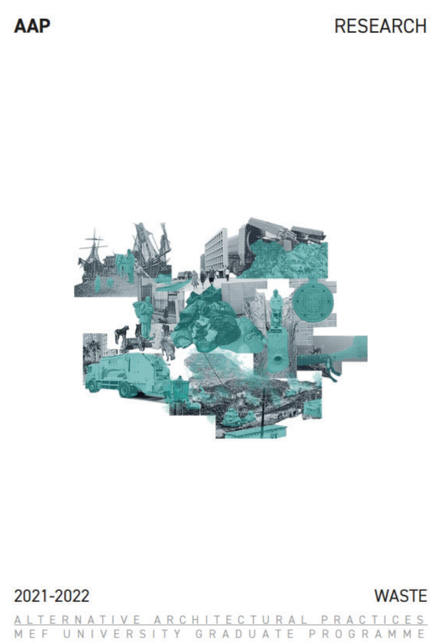


Figure 3: Alternative Architectural Practices, Waste Research book, 2022 Available at: https://www.yumpu.com/en/document/view/66395952/aap-waste

Inspired by dialogue arising during the design and construction of the Yoo, Bence Güzel Pavilion, this thesis explores the potential of urban mining as a promising strategy to address modern challenges (Figure 2). Yoo, Bence Güzel Pavilion was constructed as the final product of the "waste"-themed master's programme in Alternative Architectural Practices at MEF University, Istanbul. After the research period for that pavilion, in which we gathered information about the architectural relations of waste in Istanbul and worldwide, we had the opportunity to experience the potentials and limitations of urban mining and circular construction methods in the construction industry (Figure 3). This process also contributed to perceptions of the concept of waste throughout the life of materials and its relationship with consumers.

The first chapter of this thesis therefore explores the concept of waste, examining its material and immaterial aspects and how human activities contribute to its creation. It addresses the significant volume of solid waste produced by the construction industry, with a focus on excavation, construction, and demolition waste. Additionally, it introduces the concept of circular economy as a sustainable approach that includes urban mining to manage C&D waste effectively. Using narratives directly or indirectly related to the concept of circularity, this framework establishes the idea of circularity for C&D waste and urban mining practices, which are important approaches to the circular economy in the construction industry today.

In light of current issues and the response of the circular economy, the concept of urban mining is also discussed in the first chapter of this thesis with a focus on how urban mining emerged as a circular economy concept to address current issues. The challenges and constraints beyond discovering and measuring anthropogenic material stocks labelled as waste can be argued as an aspect of anonymity. The ownership issues caused by challenges of anonymity lead to problems while reusing the discarded materials, such as ambiguity regarding the ways in which pieces will come together. However, despite the complex relationships involved and the challenges of scalability issues, exploring the concept of circularity and its global responses, as well as the historical development of ideas related to C&D waste, can serve as a starting point to understand the logic of urban mining and its applications.

In Türkiye, an economically developing country primarily pursuing economic development strategies through the construction industry, we encountered various difficulties during the seven-month design and three-week implementation process of Yoo, Bence Güzel Pavilion.

However, we also had the opportunity to experience the potentials and constraints of mining Istanbul's construction waste. Building a structure from discarded materials with no established standards and forming connections from scratch to harvest those materials were among the issues we struggled with. The experience of conducting the design process simultaneously with material harvesting, avoiding downcycling, minimising on-site destruction, and ensuring that materials could be reused again later encouraged me to ask questions that would lead me to research methods and tools for implementing circular-design construction processes such as urban mining.

Fundamentally, using the term "mining" in urban settings offers a new perspective for viewing the built environment as a resource or a material bank. This perspective is all the more important considering that humanity has already extracted more than half of Earth's raw resources.[3] However, although the main argument of urban mining is based on the global-scale situation, urban mining and the metabolic flows it creates must be considered on the local scale.

Consequently, the second chapter of this thesis reflects on the process of designing and implementing Yoo, Bence Güzel Pavilion, including the challenges and constraints faced, to allow a subsequent investigation of global examples that address these challenges we experienced in Istanbul. Mining Istanbul's built environment has unique threats and potentials. Before discussing how we can mine wasted potential, we first need to understand the context and address local issues. The second chapter thus investigates the actors and events that have shaped local perspectives on the built environment and C&D waste. As part of the local context of Istanbul, this chapter also explores opportunities related to C&D waste, including formal and informal labour power and secondary material stocks, as well as threats such as earthquakes, urban renewal processes, and land reclamations.

On 6 February 2023, while I was working on this thesis, an earthquake devastated 11 provinces in the south-east of the country. Tens of thousands of people lost their lives, while survivors lost their homes and family and friends under the rubble of the collapsed buildings. This disaster highlighted the vital importance of considering C&D waste within the context of the existing building stock's lifecycle, urban renewal processes, and post-disaster scenarios in Istanbul, Türkiye, as a seismically active city.

In the process of harvesting construction waste materials for Yoo, Bence Güzel Pavilion, questions also arose about how to approach construction waste to avoid its accumulation, which causes both ecological and economic disadvantages, especially for economically developing countries like Türkiye. This experience prompted me to think about how urban mining processes and issues related to C&D waste are manifested in other countries with socio-economic conditions similar to or different from those of Türkiye. Therefore, the third chapter of this thesis explores urban mining strategies on both urban and building scales while projecting methods and tools that may offer insights into the mining of Istanbul's waste. Choosing cases on these different scales was crucial for identifying the strengths and weaknesses of approaches applied in different regions.

Accordingly, this thesis examines debates on circularity and urban mining, which have emerged from common problems such as resource scarcity, the climate crisis, environmental issues, biodiversity loss, and waste around the world, using critical comparative analysis. As an architect, living in Türkiye, one of the world's largest importers of waste, while considering the issue of waste affected my selection of countries to be analysed. The countries explored in Chapter 3 are categorised according to their strategies for urban mining, as well as their roles as importers or exporters in the waste trade.

This classification is presented according to geographical boundaries (North America, Europe, and Asia) while considering countries' roles as exporters or importers in the global waste trade. Urban mining is explored through examples from different countries around the world with different levels of economic development and different regulatory laws. By examining the approaches and responses of selected countries to C&D waste, this study aims to discuss applications of circular economy approaches to common problems on a global scale. I chose five countries to cover the mentioned geographical regions: the United States, the Netherlands, Belgium, Switzerland, China, and Taiwan. The first three, as developed countries, are advantageously positioned to cultivate more mature circular practices. On the other hand, China, which has recently shifted its role in the global waste trade and its approach to the circular economy, and Taiwan, a minor importer, have made significant efforts to achieve more circular material flows and cities.

Reflecting on the topics discussed in the second chapter, these promising examples at both urban and building scale will support a discussion of the potentials and limitations of urban mining in the construction industry within the context of Istanbul. Supported by the local implications in the third chapter, the categorisation described here is also created to be able to compare the approaches of countries with similar economic and political climates and to understand the strategies that could be adapted or developed for Türkiye, and specifically for Istanbul. In this context, it is aimed to understand the C&D waste generated by geographical realities such as earthquakes and the regulatory practices specific to Türkiye. This involves examining the processes that shape the existing building stock in Istanbul and developing responses to the related ecological and economic challenges.

Considering human activities as an unceasing phenomenon that shapes Earth's metabolism, "the nature of the observed phenomenon changes with corresponding changes in the apparatus."[4] Thus, observing the ways in which we build together with the economic concerns, the underlying power of social capabilities, and the material and immaterial flows that feed all of these activities could inspire dramatic shifts in construction activities.

Finally, this study compares methods and approaches for treating the existing building stock as an urban mine and initiates a discussion on resource scarcity, climate change, and land exploitation from the perspective of construction waste. Global urban mining perspectives are examined to develop suggestions for local applications in Istanbul.

4. Karen Michelle Barad, Meeting The Universe Halfway: Quantum Physics And The Entanglement Of Matter And Meaning (Durham: Duke University Press, 2007)

Understanding Construction & Demolition(C&D) Waste and Circular Economy

01

This chapter aims to provide supporting information for the main focus of this thesis, which began to emerge from a retrospective of the experience of the making of the Yoo, Bence Güzel Pavilion.
The chapter expands on the initial ideas behind Yoo, Bence Güzel Pavilion, allowing us to better understand and identify the line between waste and resources. The following questions are addressed: What is waste at the material and the semantic level, and how is it formed through anthropogenic activities? How much solid waste is produced by the construction industry, and why? What are excavation, construction, and demolition wastes? Finally, what is the circular economy, and how can the related approach of urban mining support the management of C&D waste?

This chapter also attempts to cultivate a deeper understanding of how to cope with C&D waste in line with theories related to the circular economy, the foundations of the idea of circularity, and the concept of urban mining as a tool of the circular economy. Through the perspective provided by urban metabolism, the idea of circularity becomes clearer, together with the networks and flows that constitute urban life.

With the clarity provided by the concept of urban metabolism, it is possible to understand the urban mining approach adopted by various industries, including construction, not only for its profitability but also for its potential to reduce the resource depletion of raw materials. This approach is economically accessible for underprivileged communities and has the potential to significantly mitigate issues related to waste and the global waste trade, which harm vulnerable communities and contribute to ecological and climatic impacts worldwide.

The urban mining concept as both an idea and an approach was also of significant importance in the process of completing Yoo, Bence Güzel Pavilion. Therefore, understanding the definitions and applications of the urban mining approach was critical since it affected the entire implementation of Yoo, Bence Güzel Pavilion on both intellectual and physical levels.

In this sense, Yoo, Bence Güzel Pavilion can be seen as local experimentation with practices in urban mining currently on the global agenda as an emerging field for architects and designers. This chapter accordingly offers the conceptual framework for the ideas behind Yoo, Bence Güzel Pavilion, allowing a more in-depth discussion of the urban mining of C&D waste.

Meanings of Waste

> ''... Socrates is walking alone on the beach. He stumbles upon an obscure object, polished and white. He can't figure out what it is or where it came from... the seashore is a special kind of wasteland, a place of derelict things, a gathering-zone for all the detritus of a great and eternal struggle. The enigmatic object Socrates finds on the shore is inscrutable but—for that very reason—captivating; he can't even be sure whether it is the product of nature or of human craft. Bewildered by its mysterious origins, status, and purpose, bested by it, he hurls the unknowable thing back into the sea. Socrates' problem is the problem of waste...'' [5]

In this passage, "waste" can be seen as a metaphor suggesting a multifaceted meaning and raising questions of what is worthy of being thrown away and what is worth keeping. The ambiguous and potentially useless material in this story that cannot be classified or categorised creates confusion and frustration, leading it to be discarded. According to the Merriam-Webster Dictionary, waste can mean both discarded matter and the act of wasting. In this sense, "waste" indicates the physical reality of the discarded material as well as its lost potential.[6]

After the disposal or *dispossession of waste*,[7] unwanted materials gain a new characteristic: anonymity. The combination of the anonymous possession of ambiguous material and the accumulation of non-metabolised material creates environmental or economic disadvantages for its keeper. The mobility and relocation of waste also creates new formal and informal economies around it among those who earn their living from it.

5. Brian Thill, Waste (Bloomsbury Academic, 2015) Available at: https://research-ebsco-com.ezproxy.mef.edu.tr/linkprocessor/plink?id=7d46285d-e3d1-33f1-bd30-c162c5922f7f.

6. Waste Definition & Meaning, Merriam-Webster Dictionary, Accessed February 11, 2024. https://www.merriam-webster.com/dictionary/waste.

7. Lucia Fernandez, Waste Pickers and Their Right to the City Dispossession and Displacement in Nineteenth-Century Paris and Contemporary Montevideo (Routledge,2020) Available at: https://www.taylorfrancis.com/chapters/oa-edit/10.4324/9780429200724-32/waste-pickers-right-city-luc%C3%ADa-fernandez.

Moreover, the mobility emerging from both living factors (e.g., dispossession of waste pickers and/or squatters) and non-living factors (e.g., excavation soil), as well as the relocations, energy, and material flows that feed a city, also promote waste accumulation and have consequences for living systems.[8]

Solid waste generation and accumulation have drastically increased and are now threatening the world's biodiversity and ecosystems while reserves of natural resources are being depleted. Materials that lack exchange value due to consumer preferences are disposed of in these processes, being dispossessed and gaining anonymity. The impact of relocation generated by flows of energy and material leaves its footprint on the ecosystem and causes the transformation of ecological zones into wastelands as dispossessed materials accumulate.[9]

As stated above, the generation of solid waste entails certain aspects that lead to its accumulation. In the case of C&D waste, scrapped building materials share the characteristics of other materials labelled as waste: anonymity, ambiguity, and relocation (Figure 4). This process begins with the disposal of physical material. The physical act of disposing causes a loss of purpose and loss of ownership with the material's last consumer. In other words, the anonymity of the material, which implies derelict right of use, starts with its disposal and dispossession. Lynch claims that disposal, together with cleanness, serves as a social symbol of the health and functioning of an urban system.[10] Thus, he argues that humankind is the "wastrel" of Earth and the main catalysing force of matter and energy.

However, the economic value of these materials also has a significant impact on decisions of what is waste and what is not. Materials that can be reused or recycled due to their mobility, characteristics, and defined purpose of use are not abandoned as they retain economic value.
As soon as the dereliction of a structure becomes obvious, materials such as doors, windows, kitchens, laminate flooring, or plasterboard can be removed before demolition by dismantlers (Turkish: *çıkmacılar)*, who disassemble buildings down to component units from old elevators to plastic or copper pipes[11] and reintroduce those items into the city's metabolism due to their exchange value. Lynch argues that these dismantlers have a role similar to that of *saprophytes* in nature.[12] Saprophytes break down the components of organic matter into smaller pieces, allowing that matter to be reused in natural food chains.

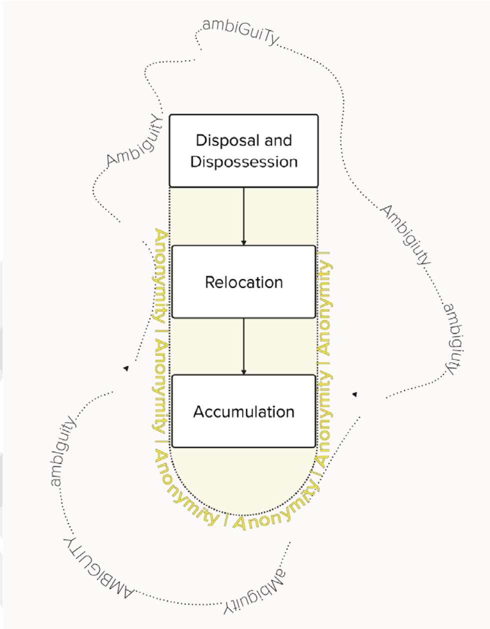


Figure 4: Diagram of Waste Accumulation Produced by the Author, 2024

8. Anna R. Davies, Geography and the Matter of Waste Mobilities (London: Royal Geographical Society, 2012) Available at: https://www.jstor.org/stable/41427940)

9. Ibid.

10. Kevin Lynch, Wasting Away (Sierra Club Books, 1990),39.

11. Onur Ceritoğlu, Yık-Yap Ve Yeniden Kullanma: İstanbul'da Çıkmacılar (Manifold, 2017) Available at: https://manifold.press/yik-yap-ve-yeniden-kullanma-istanbul-da-cikmacilar

12. Kevin Lynch, Wasting Away (Sierra Club Books, 1990), 83.

Moreover, he argues that this "dismantling" behaviour is not new to modern history. Practices of reusing materials or elements of the derelict buildings can be traced back to the Roman and Ottoman Empires, applied for temples, churches, and mosques. Materials harvested from older buildings and used for new constructions in these eras were called spolia in Latin and *devşirme* in Turkish.[13]

In Türkiye, in more recent years, a unique case of spolia and the harvesting of existing materials can be highlighted. In 1958 in a small village in the southern Aegean region of Türkiye, it was discovered that people had reused stones, pedestals, columns, and even historical tombstones gathered from the nearby historical Temple of Aphrodisias, dating back to 500 BCE, to build their village.[14] (Figure 5) After the discovery of the Temple of Aphrodisias, the village of Geyre was relocated in 1960 with an expropriation decision made by the Ministry of Culture of Türkiye. The former residents of the houses of the original Geyre dismantled parts of their houses, such as windows and doors, to carry with them as they moved. This showcases the potential of people reusing materials in cases of necessity such as resource shortages, the unavailability of building materials, or other economic hardships.

Figure 5: Aphrodisias Temple pieces in Geyre Village, Aydın, Türkiye, 1958. Credit: Ara Güler

13. Long Living Spolia, (Harvard Graduate School of Design, 2024) Available at: https://www.gsd.harvard.edu/course/long-living-spolia-spring-2024/.

14. Erman Ertuğrul, Ara Güler'in Gözünden Tüm Ayrıntılarıyla Aphrodisias 1958 (Arkeofili, 2021) Available at: https://arkeofili.com/ara-gulerin-gozunden-tum-ayrintilariyla-aphrodisias-1958/.

The ambiguous nature of derelict spaces and materials possesses a sort of charm, calling humans to explore them, but social doctrine begins repressing that desire to explore in childhood.[15] This innate interest in derelict materials was reflected by the huge sculpture made from 300,000 pieces of scrapped building materials by Clarence Schimdt on Ohayo Mountain (New York state) in 1960 (Figure 6). While this artwork produced negative reactions from his neighbours and even his wife, it was attractive to children. The cultural viewpoint holding that everything must have a purpose and an assigned use finds this type of ambiguity disturbing. In Schimdt's case, aesthetic concerns led to his sculpture being demolished; it is discussed today as an interesting experiment that displays the (in)tolerance to the ambiguity of scrap building materials. At the same time, however, this ambiguity can also be a driving factor in the cultivation of new attitudes towards waste.[16]

Figure 6: Sculpture on the Ohayo Mountain by Clarence Schmidt,1960. Source: spacesarchives.org

As another example of aesthetic concerns about waste materials, Agnes Varda's The Gleaners and I documentary narrates the deep connections between the act of collecting, the lives of gleaners, and beauty standards.[17] In her film, Varda not only documents the lives and experiences of gleaners or waste pickers but also captures their unique aesthetic perspectives and understanding of beauty.[18]

By valuing objects considered worthless by societal standards, these individuals uncover the aesthetic potential within waste.[19] This challenges societal norms and becomes a new part of the process of revaluing and recycling waste. Varda argues that the "act of collecting itself should be seen as an art form".[20] Indeed, aesthetic expectations and health concerns regarding scrapped building materials warrant more attention. In the context of waste generation, it is necessary to understand how C&D waste accumulates through various networks in the context of the science or art of construction and other related dynamics before addressing the hygienic and aesthetic concerns that may arise. To discuss these networks and dynamics, it is important to understand exactly what materials we are dealing with and the scales of accumulation. The scale of demolition waste varies across different types of demolition, such as interior demolition, selective demolition, dismantling/deconstruction, or mechanical demolition.[21] These demolition types can be implemented at one of three main levels of total demolition, partial demolition or reduction of the storeys of the structure, or repair/retrofitting, with the assessment of the existing stock.[22] Dismantling and deconstruction are methods used to reduce the environmental and economic impact of waste from leftover materials from buildings. More labour power is needed to carefully extract the reusable parts of the buildings before demolition and decrease the amount of waste generated.

Deconstruction and dismantling have also been rediscovered as industrial methods to decrease the unseen mark that demolition leaves behind: carbon emissions.[23] These activities generate dust and air pollution that can harm living beings and impact biodiversity. In some cases, such as major construction sites, they can increase the release of PM10 dust particles, which cause airborne diseases. The logistics of construction sites account for a major share of the release of these harmful particles.[24] Considering the toxicity arising from demolition activities and materials together with the volumes of output materials such as soil and cement-based substances, it can be said that excavation and demolition wastes are the most problematic outcomes of the construction industry.

Classifications of construction and demolition wastes are based on various criteria, such as their sources, their toxicities, and the demolition or extraction phase in which they are generated. According to the classification proposed by Tchobanoglous and Kreith in 2002, C&D wastes include wood, paper, plastics, concrete, insulation materials, marble, tiles, glass, and metal

15. Kevin Lynch, Wasting Away (Sierra Club Books, 1990),39-40.

16. Ibid.

17. Agnès Varda, Les glâneurs et la glâneuse (Ciné Tamaris, France, 2002)

18. Ersan Ocak, Artık Toplayıcılar ve Ben Filminde Seyircisinin Yaşam Gücünü Arttıran Bir Görüntü Toplayıcısı Olarak Agnès Varda. (SineFilozofi, 2019), 226-248 Available at: https://doi.org/10.31122/sinefilozofi.633092.

19. Ibid.

20. Agnès Varda, Les glâneurs et la glâneuse (Ciné Tamaris, France, 2002)

21. R. Baker&Son Industrial Services, Various Demolition Methods and Types, Accessed August 19, 2024. https://www.rbaker.com/press-room.php?id=230.

22. Ferhat Güven, Betonarme Yapıların Yıkımı ve Yıkım Tekniklerinin Uygulanabilirlik, Zaman ve Maliyet Açılarından Irdelenmesi, 2019.

23. Paul Yakubu, What Are the Sustainable Demolition Strategies That Can Decarbonize Architecture? (Archdaily, 2023.) Available at: https://www.archdaily.com/1008159/what-are-the-sustainable-demolition-strategies-that-can-decarbonize-architecture.

24. Holman et al., AssesIAQM Guidance on the Assessment of Dust from Demolition and Contstruction, (Institute of Air Quality Management, IES, 2014)

25. G. Tchobanoglous, and F. Keith , Handbook of Solid Waste Management, (New York: McGraw-Hill, 2002.)

26. D. A. Spivey, Environmental and Construction Management, (Engineers. Journal of Construction,1974),395-401

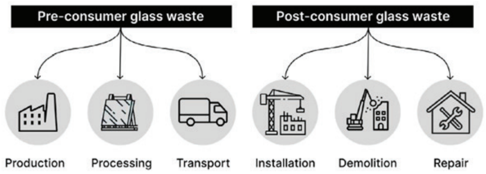


Figure 7: Pre consumer and post consumer phases of waste, Source: glassonweb

wastes arising from activities such as new constructions, road maintenance, renovation, and the demolition of buildings.[25] Another classification, developed by Spivey in 1974, focuses particularly on construction wastes.[26] By this classification, construction wastes are divided into categories such as concrete, brick, packaging materials, wood, and metal.

The C&D waste generated by linear economic models reflects the consumer effect. The scope of these linear systems can be seen in two phases: the production phase, or the pre-consumer phase, and the phase after disposal, or the post-consumer phase (Figure 7). Pre-consumer waste includes defective materials that occur on the assembly line in the course of manufacturing. It also includes materials broken or left over in construction processes and excavation waste. On the other hand, post-consumer demolition waste is waste that has been disposed of by the end consumer or that has unexpectedly reached the end of its lifecycle as a result of natural disasters.

Considering the effects of the end consumer on construction waste, a building is a final product of the construction industry indicating consumption-oriented production. During construction activities, the period in which the highest amounts of embodied carbon are exposed is the period of material production processes.[27] Considering that there are about 250 subsidiary industries that provide services to the construction industry, such as architecture and engineering, as well as supplying materials such as iron, plaster, electrical materials, transformers, boilers, curtains, furniture, glass, parquets, plastic pipes, nails, and wall paints,[28] it should not be ignored that subsidiary industries also have a responsibility and share in the production of pre-consumer construction waste.

As mentioned above, these wastes generally consist of concrete, wood, steel, brick and clay tiles, drywall and plasters, asphalt shingles, and asphalt concrete.[29] These materials are classified by their reactivity with environmental properties to ease their diversion from landfills.[30] Reporting on behalf of the US Environmental Protection Agency, Franklin Associates classified C&D waste as largely inert waste, which means that it is not chemically or biologically reactive.[31] In contrast to other classifications based on material types, this specification addresses the toxicity factor together with flammability and explosive properties that can harm the living environment. Toxicity parameters may also be important as asbestos, a commonly used building material, was found to be toxic and cancerogenic.

27. United Nations Environment Programme(UNEP), 2022 Global Status Report for Buildings and Construction: Towards a Zero-emission, Efficient and Resilient Buildings and Construction Sector (Nairobi: United Nations Environment Programme, 2022)

28. Uğur Aslanhan, İnşaatın Etkilediği 250 Sektörün Istihdamı 6 Milyonu Geçiyor (Anadolu Ajansı, May 16, 2022) Available at: https://www.aa.com.tr/tr/ekonomi/insaatin-etkiledigi-250-sektorun-istihdami-6-milyonu-geciyor/2589163#.

29. Franklin Associates, Characterization Of Building-Related Construction And Demolition Debris In The United States, 1998.

30. Ibid.

31. Ibid.

These definitions are more inclusive and transitive today considering, for example, the reactivity level of the materials. Although a material itself may not be considered toxic or harmful, it may still need to be managed separately from other construction materials. This specification for construction waste is "non-inert," discussed separately from hazardous waste in the literature.[32] As an example, gypsum and plasterboard residuals are considered non-inert post-consumer waste. Post-consumer products are defined as non-inert because of chemical compounds that react with concrete and prevent it from having recycling potential.[33] As can be seen from this example, the purpose of the specifications on classifying construction waste such as post consumer or non-inert is generally used by the strategies developed by top-down interventions of the government to manage waste. These interventions are divided into several steps: collection and sorting, processing, purification (in the case of non-inert materials), and finally, recycling or landfilling.[34] As can be seen from this example, the purpose of classifying construction waste in ways such as post-consumer or non-inert is generally to allow top-down interventions by the government to manage waste. These interventions are broken up into several steps: collection and sorting, processing, purification (in the case of non-inert materials), and, finally, recycling or landfilling. If the processes will end with recycling, a few more steps are required for the circulation of the material, including quality control and market integration. All of these steps involve various actors, such as private or municipal organisations, as well as labour power, capital, and energy exchange. The economic value embedded in the wasted materials has the potential to create significant profit in capitalist societies and so the economic factor is considered too significant to be ignored. In a way, economic advantage of reusing outputs, is the core factor driving life today in all biological and living systems,[35] not apart from cities' metabolism .

32. Construction Industry Waste and the Environment , Designing Buildings UK.
Available at: https://www.designingbuildings.co.uk/wiki/Construction_industry_waste_and_the_environment#:~:text=Non%2Dinert%20waste%20is%20waste,serious%20threat%20to%20human%20health.

33. Ana Jiménez-Rivero and Justo García-Navarro, Exploring Factors Influencing Post-Consumer Gypsum Recycling and Landfilling in the European Union, (Resources, Conservation and Recycling 116, 2017), 116–123

34. Ibid.

35. Nicholas Georgescu-Roegen, In The Entropy Law and the Economic Process (Harvard University Press, 1973)

Core Concepts of Circular Economy

> "The production of (entangled) things through metabolic circulation is necessarily a process of fusion, of the making of "heterogeneous assemblages", of constructing longer or shorter networks. In fact, both "hybridity" and "cyborg" are misleading as tropes and may even be implicated in radically reproducing the underlying binary representation of the world."[36]

The built environment is created through the *metabolic transformation of nature*[37] by humans. This metabolic transformation of nature can also be read through the metabolic transformation of the coastal line with soil, water, urban voids, oil, coal, iron, and cement flows in Istanbul.[38] Humankind reflects collective power in this way rather than individual power, transforming and commodifying nature through social relations, the social capability of organisation, and cooperation, usually around a common purpose. The binary situation between nature and human production was first described by Cicero (45 BCE) as a second nature: "*...we enjoy the mountains and the plains, the rivers and the lakes are ours, we sow the crops and trees, we give fertility to the land by conveying water to it, we confine the streams, we straighten or divert their course—in short, by means of our hands we endeavour to create in nature a kind of second nature.*" [39]

The "second nature" that Cicero referred to, created within nature, involves the transformation of the environment as a result of human communities exchanging material and energy, like other living beings, for their own needs. Although a state of separation is emphasised here, Cicero's second nature is still a part of the innate, pure environment of the gods, attributed to the first nature. In a similar vein, Cicero's second nature was defined much later by 19th-century scientist Eduard Suess as the anthroposphere, or "a layer that includes the entire human population and encompasses everything that is man-made."[40] From this perspective, the cities we accommodate, consume, and produce can be referred to as the anthroposphere itself, including the circulation of all materials, values, energy, and waste.

Considering the idea of circularity, it is necessary to address the concept of metabolism, which was first introduced in the 17th century by Santorini, a medical doctor, to measure the mechanisms of the human body

36. Nik Heynen, Maria Kaika and Erik Swyngedouw, In the Nature of Cities: Urban Political Ecology and the Politics of Urban Metabolism, (London: Routledge, 2011),21-40.

37. Ibid.

38. Esra Sert, Urban Metabolism of Istanbul: Waterfronts as Metabolized Socio-Natures Between 1839 and 2019, (METU, 2020.)

39. M. L. Cicero, On the Nature of the Gods, (Translated by Francis Brooks. London: Methuen, 1896.) Available at: https://oll.libertyfund.org/titles/cicero-on-the-nature-of-the-gods

40. Cristina Parreño Alonso, The Builtsphere: A Broken Geological Paradigm, (Journal of Architectural Education ,2022),126–136. doi:10.1080/10464883.2022.2097530.

in terms of material inputs and outputs.[41] In the 19th century, the term "metabolism" was derived from the works of chemist J.F. Liebig and redefined by Marx as the material flows between nature and human through labour.[42]

With this definition, the term gained a new layer of meaning that emphasises the socio-natural entanglement between human and nature as inseparable forces shaping Earth.[43] This process of transformation encompasses the extraction of raw resources from the environment, their conversion into commodities through labour, and the subsequent distribution of products within the economy. Although purposes vary across a wide range of material or immaterial elements, these metabolic acts generate transformation on Earth's crust, metabolising and commodifying nature.[44]

Buckminster Fuller used the metaphor ''Spaceship Earth" in 1969 as a tribute to the interconnected system of Earth described here. His metaphor advances the need for careful maintenance of the mechanical processes of "Spaceship Earth" to ensure that life can be sustained in the face of possible resource depletion.[45] He argued that humanity must accept the responsibility of enhancing Earth's regenerative capability to address future risks of resource depletion. Although his perspective is considered human-centric and profit-oriented in its approach to nature, he argued that it is humankind's responsibility to sustain the balance of the metabolism that has been corrupted by progressive urbanisation.

The concept of metabolism in the context of cities, as described by Wolman in 1965, encompasses the flows of materials and commodities that enable people to sustain their everyday life "at home, at work, and at play."[46] Similar to the cardiovascular system, which circulates the materials that are necessary for the life of a living organism, there are infrastructural support systems created by humans to sustain their lives in cities on the planetary scale, impacting the metabolism of these cities.

More than a century after Eduard Suess first proposed it, Baccini and Brunner used the word "anthroposphere" in referring to the networks mentioned above, and redefined it as a complex system of energy, material, and information fluxes. They highlighted the constant changes in the anthroposphere due to human needs, with material stocks accumulating over time as carriers of needed materials.

These concepts also reflect a definition of waste whereby cities signify the accelerated expansion of the anthroposphere, which could collapse due to resource scarcity and pollution. In response to the entropy

41. P. Baccini and P.H. Brunner, Metabolism of the Anthroposphere. 1991.

42. Karl Marx, Capital Vol.2, (London: Penguin Books, 1998.), 226–227.

43. Maria Kaika, City of Flows Modernity, Nature, and the City. (New York: Routledge, 2005.)

44. Ibid.

45. R. Buckminster Fuller, Operating manual for Spaceship Earth, 1969.

46. Abel Wolman, The Metabolism of Cities, (Scientific American 213, no. 3, 1965), 179-187.

47. P. Baccini and P.H. Brunner, Metabolism of the Anthroposphere. 1991.

48. W.J.V. Vermeulen, The social dimension of industrial ecology: On the implications of the inherent nature of social phenomena, (Progress in Industrial Ecology, An International Journal, vol. 3, no. 6, 2006), 574.

49. A. Murray and K. Haynes,The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context, (Journal of Business Ethics, vol. 140, no. 3, 2017), 369–380.

50. P. Ghisellini, C. Cialani, and S. Ulgiati, A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems, (Journal of Cleaner Production, vol. 114, 2016), 11–32.

51. W. R. Stahel, and G. Reday-Mulvey, Jobs for tomorrow: The potential for substituting manpower for energy, (Vantage Press, 1981)

52. Ellen MacArthur Foundation, Circular Economy Schools of Thought – Performance Economy, 2017. Available at: https://www.ellenmacarthurfoundation.org/the-circular-economy-in-detail-deep-dive

53. Ibid.

of the anthroposphere, they coined the term "anthropogenic metabolism" to discuss the flows and exchanges of material and energy that constantly transform the anthroposphere.[47]

The development of new approaches became visible as industrial ecology studies increasingly tended to develop measurement-based methods, such as lifecycle assessment, to understand the environmental impacts of industrial production and human consumption and to optimise their efficiency.[48] However, industrial ecology within the metabolism of the anthroposphere is still considered as the basis of the circular economy by some researchers. [49 50]

The circularity within the seemingly segregated relationship between nature and humankind has evolved towards open circulation flows of linear processes steadily transforming the anthroposphere to a closed loop, triggered by multilayered issues such as waste. In the current linear flows in the anthroposphere, materials that can no longer serve as inputs end up as waste, not only creating economic loss with the accumulation of materials but also harming living and non-living beings through both their disposal and the transformation of more raw resources. Construction activities involve the movement of immense amounts of raw materials extracted from Earth's crust, processed in industrial zones, and finally delivered to construction sites, leaving behind their own footprints on Earth.

Incorporating these concepts of circulation and metabolism, in 1981, W. Stahel and G. Reday-Mulvey published a report titled Jobs for Tomorrow: The Potential for Substituting Manpower for Energy, in which they claimed that establishing an economy based on "closed loops" promoting reuse, repair, and reproduction processes would expand new fields of work, increase economic competitiveness, and reduce resource consumption.[51] An economy based on closed loops, now viewed as the first description of "circular economy" as we understand it today, was later recognised in the literature as the performance economy, which advocates selling service for maintenance along with products to promote reuse and repair to increase the lifelong performance of products.[52]

Another reference model for the circular economy was the "cradle to cradle" approach, introduced by Stahel in response to the "cradle to grave" linear model for the industry of production and subsequently further developed by architect W. McDonough and chemist M. Braungart.[53] McDonough and Braungart described the approach as involving products designed to be part of a closed-loop system, where materials can be perpetually recycled or safely returned to nature, in their book, Cradle to Cradle: Remaking the Way We Make Things. Deemed groundbreaking at the time, their work criticised the 3R "reduce-reuse-recycle" approach of industry as not functioning properly for the living and non-living; they argued that there is a need to bring a more holistic perspective to these applications.[54]

In explaining this dysfunction, they stated that "reducing, reusing, and recycling" products was not enough to avoid environmental and health hazards if products are inherently toxic and not environmentally friendly.[55] They further noted that the term "eco-efficiency" was officially coined as a response to the Brundtland Commission in 1987 by the Business Council for Sustainable Development, comprising 48 industrial sponsors. Industrial sustainability efforts were insufficient because they operated on an existing economic paradigm.[56]

That existing economic paradigm was intertwined with the efforts of industry to redeem its bad reputation in an environmentally conscious society while making the assembly line even more profitable. The embracement of "eco-effective" solutions by industry can be considered as the emergence of the "green washing" of industry. While eco-efficiency and the 3R approach may allow companies to decrease the harm they do to the environment, the need for an overarching shift in the existing economic paradigm was emphasised.[57] The authors suggested learning from biological systems to "regulate" and create a circular industrial metabolism by closing the loop without downgrading materials. The proposed cradle to cradle approach was, in a sense, a collection of concepts developed in diverse areas such as environmental management, systems thinking, and industrial ecology.[58]

Overall, re-thinking construction waste and the lifecycles of buildings within this framework can be useful in understanding profit-oriented industrial processes. These processes are still functioning today in the contemporary construction industry through networks of material supply and disposal intertwined with material and immaterial flows. In this way, it may be possible to reinterpret the mechanism of one of the sectors, the construction industry, most responsible for generating waste and carbon emissions on a global scale, and to support the more efficient use of the finite resources of the planet.

54. William McDonough and Micheal Braungart, Cradle to Cradle: Remaking the Way We Make Things, 2002.

55. Ibid.

56. Ibid.

57. Ibid.

58. John Paul Kusz. Book Review: Cradle to Cradle: Remaking the Way We Make Things Design Issues 22, no. 1 (2006): 77–78. https://doi.org/10.1162/074793606775247772.

Circular Economy in the Construction Industry

59. Hélène Frichot, Wasteocene: The Dirty Architecture of Progress, (The Architectural Review, 2021.)

60. Raymond Williams, Keywords: A Vocabulary of Culture and Society. (New York, NY: Oxford University Press, 2017.)

61. Lloyd Katie Thomas, Tilo Amhoff, and Nick Beech, Industries of Architecture (London: Routledge, Taylor & Francis Group, 2016.)

62. Eurostat,2020

> “ When we consider waste – its management, how it is both revealed and hidden, which labouring bodies are wasted away in the process, and how it is present not only in the construction phase, but all the way through to demolition – we see that the progress of architecture is inextricably tied up with the production of waste. This is the most crucial formula of waste: waste is the inevitable entropic outcome of what we call progress.’’[59]

The word ”industry” refers to any kind of production and work activity,[60] embodying all production of material and immaterial commodities from the agriculture industry to the entertainment industry.[61] However, the construction industry has the biggest share of solid waste generation among all other industries[62] (Figure 8) Because of the inevitable productions of the construction industry, construction waste is a by-product or outcome of the materials created by the metabolising processes of industrial production. In the production cycles of industries, some materials that cannot be used as input lead to the accumulation of non-metabolised materials and eventually become the ultimate output of waste. These non-metabolised residues in urban areas arise from activities such as construction, renovation, repair, and demolition activities.

As with other solid wastes, the “take-make-waste” patterns of linear consumption chains in the construction industry eventually lead to the accumulation of non-metabolised materials, or waste, which adversely

Figure 8: Waste share of the industries, Source: Eurostat, 2020

affects living beings in the ecosystem as materials in urban circulation end up in landfills. The attempt to make processes and flows more circular does not only entail creating new circulation routes for non-metabolised materials.
It also involves decreasing the usage of finite raw materials and minimising dependency on global markets while creating new commodity flows from discarded materials.[63]

The circular economy is now an important goal among countries' policies in response to climate change and resource consumption. As C&D processes account for nearly half of the total global material consumption, the built environment and the construction industry are recognised as main fields in which a circular economy must be implemented.[64]

As a particularly well-known agreement, the European Green Deal was approved in 2020 with the aim of making European Union countries climate-neutral by 2050. Additionally, the United Nations Sustainable Development Goals, as international sustainability markers, indirectly mediate the circular economy for climate-oriented reasons.[65] These regulative political frameworks serve as triggering forces for countries of various levels of economic maturity to take part in efforts against climate change. The construction industry is of key significance in global efforts to control the annual 1.5-degree temperature increase because of its major contribution to carbon emissions.[66] More recently, the role of the construction industry in reaching net-zero emissions by 2030 was officially addressed via the global initiative "Buildings Breakthrough" at the COP28 United Nations Climate Change Conference.[67]

Assessments and Certificates

The key strategies of the target described here are prioritising the renovation of existing building stock to make it energy-efficient and resilient to future disasters, encouraging the use of innovative materials, investing in building technologies to promote near-zero-emission buildings, and supporting sustainable and resilient building solutions with appropriate policies and incentives.[68,69]

The framework offered in the aforementioned report has been described as generic, leaving many question about the adaptability of countries at various economic development levels. Besides descriptive and analogical perspectives that help comprehend the circular economy, most industries use assessments and certifications to measure and intervene in the

63. European Commission, 2014; Stahel and Reday-Mulvey, 1976; Ellen MacArthur Foundation, 2013; Hebel et al., 2014

64. Circle Economy Foundation, The Circularity Gap Report 2024 Available at: https://www.circularity-gap.world/2024.

65. Statistics Netherlands, Circular Economy and the Sustainable Development Goals, (Statistics Netherlands, 2022.) Available at: https://www.cbs.nl/en-gb/longread/rapportages/2022/circular-economy-and-the-sustainable-development-goals.

66. GBPN, Building the Path to 1.5°C: What the Paris Agreement Means for Buildings & Construction, (GBPN, 2021.) Available at: https://www.gbpn.org/building-path-15c-what-paris-agreement-means-buildings-construction/.

67. Fostering Collaboration: Buildings Breakthrough. globalabc. Accessed August 20, 2024. Available at: https://globalabc.org/our-work/fostering-collaboration.

68. Ibid.

69. Buildings – Breakthrough Agenda Report 2023 – Analysis, (IEA,2023) Accessed August 20, 2024. Available at: https://www.iea.org/reports/breakthrough-agendareport-2023/buildings.

70. Matthias Heinrich and Werner Lang, Materials Passports-Best Practice: Innovative Solutions for a Transition to a Circular Economy in the Built Environment, (Technische Universität München& BAMB, 2019)

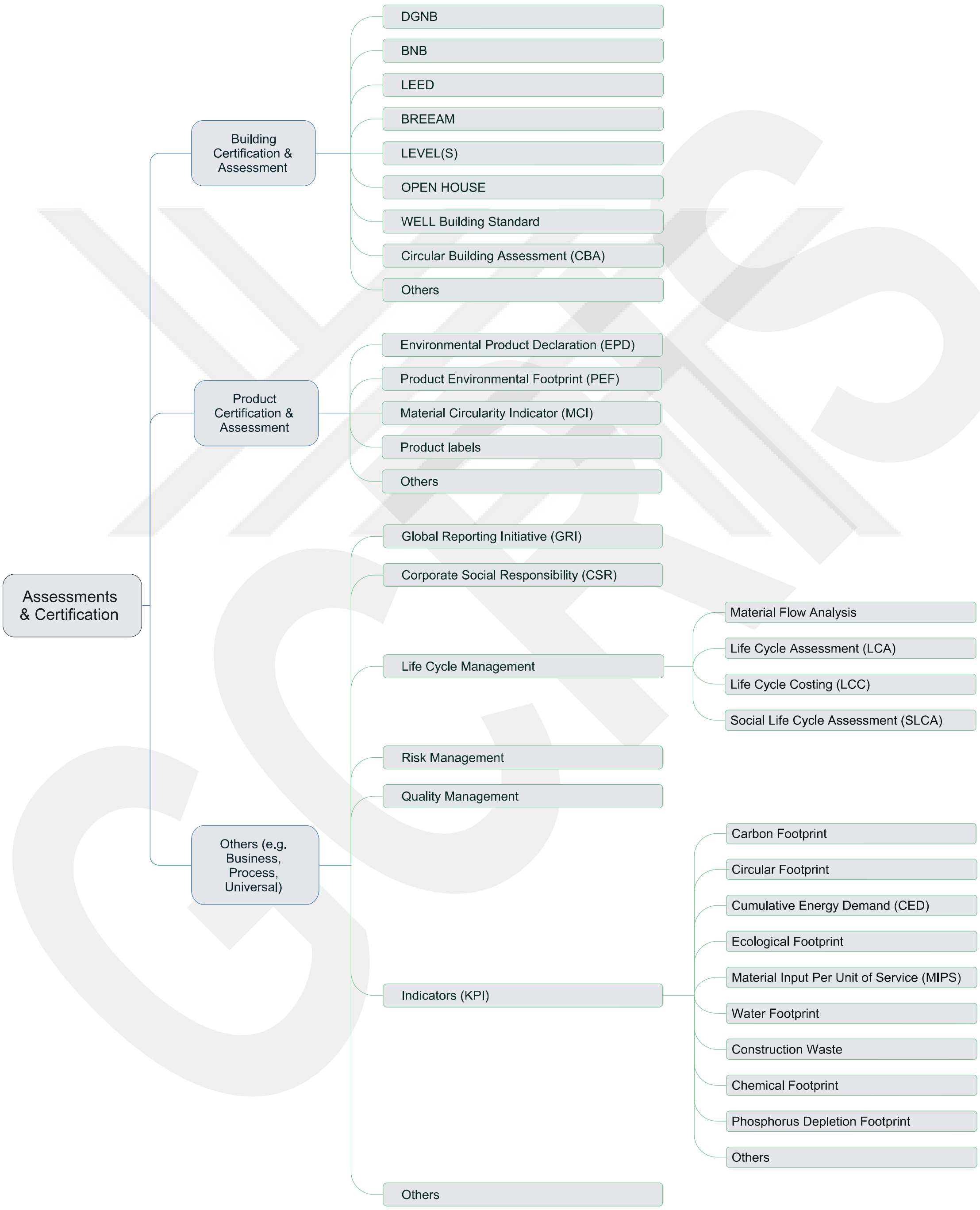


Figure 9: Three levels of the assessment methods for circular economy in construction industry. Source: Heinrich& Lang,2019

circulation of materials in cities. These measurements and assessments can be addressed on one of three main levels: building certification and assessment, product certification and assessment, and universal measures, processes, and businesses.[70] (Figure 9)

For example, the Environmental Product Declaration (EPD), which is based on the International Organization for Standardization's ISO/TS 14027:2017, gained popularity among manufacturers for publicly sharing objective lifecycle assessments and environmental impacts of their products.[71] EPDs, which can be prepared within different frameworks from "cradle to grave" to "cradle to cradle," measure the environmental footprints of products from the raw material supply chain to the production, use, and waste disposal stages.[72]

Although this documentation is not legally mandatory for manufacturers, it is required for LEED v4.1 certification.[73] It is also supported by some regulations in parallel with the European Union's zero-carbon policies and circular economy vision plans. The purpose of EPD documentation is to create a transparent and objective dataset for relevant stakeholders of the construction industry on the material supply processes that affect the lifecycle and carbon footprint of a building. Although research was not conducted within the scope of this thesis to quantify the extent to which these efforts have paid off in practice, there are controversies about the certification of "sustainability" being used as a marketing strategy rather than a practical benefit.[74]

However, making the production chains and processes of sub-industries visible can lead to discussions on the "expiry dates" and designated lifespans of the materials, the technologies used, and thus the buildings themselves. Three years after their first book was published, McDonough and Braungart, the co-founders of the "cradle to cradle" approach, started a certification programme to guide industries towards optimising their products.[75] The certificate is based on five categories: material health, product circularity, clean air and climate production, water and soil stewardship, and social fairness. To ease the transition to a circular economy, this certificate is listed as a recommendation for federal purchasing on the website of the US Environmental Protection Agency.[76]

Leaving aside issues that could emerge from adaptability and governments' responsibilities, there is also an opportunity for architects, designers, manufacturers, contractors, and all other stakeholders of the

71. You Are Hyper-Transparent, Others Do the Rest. (EPD Usage, EPD International.) Accessed May 16, 2024. Available at: https://www.environdec.com/all-about-epds/epd-applications.

72. Ibid.

73. Tommy Linstroth, Finding Epds for LEED v4 and v4.1. (Green Badger, 2022.) Available at: https://getgreenbadger.com/leed-epd/.

74. Daniel C. Matisoff, Douglas S. Noonan, and Anna M. Mazzolini, Performance or marketing benefits? the case of LEED certification, (Environmental Science & Technology. Accessed May 16, 2024.) Available at: https://pubs.acs.org/doi/abs/10.1021/es4042447.

75. Cradle to Cradle Certified, Version 4.0., (Cradle to Cradle Products Innovation Institute. Accessed May 30, 2024.) Available at: https://c2ccertified.org/the-standard/version-4-0.

76. Recommendations of Specifications, Standards, and Ecolabels for Federal Purchasing. (EPA, Accessed August 20, 2024.) Available at: https://www.epa.gov/greenerproducts/recommendations-specifications-standards-and-ecolabels-federal-purchasing.

77. Ed Van Hinte, Cesare Peeren, and Jan Jongert, Superuse: Constructing New Architecture by Shortcutting Material Flows. (010 Publishers, 2007.) Available at: https://www.google.com.tr/books/edition/Superuse/QnI1m8-Mku4C?hl=en&gbpv=1&printsec=frontcover.

78. Ibid.

79. Ibid.

80. Paul Fennell, Justin Driver, Christopher Bataille, and Steven J. Davis, Cement and Steel- Nine Steps to Net Zero, (Nature News, March 23, 2022.) Available at: https://www.nature.com/articles/d41586-022-00758-4.

81. Zach Winn, Cleaning up One of the World's Most Commonly Used Substances, (MIT Sustainability, 2023.) Available at: https://sustainability.mit.edu/article/cleaning-one-worlds-most-commonly-used-substances

construction industry to take responsibility and become pioneers in the transition to circularity. However, in developing countries such as India and Türkiye, informal workers such as waste pickers, scrap dealers, and dismantlers must also be included in these approaches and networks with an appropriate share of responsibility and respect.

In addition to an inclusive approach to labour power in the industry, using the tools and methods that the circular economy provides to regulate the emissions of the entire lifecycle of a construction project would be an important step towards reducing the carbon emissions of the built environment. With the holistic perspective provided by the lifecycle concept, all stages, from resource extraction to product manufacturing and use to disposal, known as "cradle to grave," can be improved.

Understanding the lifecycle of a building is closely linked to understanding what parts and elements buildings consist of. To maintain the existing stock while designing new buildings, feedback on the constraints of the existing stock is needed. Therefore, seeking answers to the question of how materials come together is an initial step in understanding how construction assemblages can be reversed. Buildings comprise materials processed from raw sources, elements that are the final form of processed materials, and components that are assembled by bringing elements together.[77] The components that make up a building are made of materials formed by the assemblage of raw materials in production processes that give materials certain shapes and proportions.[78] The standardisation of raw materials enables the cataloguing of materiality for the building in the design stage, and materiality also has a significant role in the lifecycle of the building. If the final production of the construction industry is to be the building itself, then the building is an assemblage of "building parts," based on the combination of components to form a "complete functional object."[79]

This hierarchical order that comes together as a building enables architects and designers to reverse the linear process of raw material becoming construction waste from the very beginning.
Finding ways to intervene in the lifecycle as well as the end-of-life demolition of buildings can transform the end of life of a building to a new cycle. This could entail donating elements or components through dismantling before the components can become C&D waste.

On the other hand, the recycling industry treats materials, elements, components, and parts as raw materials that need to be broken down before being turned into waste. For example, the cement and steel industries have an important share in the built environment,[80] and their recycling processes require excessive steps and energy. However, cement, as the main ingredient of concrete, is the most consumed material around the world after water. [81]

Design for Disassembly (DfD)

In some cases, building elements, components, and parts can be dismantled and incorporated into urban metabolism without downgrading. These harvested materials require large storage areas, equipment, and labour power, entailing economic costs. However, the costs that arise in harvesting and storing these materials that embody value can be considered as hibernated capital. Evoking the potential of use is possible through architecture and design.

Looking at C&D waste from the perspective of its final consumer and end of life provides a basis for architectural design methods that could minimise waste production and natural resource consumption in closed cycles of construction activities in future projections. On the other hand, designing buildings as material storage for future cities can eliminate the need for specialised large storage areas.[82] Making buildings demountable allows for future possibilities while establishing the relationship with current users without eliminating future uses. Thus, “design for disassembly” strategies can be adapted in the pre-consumer stages of the building as a design strategy. Disassembly, in this case, is considered as an alternative to demolition.[83]

Designing buildings for deconstruction aims to divert them from landfills, reusing and recycling their elements or components at the end of their lifecycles. In other words, design for disassembly can be considered a method that extends the service of materials in the circuits of the city.

In terms of extending the service of the elements and components of a building or structure, preparing material passports is also a significant step in keeping elements and components from becoming waste.

Material Passports and Material Passport Platforms

Documenting information with material passports can enable intervention in the lifecycle of products in the built environment. The BAMB (Buildings as Material Banks) programme funded by the European Union in the scope of Horizon 2020 addresses material passports for circular construction.

82. Felix Heisel, Dirk Hebel, Werner Sobek, Resource-respectful construction – the case of the Urban Mining and Recycling unit (UMAR), (IOP Conference Series: Earth and Environmental Science, 225:012049,2019) DOI:10.1088/1755-1315/225/1/012049.

83. Philip Crowther, Design for Disassembly to Extend Service Life and Increase Sustainability, 1999.

Among various strategies and tools for utilising circular materials in the built environment, building passports are seen as a key resource. They encompass material data, including physical, chemical, and biological properties and the toxicity of materials, as well as design and production processes, transportation and logistics, construction, maintenance, and disassembly. However, material passports, which are subsumed by building passports, facilitate "design for disassembly" by recording information on how products can be easily taken apart, which is crucial for future recovery and the reuse of materials.[84] They also enable efficient logistics by providing records of a product's location and ownership, which is important during renovation or demolition.[85] With the information that a material passport provides, it is possible to track the current condition and history of products and assess their usability and value for recovery. Furthermore, material passports allow for the strategic planning of disassembly processes and help identify markets for reclaimed components, reducing risks for companies involved in the second-hand product trade. However, material passports are an effective method for the construction industry only when they are registered in a database that can be accessed centrally, such as the Material Passport Platform (MPP).[86]

An inclusive database is needed to recognise inconsistencies in the data to be used by stakeholders such as material suppliers, contractors, and architects to choose materials accordingly for future use. For example, architects can access information about the materials, their properties, sustainability rates, and lifecycle impact to reclaim materials that align with specific design considerations.[87] Data from the MPP can serve as active input with the material passport's adaptation to the digital twin of the building through building information modelling (BIM).[88]

Strengthening digital tools with extensive information, such as supporting BIM with the MPP, is considered another important strategy for architects to make reclaimed materials accessible. However, using this centralised database for future urban mining practices will also bring challenges ranging from transparency to data privacy. Although the digitalisation of this information seems promising for the transition of the construction industry to a circular economy, it is important to not forget that the digital cloud is also relentlessly material with ecological impacts of its own.[89]

84. Matthias Heinrich and Werner Lang, Materials Passports-Best Practice: Innovative Solutions for a Transition to a Circular Economy in the Built Environment, (Technische Universität München& BAMB, 2019)

86. Ibid.

87. L. Luscuere, D. Mulhall, Circularity Information Management for Buildings: The Example of Materials Passports, 2017.

88. Matthias Heinrich and Werner Lang, Materials Passports-Best Practice: Innovative Solutions for a Transition to a Circular Economy in the Built Environment, (Technische Universität München& BAMB, 2019)

89. Steven Gonzalez Monserrate, The Staggering Ecological Impacts of Computation and the Cloud, (The MIT Press Reader, 2022.) Available at: https://thereader.mitpress.mit.edu/the-staggering-ecological-impacts-of-computation-and-the-cloud/.

Urban Mining in Built Environment

> ‘’... in the highly developed economies of the future, it is probable that cities will become huge, rich and diverse mines of raw materials. ... The largest, most prosperous cities will be the richest, the most easily worked, and the most inexhaustible mines.” [90]

The term “urban mining” was used for the first time in 1969 by urbanist writer Jane Jacobs, who predicted that future cities would be mines from which precious materials could be obtained, in her book titled The Economy of Cities. [91] With this prediction, she highlighted the resources embedded within existing products, building stocks, and infrastructures, but the discussion also triggered a series of questions related to the finite and destructive character of the traditional mining of geological ores and paved the way to a new perspective on material supplies in the face of potential environmental and economic crises related to possible waste management issues. The critical point of this idea is the claim that cities that can reclaim waste and disposed of or dispossessed materials and convert them into precious usable materials will be cities with advanced economies.

Roughly two decades later, in 1988, the term “urban mines” was used by Japanese professor Randolph Nanjo to discuss the fact that the proportion of metals in products deposited in the anthroposphere exceeded that of natural deposits and materials accumulated on Earth’s surface.[92] Urban mines, as defined by Nanjo, comprise metals that have been separated from raw sources by human agents and brought into urban circulation. However, the scope of urban mine sources has now extended its boundary from metals to everything that has an exchange value.

In 1991, Baccini and Brunner argued that cities in the anthroposphere, which they described as “a complex system of energy, material and information flows,” would eventually collapse due to resource scarcity and environmental issues related to waste production caused by rapid expansion.[93] Therefore, in the current scenario, material resource extinction and proper waste disposal emerge as critical global challenges. In this regard, the concept of urban mining may be of critical importance in dealing with the accumulation of anthropogenic material stocks and waste streams (Figure 10).

Urban mining is also an integral part of the transition to a circular economy, and although there is no consensus on its definition in this context, it generally

90. Jane Jacobs, In The Economy of the Cities, (New York: Random House, 1970.) Vintage Books ed., 119–20

91. Ibid.

92. T. Nakamura, K. Halada, Potential of urban mine. (Berlin: SpringerBriefs in Applied Sciences and Technology, 2015), 7–29. Available at: https://www.researchgate.net/publication/300363889_Potential_of_Urban_Mine

93. Peter Baccini, and Paul H. Brunner, Metabolism of the anthroposphere, (Berlin, Heidelberg: Springer Berlin Heidelberg, 1991.)

94. Raffaello Cossu and Ian D. Williams, Urban mining: Concepts, terminology, challenges, (Waste Management, Volume 45, 2015), 1-3, https://doi.org/10.1016/j.wasman.2015.09.040.

95. Ibid.

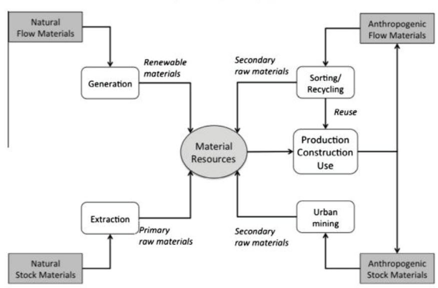


Figure 10: Material resources, origins and generation
Source: Cossu & Williams,2015

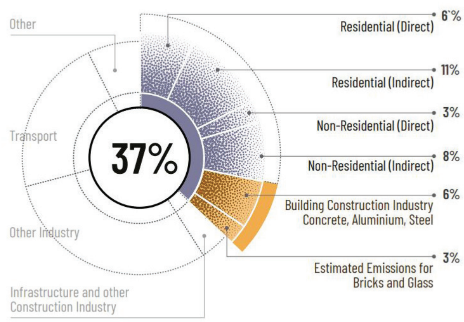


Figure 11: Global Share of the Building and Construction Operational Process CO2 Emissions, 2021 | Source: UNEP 2022

Figure 12: Sequence that references concepts in the recovery, recycling and extraction of resources from waste. Source: Cossu & Williams,2015 (Image reproduced by the author.)

involves the recovery of materials from anthropogenic sources.[94] This process is also referred to by various other names such as "secondary mining," "waste mining," and "refuse mining."[95]

Urban mining may be a significant method for resourcing in construction in terms of both ecological and economic benefits considering the fact that urban areas generate up to 80% of the gross domestic product (GDP) and are responsible for 70% of the global emission of carbon in the form of greenhouse gases.[96] Moreover, buildings and construction activities were responsible for 37% of global carbon emissions in 2021.[97](Figure 11) On a global scale, cities have significant roles in terms of environmental pollution, energy, and material consumption.[98,99] As a tool for the circular economy, urban mining, which approaches the existing building stock as a mine and involves strategies for engaging with design processes and supply networks to re-circulate buildings that have reached the end of their lifecycle, is described in the following sections.

Originating from the need to address resource depletion, waste generation, and environmental concerns in urban areas, urban mining focuses on the recovery of valuable resources from the existing urban infrastructure, existing building stock, and waste streams.[100] In this way, it is considered as a circular economy strategy in the construction industry and a tool for reducing, recovery, and recycling (Figure 12).

From a global perspective, urban mines are divided into two categories as long-term and short-term urban mines. While short-term mines mainly include waste electrical and electronic equipment and waste generated during industrial production processes, long-term urban mines contain industrial, commercial, and residential building stock; infrastructural materials such as those for canals, bridges, and streets; and C&D waste.[101] This thesis focuses on long-term urban mines.

Population growth is directly linked to the consumption of and demand for construction materials. Despite the slowing pace of growth,[102] increasing populations create pressure on resources fuelled by industrial production because of consumption habits and waste management policies.[103] Cities as anthropogenic material stocks become a source of processed and/or residual materials due to the volume of raw materials joining the production and consumption line (Figure 13). In fact, the remaining geographical ores of iron and copper, which are the core materials of the construction industry and infrastructure, are comparable to the volume of materials in use in cities or

96. Mahendra et al., Seven Transformations for More Equitable and Sustainable Cities, World Resources Report Towards a More Equal City, (Washington, DC: World Resources Institute, 2021.) https://doi.org/10.46830/wrirpt.19.00124.

97. "Building Materials and the Climate: Constructing a New Future.", (Nairobi: United Nations Environment Programme, 2023)

98. C. Peter, M. Swilling, Sustainable, Resource Efficient Cities—Making it Happen! (Paris, France: UNEP ,2012.)

99. Seto et al., Human settlements, infrastructure and spatial planning, (Cambridge, UK: Cambridge University Press, 2014.)

100. Faisal Aldebei, and Mihály Dombi, Mining the Built Environment: Telling the Story of Urban Mining, (Buildings 11, no. 9, 2021) https://doi.org/10.3390/buildings11090388.

101. Arora et al., Potential and Relevance of Urban Mining in the Context of Sustainable Cities, (IIMB Management Review 29, no. 3, 2017), 210–24. https://doi.org/10.1016/j.iimb.2017.06.001 buildings11090388.

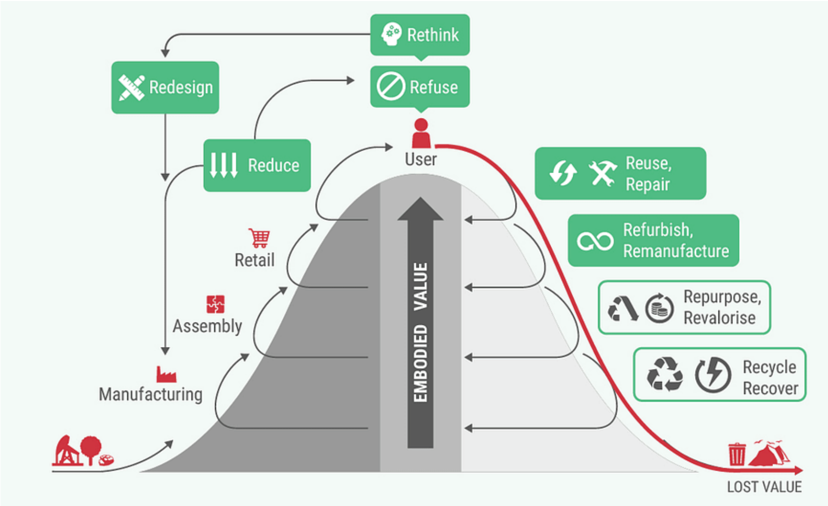


Figure 13: Adapted Circular Value Hill Model Source: Metabolic HQ

hibernated and obsolete.[104]

The search for new resources, fuelled by the anthropocentric depletion of Earth's crust, has even turned towards extraterrestrial regions. In October 2023, the Psyche, as an exploration project of NASA, was launched to investigate the future possibility of the extraction of valuable minerals through asteroid mining.[105] Although this project, aimed at exploring and mining metals such as gold and iron on asteroids as well as considering future possibilities of mining the Moon and Mars and addressing the associated physical and economic constraints, may prove infeasible in the end, it certainly demonstrates the seriousness of resource extinction. Space mining is also being promoted as a solution by some with the aim of moving industrial zones to space to avoid environmental harm and waste pollution caused by industrial activities, using Earth as only a residential area.[106] Although this proposal aims to leave Earth as a habitable space, it is impossible to avoid the negative environmental impacts of the industrial activities required to develop and sustain the necessary technology. These include the enormous economic costs of producing the equipment, the carbon emissions from launching vessels into orbit, and the environmental and socio-economic consequences of introducing new flows into Earth's closed metabolic systems. In this sense, space mining is a perfect example of the tendency to continue consuming more resources instead of closing the loop and using existing materials. Similarly to the intentions behind space mining, it is important to be aware of the agendas behind circular economy strategies and urban mining.

Leaving aside space mining and the new socio-economic and ecological

102. "World Population Prospects: The 2022 Revision." (United Nations, Department of Economic and Social Affairs,2022.)

103. Park et al., A Review of Urban Mining in the Past, Present and Future, (Recycling Waste Manag 2, 2017.), 127. doi:10.4172/2475-7675.1000127.

104. Johansson et al., An Integrated Review of Concepts and Initiatives for Mining the Technosphere: Towards a New Taxonomy.,(Journal of Cleaner Production 55,2013), 35-44. https://doi.org/10.1016/j.jclepro.2012.04.007.

105. "Space Mining Is Getting Closer to Becoming a Reality, and Canada Could Play a Major Role (CBC News." CBCnews, 2023.) Available at: https://www.cbc.ca/news/science/space-mining-1.7012869.

106. Alex Gilbert, Mining in Space Is Coming, (Milken Institute Review, Accessed May 19, 2024.) Available at: https://www.milkenreview.org/articles/mining-in-space-is-coming.

107. Elif Kendir-Beraha, "Mimarlıkta Ölümden Sonra Yaşam Var Mı?" (XXI, 2017), Available at: https://xxi.com.tr/i/mimarlikta-olumden-sonra-yasam-var-mi.

108. Wei-Qiang Chen and Xianlai Zeng, Urban Mining of Metals and Minerals for a Circular Economy and the Sustainable Development Goals, (Routledge Handbook of the Extractive Industries and Sustainable Development, 2022), 282–96. https://doi.org/10.4324/978100300131717.

dilemmas it will bring, the idea of urban mining and circular economy strategies in the construction industry could be a significant and highly feasible starting point for the utilisation of cities as accessible and adaptable resources in the not-too-distant future. The construction sector accounts for about 30% of solid waste generation, and adapting it to a circular model based on reduce-reuse-recycle principles with urban mining can provide a strong conceptual basis for building economically resilient and liveable cities that are also sensitive to ecological realities in the future.

Moving away from viewing the built environment solely as an urban mine or a repository of materials for future production, the characteristics of living, ageing, maintained, and dying buildings also reflect questions of reusability.[107] The fact that buildings have lifecycles just like humans and other living things makes it possible to reuse C&D waste after the natural lifespan of a building has ended. The attribution of these human characteristics to buildings is inherent in urban mining. The Netherlands-based Superuse Studios, for example, identify buildings from which materials will be harvested as "donors." Building materials that are reused in this approach can be metaphorically compared to organ donation.

Some studies show that the concept of urban mining plays a key role in the circular economy strategies of both developed countries and developing countries, as it contributes to the economy by increasing job opportunities and promoting resource efficiency, environmental protection, waste reduction, and social inclusion while advancing the 17 Sustainable Development

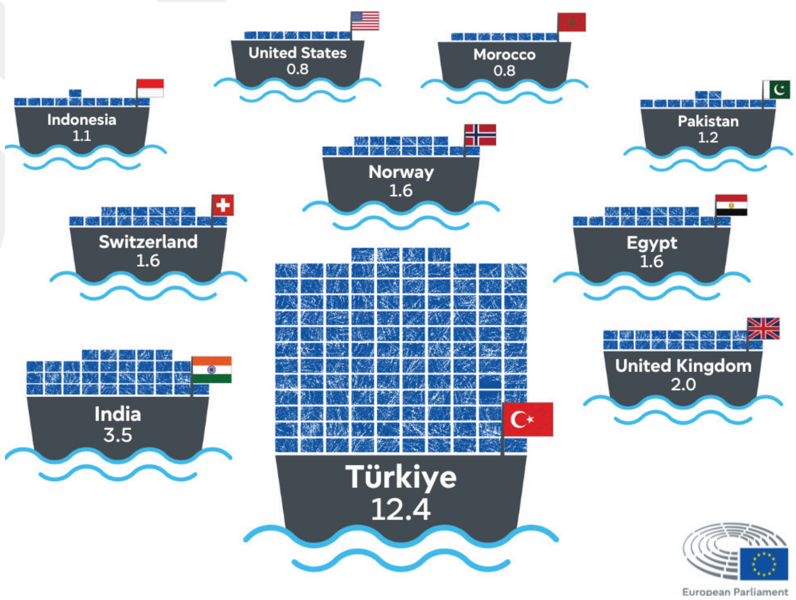


Figure 14: EU Countries Solid Waste Exports to non-EU Countries,2022 Source: Eurostat

Goals prepared by the United Nations in 2015 to achieve global sustainable development by 2030.[108]

However, comparing the volumes of waste trade and recycling rates of developed and developing countries does not fully capture the picture. For example, in 2022, EU countries exported 17.8 million tonnes of iron and steel to non-EU countries such as Türkiye[109] (Figure 14) On the other hand, despite recycling rates seeming far higher, the rate of circular material use, which measures the use of secondary sources, was only 23.9% in 2022 in the EU for metals.[110] Thus, gaps between the results of these calculations raise questions about the recycling rates of countries that promote circular strategies.

Despite the 2015 updating of the EU's Waste Framework Directive to increase the responsibility of waste-exporting countries to control the recycling of waste in importing countries in an environmentally sound manner,[111] the carbon emissions of metal recycling industries are high and 55% of the waste exported from EU countries to non-EU countries is iron and steel.[112] It can accordingly be said that, together with the waste itself, the carbon footprints emitted by the recycling of metals are also traded. Consequently, the principles of reduction and reuse should be prioritised over recycling in the implementation of urban mining. This will help to avoid global resource extraction and prevent the further expansion of the waste trade while aiming to reduce waste accumulation. In these cases, urban mining includes reducing the use of raw resources and reusing anthropogenic stocks to be mined near local sources, which can make a critical difference.

Mining of the built environment begins from the urban scale with the assessment of material flows and stocks to identify valuable resources that can be reclaimed from existing buildings and infrastructure in the city. Moreover, it can also produce global consumption on a regional scale (Figure 15). Mapping the material flows of a city with material flow analysis (MFA) can provide insights about how building materials are used, reused, and disposed of, allowing the identification of strategies for urban mining.[113] With the data provided by MFA, urban mining on the building scale can be supported with design strategies such as design for disassembly, and MFA can help identify possible reclamation sources during the design process.[114] The related challenges and benefits will be discussed considering various examples in the following chapters on both urban scale and building scale.

109. Cengiz Bölükbaş, "Avrupa'nın Çöp Kutusu: Türkiye." Aposto, 2024. Available at: https://aposto.com/s/avrupanin-cop-kutusu-turkiye

110. "Circular Material Use Rate in Europe." European Environment Agency. Available at: https://www.eea.europa.eu/en/analysis/indicators/circular-material-use-rate-in-europe?activeAccordion=546a7c35-9188-4d23-94ee-005d97c26f2b.

111. Wei-Qiang Chen and Xianlai Zeng, Urban Mining of Metals and Minerals for a Circular Economy and the Sustainable Development Goals, (Routledge Handbook of the Extractive Industries and Sustainable Development, 2022), 282–96. https://doi.org/10.4324/978100300131717.

112 "Sustainable Waste Management: What the EU Is Doing: Topics: European Parliament." (European Parliament, Accessed May 19, 2024.) Available at: https://www.europarl.europa.eu/topics/en/article/20180328STO00751/sustainable-waste-management-what-the-eu-is-doing

113 Faisal Aldebei, and Mihály Dombi, Mining the Built Environment: Telling the Story of Urban Mining, (Buildings 11, no. 9, 2021) https://doi.org/10.3390/buildings11090388.

114 Matthias Heinrich and Werner Lang, Materials Passports-Best Practice: Innovative Solutions for a Transition to a Circular Economy in the Built Environment, (Technische Universität München& BAMB, 2019)

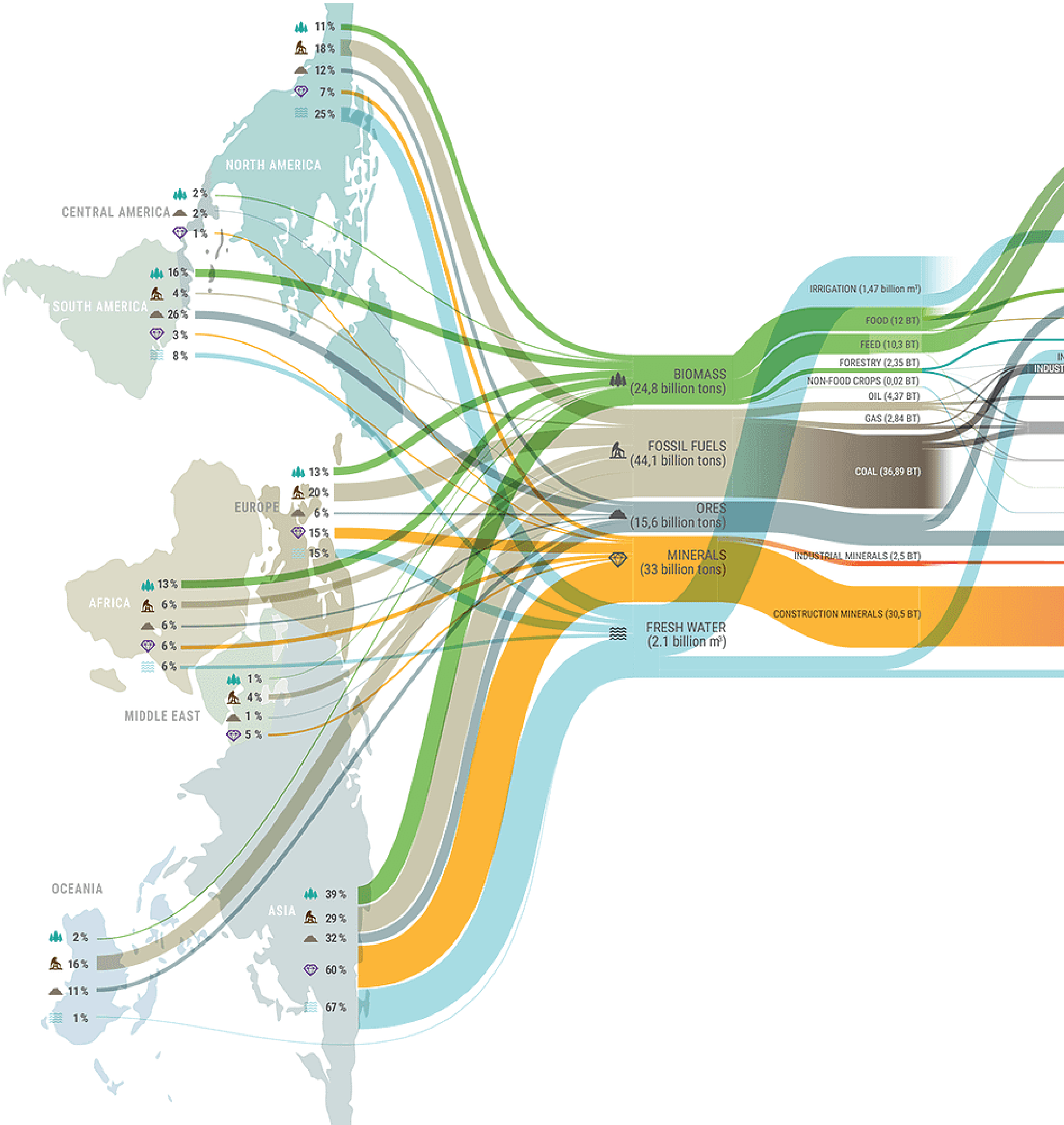
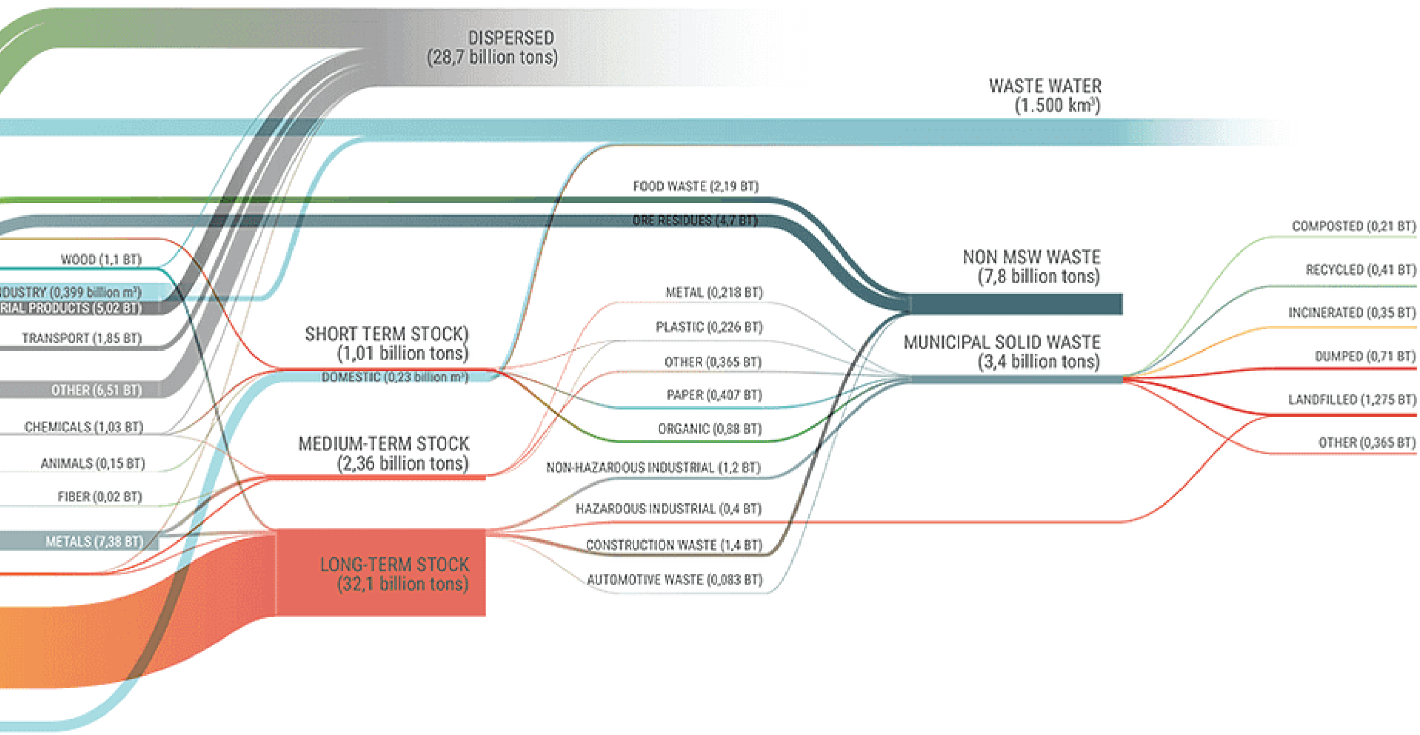


Figure 15: MFA of global consumption of the resources by regions, 2012. Source: Metabolic HQ



LEGEND:

- Biomass (food, feed, forestry, and other)
- Fossil fuels (coal, gas, oil, and other)
- Ores
- Minerals (industrial and construction)
- Fresh water

TRACING THE C&D WASTE AND URBAN MINING POTENTIALSIN ISTANBUL 02

In the making of Yoo, Bence Güzel Pavilion, we encountered many challenges during the process of designing and building a small-scale project with scrap materials in Istanbul. Some of these hardships required the fundamental overhauling of the design process, which took considerable effort and time. Imagining the future of the urban mining of scrap building materials was even harder since the vast majority of the buildings in Istanbul were built or are being built with reinforced concrete. Furthermore, I was prompted to think about the circumstances in which mining materials from the built environment might become a “new normal” for architects and other stakeholders of the construction industry.

As the first step of a practical assessment, this chapter investigates the urban mining potentials of Istanbul by tracing the city’s wasted potentials. Wasted potentials come with specific constraints, especially in a metropolis like Istanbul. The nature of excavation, construction, and demolition wastes and the ways to manage these wastes are more closely linked to the economic, social, and political climate in Istanbul compared to other cities in Türkiye because of Istanbul’s population density, capital flows, and industrial production capacity. For these reasons, Istanbul and its industrial hinterlands have made particularly significant contributions to the economic development of the country. Job opportunities emerge from the intense capital flow in Istanbul, while ecological disasters also arise from time to time in direct proportion to the size of the population due to issues of waste.

The increasing size of the population has also triggered a housing shortage over the years, and the demand for housing has affected the construction industry. The city has become an enormous unfinished construction site. To understand the wasted potential and to stop wasting it, it is necessary to understand the local and global forces that shape the built environment of Istanbul. This chapter, provides a discussion of the local potentials and constraints for the urban mining of building materials within the framework of the personal experience of Yoo, Bence Güzel Pavilion.

115. TÜİK, "İl Bazında Gayrisafi Yurt İçi Hasıla, 2022." Available at: https://data.tuik.gov.tr/Bulten/Index?p=Il-Bazinda-Gayrisafi-Yurt-Ici-Hasila-2022-45867#

116. Cevat Geray, "Gecekondu Sorununa Toplu Bir Bakış" (1968)

117. Gökçe et al., Gecekondularda ailelerarası geleneksel dayanışmanın çağdaş organizasyonlara dönüşümü, (Ankara: TC Başbakanlık Kadın ve Sosyal Hizmetler Müsteşarlığı Yayınları, 1993)

A brief overview to Istanbul, Türkiye

Istanbul is the city with the highest share of Türkiye's economy as reflected by a GDP ratio of 30.4%.[115] In line with this share in the national economy due to its industrial production and large labour force resulting from the city's high population (Figure 16), it is also a city with high waste production. The urban renewal demolitions that have been ongoing for almost three decades have also had a significant contribution to the generation of C&D waste in Istanbul.

While discussing Istanbul's C&D waste, it is necessary to understand the urban renewal processes and events that have led to the current situation. With the industrialisation of agriculture in the 1950s, migration from rural areas accelerated and population growth and housing demand in Istanbul increased accordingly. With migration from rural areas, informal squatter settlements began appearing in the city. In the 1980s, urban renewal actions established by neoliberal policies caused the gentrification of these informal settlements known in Turkish as gecekondu. Due to the squatters' connections to rural life and traditions, discussions arose regarding whether these settlements and lifestyles were urban or rural. For example, in 1968, Geray stated that the squatter settlements constituted a transitional phase from rural society to urban society and exhibited a heterogeneous, cosmopolitan, and dynamic social structure.[116] In 1993, Gökçe et al. argued that urban squatter populations are gaining an urban identity through economic integration, participation in urban production, and changing consumption patterns.[117] That study identified two main types of problems facing squatter families: economic problems and a lack of proportional development in the context of urbanisation despite modernisation. Gökçe et al. emphasised the need to maintain traditional solidarity ties while facilitating the transition to modern organisational patterns, and they advocated for increased efforts to create equitable and participatory structures in this process. For these reasons, marginalised populations and their relations within their communities may set a precedent for networks of urban mining in Istanbul.

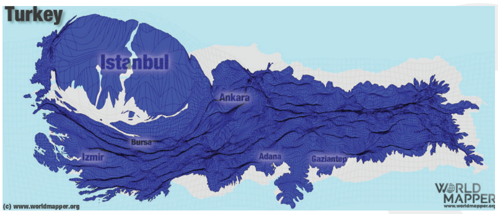


Figure 16: Gridded Population Cartogram of Türkiye Source: worldmapper.org

Figure 17: 1999 Marmara Earthquake Source: Politeknik

In the 2000s, urban renewal actions around the country were fuelled by concerns about earthquake resilience. As repeatedly shown by the consecutive earthquakes Türkiye has experienced, such as the 1999 Marmara earthquake, the 2011 Van earthquake, the 2020 Izmir earthquake, and finally the earthquakes of 6 February 2023 in Kahramanmaraş, seriously affecting a total of 11 provinces (Figures 17 and 18), efforts to improve the quality of the building stock are still critically important.

After the earthquakes that happened in South-East Türkiye in 2023, reaching a magnitude of 7.4, the earthquake report published by the Union of Turkish Engineers and Architects (TMMOB) Chamber of Architects highlighted the vast amount of damage to be expected based on a ground study and the low quality of building stock, which had already been determined in a study conducted in 2020. [118]

Despite warnings made to local governments about preparing building stocks for a major earthquake, the necessary actions to avoid significant damage were not prioritised and a massive loss of life occurred as a result of damage to buildings in the earthquakes in February 2023. [119] As a result of this negligence, tens of thousands of people lost their lives in these earthquakes and millions were left homeless.

The fact that more than half of the residential buildings in the provinces affected by these earthquakes were built in 2001 or later,[120] and thus obligated to comply with building regulations that emerged after the 1999 Marmara earthquake, points directly to shortcomings of the inspection process in the construction industry in Türkiye. Considering that another Istanbul earthquake has long been expected, there is much to discuss and much to do regarding both the strengthening of the existing building stock and the demolition waste that will be generated in that process. Looking at the relevant history would be a helpful starting point for such a discussion.

After the 1999 Marmara earthquake, urban renewal activities gained great momentum in Türkiye.[121] The great loss of life and property as a result of that earthquake fuelled discussions about the vulnerability of buildings to earthquakes and the necessity of appropriate urban renewal. Following that earthquake, the Turkish government, in partnership with the World Bank, launched the Marmara Earthquake Emergency Recovery Project (MEER) in 1999.[122] This project was intended to upgrade legal frameworks and work with the construction sector and local communities to create world-class infrastructures and master plans in response to the disaster.

Following that, the Law on the Transformation of Areas under Disaster Risk was adopted on 16 May 2012, which facilitated the renewal of buildings facing disaster risks and the implementation of urban renewal projects.[123] Buildings at risk of collapsing in an earthquake were demolished; new and safe building stocks were renovated and old buildings that had

118. Emine Merdim, "TMMOB Mimarlar Odası Kahramanmaraş Şubesi Deprem Raporu Yayınlandı.", Arkitera, March 10, 2023 Available at: https://www.arkitera.com/haber/tmmob-mimarlar-odasi-kahramanmaras-subesi-deprem-raporu-yayinlandi/

119. Ibid.

120. Euronews, "Deprem: Halkın Yüzde 51'i 2001 Sonrasında Yapılan Binalarda Oturuyordu.", Accessed November 9, 2023 Available at: https://tr.euronews.com/2023/02/10/deprem-bolgesinde-halkin-yuzde-51i-2001-sonrasinda-yapilan-binalarda-oturuyordu.

121. Taner Kılıç and Seçkin Hardal, "İstanbul'daki Kentsel Dönüşüm Projelerinin Genel Bir Eleştirisi", Journal of International Social Research 12, no. 62 (February 28, 2019): 347–55. https://doi.org/10.17719/jisr.2019.3058.

122. World Bank, "Project Information Document, Turkey Marmara Earthquake Emergency Reconstruction, MEER Project" (Washington,1999)

123. Kılıç and Hardal, "İstanbul'daki Kentsel Dönüşüm Projelerinin Genel Bir Eleştirisi", 347–55.

Figure 18: Debris removal, Antakya, Hatay (2023) Source: Antakya Gazetesi

124. Oytun Boran Sezgin, “İnşaat Sektöründeki Projelerde Kalite Performansını Belirleyen Başarı Faktörleri:İzmir Ili Örneği,” 2011.

125. İ. C Bayrak and O.M. Telatar, “İnşaat sektörü ve ekonomik büyüme ilişkisi: Türkiye ekonomisi üzerine ampirik bir analiz”, (Gümüşhane Üniversitesi Sosyal Bilimler Enstitüsü Elektronik Dergisi, 12(3),2021): 1283-1297

126. Ensar Yılmaz, “İnşaatın politik ekonomisi: İnşaat sadece inşaat değildir” [The political economy of construction: Construction is never just construction], Gazete Duvar, 7 December 2020, Available at: gazeteduvar.com.tr/insaatin-politik-ekonomisi-insaat-sadece-insaat-degildir-haber-1506458.

127. T24, “Barınamıyoruz Hareketi, Bakanlık önünde: 10 öğrenciden dokuzu yurda yerleşemiyor, bizi görmezseniz sokaklara, çadırlarla geri döneceğiz“, November, 2024. Available at: https://t24.com.tr/haber/barinamiyoruz-hareketi-bakanlik-onunde-10-ogrenciden-dokuzu-yurda-yerlesemiyor-bizi-gormezseniz-sokaklara-cadirlarla-geri-donecegiz,1133855

128. Kadriye Elif Maçin and İbrahim Demir, “Kentsel Dönüşüm Sürecinde İstanbul’da İnşaat ve Yıkıntı (İ&Y) Atıkları Yönetimi”,İTÜ, 2017.

129. Hülya Coşkun,“Istanbul: The Ecology, Nature and Disasters Designing Future Cities with Innovative Housing Projects.”, (Urban and Transit Planning, 2023): 93–110. https://doi.org/10.1007/978-3-031-20995-6_9.

130. Yeşil Gazete, “Hatay’Daki Milleyha Sulak Alanı’nda Dev Moloz Dağlarının Arasında Vadiler Oluştu”, March 18, 2024. Available at: https://yesilgazete.org/hataydaki-milleyha-sulak-alaninda-dev-moloz-daglarinin-arasinda-vadiler-olustu/

Figure 19: Students from “Barınamıyoruz Hareketi”, Source: T24
(Banners left to right: “We cannot get shelter”, 9/10 of the students cannot accommodate on dormitories.”, “No space in dormitories, renting a house become a dream.”)

Figure 20: Mileyha Wetland after earthquake,2023
Source: haberet.com

completed their economic lifespans were replaced.

Since the early 2000s, construction-based economic strategies have been adopted to increase the growth of the Turkish economy. Consideration of the multi-stakeholder nature of the construction industry that feeds the material and labour needs of up to 150 sub-sectors, such as the cement, ceramics, wood, steel, timber, and glass industries,[124] emerged as a tool for economic growth and architectural production.

The construction industry of Türkiye, whose share in the gross national product (GNP) gained momentum steadily until 2017, facilitated an increase in the investments made in the construction industry as it was one of the leading industries for economic development in the period in question. However, with the regression of the construction industry’s share of GNP to 5.5% in 2020, following the 2018 global economic crises, the construction industry’s contributions to the growth of the Turkish economy began being questioned.[125] Furthermore, the tendency to pursue building production to increase economic growth has led to related problems such as the increasing prevalence of low-quality building stock, high rents, and ultimately the housing crisis, while it has made an inefficient contribution to economic growth in the long term.[126] As a result of the ongoing housing problems in Istanbul, in 2021, students who could not afford accommodation expenses due to the lack of capacity in dormitories and the excessive increase in housing rents took action by starting the “Barınamıyoruz Hareketi,” or “We cannot get shelter” Movement.[127] (Figure 19)

In 2004, standards and regulations on waste management were developed as part of the alignment process between Türkiye and the European Union.[128] This process contributed to the current organisational scheme and regulatory basis of C&D waste management in Türkiye. The logistics of C&D waste were still the primary responsibility of contractors, answerable to the local municipality. However, these wastes were simultaneously becoming a major design problem for architects in Istanbul within the setting of a global tendency towards a transition to a circular economy. After the Turkish government signed the Paris Climate Agreement in 2021, climate change was officially recognised by Türkiye. This official recognition sparked debates on sustainability, social housing, financing, and urban growth.[129]

Istanbul, which provides its residents water from the northern forests of the province, is under pressure from climate change as well as deforestation caused by both construction and mining activities. While Istanbul struggles with deforestation and water scarcity, the Turkish government has initiated plans within the framework of the Paris Climate Agreement to tackle climate change and aims to see Istanbul become a carbon-neutral and climate-resilient city by 2053.

However, in the context of Türkiye, which has problems with both its building stock and C&D waste management, transforming the built environment to be carbon-neutral and resilient by 2053 seems to be wishful thinking. Existing examples such as the dumping of building rubble into the Mileyha Wetland, which hosts important bird species, supports this conclusion.[130] ((Figure 20 and Figure 21). A similar situation is occurring on the Samandağ coastline of Hatay, one of the provinces most severely affected by the Kahramanmaraş-centred earthquakes of 6 February 2023.

The major Istanbul earthquake that is expected to be generated at any time by the Northern Anatolian Fault Line will have a similarly enormous effect on Istanbul and its surroundings.[131] According to reports prepared by local authorities in 2021, if this expected earthquake occurs in Istanbul, there will be approximately 25 million tonnes of demolition debris. More than half of that debris would consist of reinforced concrete and the remaining part would comprise brick, timber, and other relatively light materials. Since vehicles would be needed to carry such a weight in a city damaged by an earthquake, it would take three years to remove the predicted building debris with the current equipment.[132]

Another report prepared after the 6 February earthquakes in 2023 stated that among over 1.5 million buildings investigated, approximately 300,000 buildings would not be expected to collapse in the event of a 7.5 magnitude earthquake.[133] This means that roughly 75% of the considered buildings would collapse and become rubble. The distorted image produced on a 3D base map published by BİMTAŞ resembles such a situation after an earthquake (Figure 22). In such a scenario, the planning and implementation of construction waste management is critically important for accelerating the return to normality of the city and its residents.

Indeed, the February earthquakes prompted studies that may constitute important resources both before and after the expected Istanbul earthquake. One of the resources published in March 2023 by the United Nations in collaboration with various stakeholders including the Turkish government and relevant agencies such as the Disaster and Emergency Management Authority of Türkiye (AFAD)[134] outlined several lessons learned from the

Figure 21: Mileyha Wetland, 2023 Source: Emin Yoğurtçuoğlu (image taken from yesilgazete.com)

Figure 22: Galata Tower and Karaköy, Credit: Erdal İnci, BIMTAS

131. Sözcü Gazetesi, "Naci Görür'Den İstanbul Depremi Uyarısı- Sözcü Gazetesi." Sözcü. Accessed May 7, 2024. Available at: https://www.sozcu.com.tr/naci-gorur-den-istanbul-uyarisi-cok-buyuk-bir-afetle-karsilasabilir-p39794

132. İstanbul Büyükşehir Belediyesi Deprem Risk Yönetimi ve Kentsel İyileştirme Daire Başkanlığı Deprem ve Zemin İnceleme Müdürlüğü, "Olası Yıkıcı Bir İstanbul Depreminde Oluşabilecek Enkaza Dair Yönetim Planı", Accessed May 2024.

133. Mehmet Kılıç Baran, "İlçe Ilçe İBB Deprem Raporundan Öne Çıkanlar", Diken, 2023. Available at: https://www.diken.com.tr/ilce-ilce-ibb-deprem-raporundan-one-cikanlar/

134. United Nations and T.C. Strateji ve Bütçe Başkanlığı "2023 Kahramanmaraş and Hatay Earthquakes Report" March 2023. Available at: https://www.sbb.gov.tr/wp-content/uploads/2023/03/2023-Kahramanmaras-and-Hatay-Earthquakes-Report.pdf destruction in Kahramanmaraş and Hatay that could be relevant for future disaster preparedness and responses such as improving data collection and coordination, building resilience to prioritise seismic safety standards, performing comprehensive risk assessments to help identify vulnerabilities to be addressed, strengthening policy and legislative frameworks, investing in disaster-resilient infrastructures, and, last but not least, ensuring sustainable recovery practices while recycling the debris.[135] In August 2024, the United Nations Development Programme (UNDP) and the Turkish government constructed model facilities to process and recycle demolition debris with funds provided by the Japanese government.[136] Additionally, together with the European Union, UN, UNDP, and World Bank, the Turkish government prepared a recovery project called TERRA, or Türkiye Earthquakes Recovery and Reconstruction Assessment, to support earthquake recovery actions that require funding. Necessary funds were calculated as USD 66 billion for the reconstruction of buildings with total damage and losses in the housing industry, including debris removal and cleaning costs.[137] Besides outlining the financial costs of recovery and reconstruction after an earthquake, the report also suggests a range of changes in construction standards and policies across the country.[138]

More recently, in June 2024, a new report was published by the Natural Building Materials Association (Turkish: Doğal Yapı Malzemeleri Derneği) and World Wildlife Fund (WWF) Türkiye on the earthquake-affected building stock of Gaziantep. This report noted that the use of natural building materials can contribute to the creation of disaster-resilient buildings as part of a building biology approach that addresses the integrative relationships between buildings, humans, and the environment, viewing buildings as living organisms.[139] The report included design considerations for the improvement of buildings of 2 or 3 storeys in rural areas with examples from countries such as India (Figure 23 and Figure 24). Although these examples cannot be identically replicated for a city on the scale of Istanbul, they offer significant clues to what can be done in post-disaster processes.

Taken together, these studies conducted on various scales from building to regional scales reflect the importance of communication networks and the involvement of stakeholders in responding to disasters in Istanbul and Türkiye

Figure 23: Compartment S4, earthquake and landslide resistant BASA Tourism Center in Khirsu, Uttarakhand, India Source: stirworld.com

135. Ibid.

136. EU, UN, UNDP, The World Bank, T.C. Strateji ve Bütçe Başkanlığı, "Türkiye Recovery and Reconstruction Assessment", Available at: https://www.sbb.gov.tr/wp-content/uploads/2023/03/Turkiye-Recovery-and-Reconstruction-Assessment.pdf

137. UNDP, "UNDP Builds Two Model Facilities to Process and Recycle Earthquake Debris in Türkiye.", Available at: https://www.undp.org/turkiye/press-releases/undp-builds-two-model-facilities-process-and-recycle-earthquake-debris-turkiye.

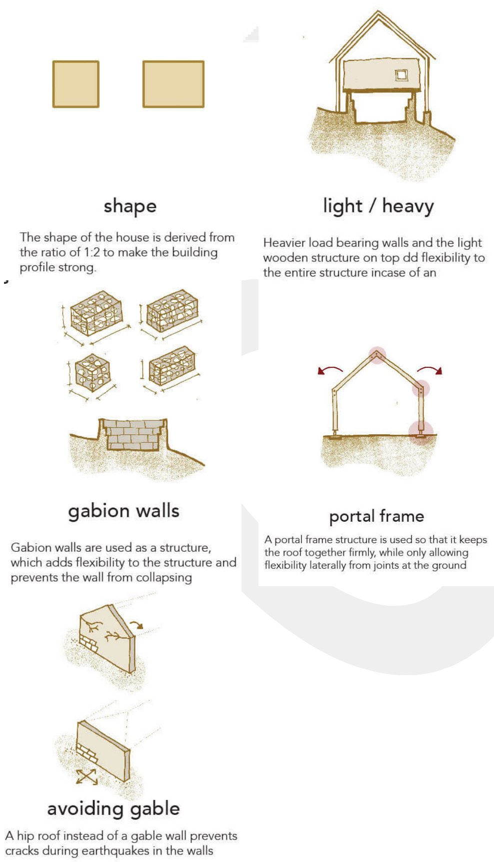


Figure 24: Design considerations of Compartment S4 in India, Image Credit: Pritam Negi, stirworld.com

Construction and Demolition Waste in Istanbul

In 2004, just before the beginning of EU-Türkiye negotiations in 2005, a regulation on the control of excavation, construction, and demolition waste was published. Before this specific regulation on excavation, construction, and demolition waste management, these wastes were managed within the legal framework of the regulation on control of solid waste published in 1991.[140]

With this new regulation, non-hazardous excavation soil and C&D wastes were to be managed with the following methods: primarily reduction at the source, with collection of reusable components or selective demolition (Turkish: *seçici yıkım*), temporary accumulation, transportation, and the regulation of technical and administrative issues, as well as compliance with general rules of recovery, utilisation, and disposal[141] (Figure 25) Selective demolition via deconstruction requires more labour power than other demolition types.

Demolition activities also generate dust and air pollution that can harm living beings and impact biodiversity. In some cases, like major construction sites, they increase the release of PM10 dust particles that cause airborne diseases, and the logistics of construction sites play a major role in the release of harmful particles.[142] Although there are rules in place for construction sites to eliminate these risks, these dust particles still pose a serious threat to nearby communities. In particular, the chemically toxic building material asbestos can be extremely dangerous as an air pollutant in cases of demolitions triggered by natural disasters in developing countries such as Türkiye.

Examples of "planned demolitions" illustrate the dysfunction of these regulations in daily life, particularly regarding asbestos disposal. In 2014, municipalities in various regions of Türkiye demolished asbestos-containing water pipes without taking proper precautions. Similarly, in Istanbul in 2018, asbestos was left in the rubble of buildings demolished as part of an urban transformation in Üsküdar's Kirazlıtepe neighbourhood for days, posing health risks. Furthermore, workers exposed to asbestos in construction sites in Istanbul have experienced health problems, further highlighting the regulatory gaps[143] (Figure 26).

In a study published in 2018, it was estimated that 55-65 tonnes of demolition waste in Istanbul would be generated from urban renewal if 75% of the buildings in the areas designated as risk areas were demolished in the

138. UNDP, "UNDP Builds Two Model Facilities to Process and Recycle Earthquake Debris in Türkiye.", Available at: https://www.undp.org/turkiye/press-releases/undp-builds-two-model-facilities-process-and-recycle-earthquake-debris-turkiye.

139. WWF Türkiye and DYMD," Afetlere Dirençli Kentler için Doğal Yapı Malzemeleri ve Yöntemleri", 2024. Available at: https://www.wwf.org.tr/?14720/Afetlere-DirencliKentlericinDogalYapiMalzemeleriveYuntemleri

Figure 25: Selective Demolition in motion in İstanbul. Photo: Onur Ceritoğlu

Figure 26: Üsküdar Kirazlıtepe Neighborhood, 2019 Source: flashahaber.com.tr

140. Savaş Bayram, Mehmet Emin Öcal and Emel Oral, "Legislation Of Construction Waste Concept And A Case Study At A Ready Mixed Concrete Plant" Engineering Sciences 7 (2012): 106-118.

141. Maçin and Demir, "Kentsel Dönüşüm Sürecinde İstanbul'da İnşaat ve Yıkıntı (İ&Y) Atıkları Yönetimi"

142. Holman et al. "AssesIAQM Guidance on the Assessment of Dust from Demolition and Contstruction, Institute of Air Quality Management." IES, 2014.

143. Aslı Odman, "Asbest Tehlike Haritası: 'Ortalık Toz Duman.'" Medium, November 27, 2019. Available at: https://medium.com/beyond-istanbul/asbest-tehlike-haritas%C4%B1-ortal%C4%B1k-toz-duman-d1fc2af8bb13#_ftn8

144. Maçin and Demir, "Kentsel Dönüşüm Sürecinde İstanbul'da İnşaat ve Yıkıntı (İ&Y) Atıkları Yönetimi"

145. Ibid.

Figure 27: Land Reclaimation process of İstanbul Airport Source: AA

next 25 years.[144] Together with excavation soil, this number would reach 659 million tonnes,[145] constituting enough excavation and demolition waste to fill 13 times the total volume of the 58 landfill areas overseen by İSTAÇ, the Istanbul Metropolitan Municipality's sanitation contractor, on both the Asian and European sides of Istanbul in 2019-2022.[146] Based on this information, in a 25-year period, new landfills should be constructed every 2 years on average to store only the excavation and demolition waste to be generated from urban transformation. Considering that these wastes constitute nearly half of the solid waste generated by the city, increasing the waste storage capacity in the upcoming period will be unavoidable, even with increased incineration and recycling rates. This capacity will require exceptionally large areas. For example, the C&D waste generated by the construction of the Istanbul Airport metro line was dumped in the province's northern forests illegally in 2021 while the site for the Istanbul Airport was reclaimed[147] (Figure 27). The northern forests, which are the source of the city's water and an important coastline, are under threat.

According to data released by İSTAÇ, 5 million tonnes of C&D waste are generated in Istanbul every month.[148] Although the precise ratios of this sum in terms of excavation waste, demolition waste, and construction waste are not specified, it can be calculated that the total amount of excavation and urban transformation demolition waste predicted to be generated in the 25-year period mentioned above will be reached in just 10 years. While this difference may be due to differences in data sources used by İSTAÇ and the Istanbul Metropolitan Municipality, it is shocking that the prospective timeline varies by more than 100%. When İSTAÇ's data are taken into consideration, the future prospects are highly distressing.

Figure 28: Before and after of the Maltepe Land Reclamation, Source: beyondistanbul

146. IBB Çevre Koruma ve Kontrol Dairesi Başkanlığı, "Hafriyat Toprağı, İnşaat ve Yıkıntı Atıklarının Denetimi", April 27, 2023. Available at: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://cevre.ibb.istanbul/wp-content/uploads/2023/04/AVRUPA-YAKASI-IZINLI-DEPOLAMA-ALANLARI.pdf.

147. Durum Gazetesi, "Kuzey Ormanları'nda Doğa Katliamı.", Accessed August 29, 2024. https://www.durumgazetesi.com.tr/kuzey-ormanlarinda-doga-katliami

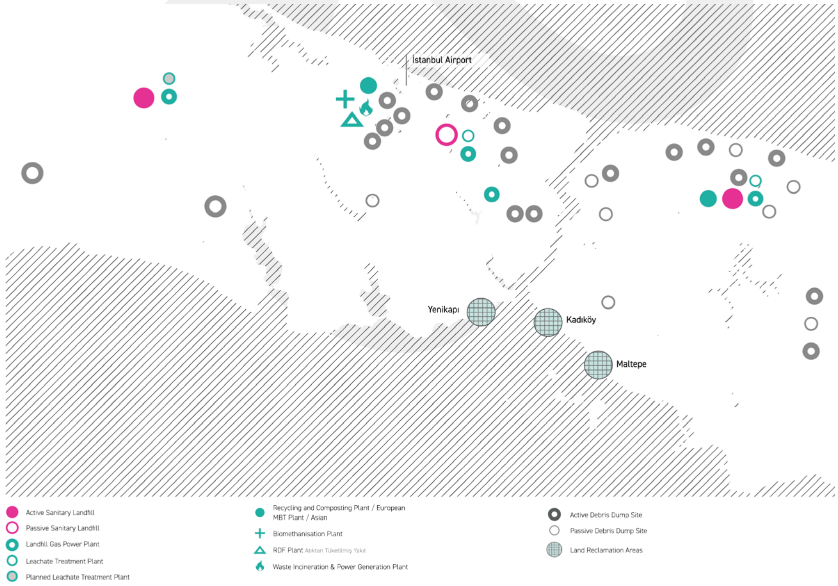
148. İSTAÇ, "Hafriyat-İnşaat ve Yıkıntı Atıkları: İstaç.", Accessed August 2, 2024. Available at: http://istac.ssplab.com/tr/temiz-istanbul/hizmetlerimiz/hafriyat-insaat-ve-yikinti-atiklari

İSTAÇ's 2023 annual report stated that in 2023, a total of 23.5 million tonnes of excavation waste was disposed of within excavation storage areas, recycling facilities, and reclamation projects. It was further stated that 56,500 trees were planted while rehabilitating areas such as old mines with excavation soil.[149]

Although it seems reasonable to use a "waste" like excavation soil, which becomes waste due to its relocation, for rehabilitation purposes, it should be taken into consideration that this approach could also be instrumentalised to promote more mining activities that negatively affect the ecosystem, watersheds, and wildlife, especially in the northern forests of Istanbul.

In addition to the rehabilitation of old mines, metabolic flows of excavation waste are transforming the coastlines of Istanbul with mega-scale land reclamations (Figure 28). Since every square metre in Istanbul, a crowded metropolis, is quite valuable, stored excavation waste becomes a commodity with exchange value. A large amount of contractors' excavation waste was exchanged for a significant fee established by İSTAÇ per cubic metre for disposal. [150]

The capital flows generated by excavation wastes can be understood as arising from gaps in the regulations for managing excavation, construction, and demolition waste. Specifically, the formal regulation on the control of



149. İSTAÇ, "İSTAÇ 2023 Faaliyet Raporu", Accessed August 2, 2024. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.istac.istanbul/assets/belgeler_ve_raporlar/istac-2023-yili-faaliyet-raporu---web-.pdf

150. İSTAÇ, "İSTAÇ 2023 Faaliyet Raporu", Accessed August 2, 2024. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.istac.istanbul/assets/belgeler_ve_raporlar/istac-2023-yili-faaliyet-raporu---web-.pdf

151. Republic of Türkiye, Ministry of Environment and Forestry, "Hafriyat Toprağı, İnşaat Ve Yıkıntı Atıklarının Kontrolü Yönetmeliği." Official Newspaper no. 25406. Accessed August 2, 2024.

Figure 29: Plants and Dump Sites in Istanbul, Image Credit: AAP MEF, 2022

excavation soil and C&D waste determines the responsibilities of waste generators and logistics operators in disposal, on-site sorting, and recovery processes.[151] Within the scope of this regulation, there are costs that companies are obliged to pay for the disposal of waste per volume. Although the stated financial obligation is a constraint aiming to limit the amount of waste generated, the existing regulatory gap leads to the transformation of this situation into a source of profit. Primary examples are the Yenikapı and Maltepe reclamation areas in Istanbul.

In response to profit-driven construction activities, the managing of excavation waste has been incorporated within land reclamation projects in Istanbul. According to a TBMM Q&A report about the bid processes for the Maltepe Coastal Land Reclamation construction project that started in 2012, the main flow of soil used for the sea embankment was provided from Istanbul Finance Center excavation debris[152] (Figure 28). Based on calculations made by Küçükakça and Akkaya in 2014, it was stated that the excavation waste from the Istanbul International Finance Center was brought to the Maltepe land reclamation area instead of the closest landfill and reflected as income for İSTAÇ in addition to the profits of the contractor companies.[153](Figure 29)

At the same time, the implementation of this project was achieved with top-down decisions and without an environmental impact assessment. Therefore, it became crucial to justify the income network established with excavation waste using the argument that such projects benefit the public sphere. Despite concerns about impact on the coastal ecosystem and potential impact in the case of an earthquake, these mega-scale coastal reclamations can be considered as products of capital-driven metabolic flows.

The Maltepe and Yenikapı land reclamations also stand as important examples of the secondary transformation of wasted materials generated by the construction of mega projects and rubble from urban renewal through complex labour relations and material flows.[154] Disposal through land reclamation is technically governed by regulations on managing large-scale solid construction waste, but these applications are still controversial in terms of not only long-term maintenance costs and carbon footprints but also the dispossession of local cat populations in the case of the land reclamation in Maltepe.[155] The appearance of a "closed loop" is created by usage opportunities or a human-centric kind of "cyclifier." [156] Such a cyclifier mediates waste flows with the demand for production, transforms waste, and reintroduces it to material flows as a resource [157] (Figure 30, Figure 31).

152. Türkiye İçişleri Bakanlığı Mahalli İdareler Genel Müdürlüğü, CEVAP, Sayı: 14399437-010.09-23139. (Regarding the written question proposal no. 7/18755). August 15, 2013. Accessed May 6, 2024. Available at: https://www2.tbmm.gov.tr/d24/7/7-18755sgc.pdf

153. Emrah Küçükakça and Ali Akkaya, "İstanbul Kıyı Alanlarındaki Dolgu Projelerinin Sosyo-Ekonomik, Ekolojik Ve Hukuki Analizi ." 8. Kıyı Mühendisliği Sempozyumu, 2014.

154. Esra Sert, "Urban Metabolism of Istanbul: Waterfronts as Metabolized Socio-Natures Between 1839 and 2019", METU, 2020.

155. Son Dakika, "Hayvanseverler Kediler İçin Toplandı.", October 17, 2012. Available at: https://www.sondakika.com/guncel/haber-hayvanseverler-kediler-icin-toplandi-4021061/

156. Nels Nelson, Jan Jongert and Gijsbert Korevaar, "Cyclifiers: An Investigation into Actors That Enable Intra-Urban Metabolism." Cyclifier, 2015. Available at: https://www.cyclifier.org/wp-content/uploads/Cyclifiers-paper-2015.pdf.

157. Cyclifier. Accessed August 23, 2024. Available at: https://www.cyclifier.org/

158. CNN Türk, "Denizi Doldurup Yapılan Parklar Ile İstanbul'Un Yüzölçümü Büyüdü", 2014. Available at: https://www.cnnturk.com/turkiye/denizi-doldurup-yapilan-parklar-ile-istanbulun-yuzolcumu-buyudu-443618

Figure 30: Comparision between urban metabolism flows originating from non-renewable sources in the anthroposphere with and without the cyclifiers. Source: Nelson et al.

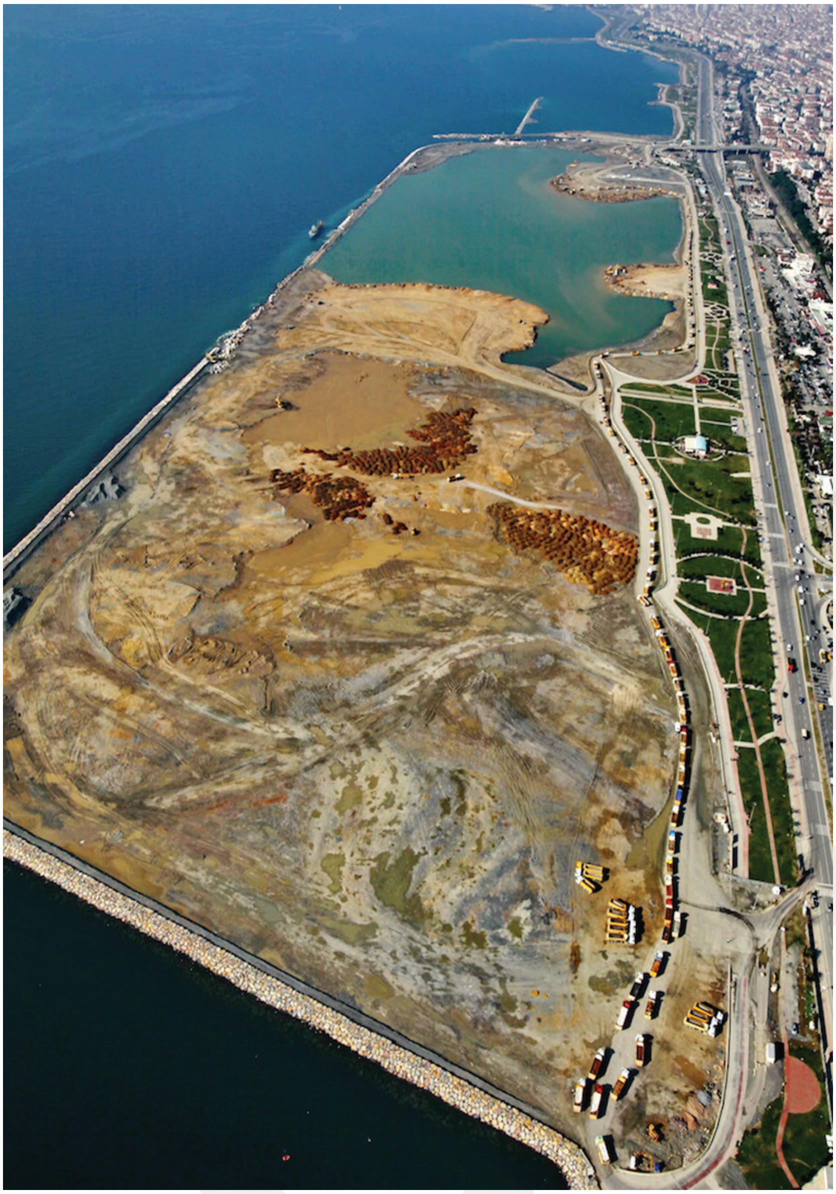


Figure 31: Maltepe Land Reclaimation, Source: Özka İnşaat

Figure 32: Maltepe Land Reclamation. Source: Özka İnşaat.

Land reclamations in Istanbul can thus be seen as a form of cyclification, transforming excavation waste into social facilities with various functions. [158] Land reclamation is generally justified by promoting these spaces for the sake of the public and new green infrastructure for the city (Figure 32). However, since these transformations through land reclamations disrupt ecological systems and displace local species while benefiting construction companies, they remain opportunistic acts.

Urban Mining Potentials in Istanbul

Figure 33: A dismantler in Istanbul, Source: Onur Ceritoğlu

In light of the specific context of Istanbul, waste also reflects embedded economic value, constituting a new resource with new potential uses. The concepts described above, such as cradle to cradle, circularity, and urban mining, were established many years ago in the crowded cities of developing countries, such as Istanbul, largely shaped by informal waste workers who recognised the economic value of scrap material. Despite their harsh working conditions, junk dealers (Turkish: hurdacı) and dismantlers (çıkmacı) play key roles in the reintroduction of discarded materials into circulation through reuse or recycling. Junk dealers, as collectors of the informal recycling network, are the most crucial actors in the transfer of precious metals such as aluminium, iron, and copper to recycling companies in the city. In selective demolition and the reclamation of reusable building elements, the dismantlers play a key role (Figure 33, Figure 34) They are the saprophytes of the anthroposphere, ensuring that reusable components in existing buildings of the city, which have reached the ends of their lifecycles and have been selected for demolition, can participate in other lifecycles. From PVC windows to kitchen cupboards, from flooring materials to plumbing elements, and from bricks to copper pipes, these dismantlers mediate the removal and circulation of all materials. Materials obtained in this way are also in demand in international markets, such as in Georgia.[159] Since the 2000s, this field of work has become more prominent in light of urban renewal processes.[160]

According to a report prepared by the IMM Istanbul Planning Agency, these informal job opportunities have unintentionally grown in Istanbul with recognition of the economic exchange value of waste by both domestic and foreign migrants seeking to earn a living since the 1970s.[161] Despite their significance in the material circulation in the city, this report reveals that they work in precarious conditions without any insurance, facing discrimination from both society and the social security system. However, taking an inclusive approach to preserving the rights of these informal workers and warehousemen who contribute to the reclaiming, recycling, and storing of materials would make a significant contribution to services and space for the urban mining of construction wastes in Istanbul.

Another potential resource for a “maker hub” or a school for repairing and dismantling in the context of urban mining practices may be the vocational

Figure 34: Dismantler Warehouse, Source: Onur Ceritoğlu

159. Onur Ceritoğlu and Can Altay, “Kentsel Dönüşümün Artıkları – Çıkmacılar: Enformel Kentleşme Ile Yıkımların Arasında.” Toplum ve Bilim , no. 138-139 (2016): 139–146.

160. Onur Ceritoğlu, “Çıkmacılar: Enkazdan Mal Kurtarmak.”, Istanbul Yollarında Kentsel Politik Ekoloji, (İstanbul, 2019): 62–67.

161. IBB& IPA, “Kentin Yükünü Sirtlananlar İstanbul’un Katı Atık Toplayıcıları Sorunlar Ve Talepler”, 2022, İstanbul.

technical high schools of Istanbul. These institutions have previously shown that they have the workforce and equipment to provide products and shelters needed in times of crisis such as epidemics and earthquakes to be quickly produced and introduced into circulation[162] (Figure 35). With the integration of these institutions into circular strategies for both industrial and educational purposes, their provision of services for repair and maintenance could be an opportunity for creating an expansive urban mining network in Istanbul.

Other sources for waste materials in potential harvesting maps are the scrap warehouses of public institutions that store assets, inventoried goods, or furniture at the end of their economic lives. According to the Chattel Code (Turkish: Taşınır Mal Yönetmeliği) published in 2007, inventoried materials that reach the end of their lifecycles and are reclaimed by being delegated to other public establishments can enter the market for possible purchasers such as recycling companies or the Mechanical and Chemical Industry Corporation (Turkish acronym: MKE). The cataloguing system for scrapped inventory stocks should be applied and improved with digital tools. The Chattel Code legally obligates public institutions to keep records of scrapped inventory stock and store it in specified warehouses, but according to reports prepared based on Court of Accounts Law No. 6085, some scrap materials that lack proper inventory records are mixed with usable items and are not removed from the records after being sent to the MKE.[163] These issues highlight the current deficiencies in the record-keeping system for scrapped inventory. However, implementing the MPP for these inventories would be a good starting point for urban mining in Istanbul while creating a more controllable recording system for public institutions.

Considering that the built environment consists of concrete and steel assemblages, reinforced concrete is the main construction material used in Istanbul. Therefore, reintroducing materials into the city's metabolism demands more complex socio-cultural and economic strategies for the buildings of the cities. For future advancements, it must be kept in mind that current methods for the transformation of C&D waste as aggregates for infrastructure construction or of excavation waste as infill material for old mines and land reclamation areas are not considered "sustainable" methods. In fact, when C&D waste is considered as a by-product, recycling can even be used as a tool to justify the generation of more excavation, construction, and demolition waste.[164] The extensive use of reinforced concrete as a mainstream construction component can be considered a problem in Istanbul

Figure 35: Students constructing a container shelter for earthquake victims, 2023. Source: Elif Özlem Çelikler- AA

162. Ministry of National Education (MEB), "Meslek Liseleri Deprem Bölgeleri için Konteyner Sınıf ve Çadır Üretiyor", 2023. Available at: https://istanbul.meb.gov.tr/www/meslek-liseleri-deprem-bolgeleri-icin-konteyner-sinif-ve-cadir-uretiyor/icerik/4785

163. Mehmet Cemil Artık and Erkan Topal, "Taşınır Mal İşlemleri ve TKYS Uygulamalarında Karşılaşılan Sorunlar." İstanbul Üniversitesi Cerrahpaşa Strateji Geliştirme Daire Başkanlığı , 2021. https://cdn.iuc.edu.tr/FileHandler2.ashx?f=02-kasim-2021-egitim-semineri-02.11.2021-duzenlenmis---kopya.pdf

164. Anirban Mukhopadhyay and Gita VJohar, "Indulgence as self-reward for prior shopping restraint: A justification-based mechanism", (Journal of Consumer Psychology Vol:19 Issue:3,2009): 334-345 DOI: https://doi.org/10.1016/j.jcps.2009.02.016

Figure 36: NoXX Apartment, Beyoğlu, İstanbul, 2013. Photo Credit: Cemal Emden

for both an earthquake- and a climate-resistant built environment. Since it requires on-site supervision to prevent waste and quality deficiencies, it requires more energy and labour power backed by top-down regulations. This heightens the importance of increasing the applicability of urban mining in the construction industry in Istanbul, which could be managed through design decisions about construction methods. For example, the NoXX Apartment was designed with mountable details utilising construction materials such as steel, brick, and wooden elements as a response to the challenges of conventional construction in the narrow streets of the Beyoğlu district.[165] Planning the connection details of building elements while preserving the materials' original properties without any painting or covering [166] is another design strategy allowing future buildings to become material stock for urban mining. (Figure 36)

OOn the other hand, considering Türkiye's significant land potential for the cultivation of industrial forests could transform the conventional use of reinforced concrete as the primary structural material used in the country by providing a sustainable alternative for structural timber production, especially considering that 29% of the country is covered with forests and only 3% of those forests are industrial forests.[167] Making timber use economically feasible could also be a future investment for increasing the material palette for the design for disassembly method of urban mining in Istanbul.

In this context, the implementation process of Yoo, Bence Güzel Pavilion, which was built with demountable timber, can be revisited together with the contextual potentials and constraints of other built examples. The following section accordingly offers insights into urban mining in light of the current potentials and restrictions of Istanbul by exploring the design and construction processes of Yoo, Bence Güzel Pavilion.

Background of Yoo, Bence Güzel! Pavilion: A speculative Neighbourhood

One of the outputs of our research[168] on waste in the Alternative Architectural Practices Programme of MEF University was the finding that waste management has spatial similarities in Istanbul and many other parts of the world (Figure 37) TThe logistics between spaces are not currently sustainable in ecological or managerial terms. Thus, we started to think about the fundamental concept of waste as the result of our daily life necessities

165. Mimarizm, "NoXX Apartmanı",2015. Available at: https://www.mimarizm.com/mimari-projeler/konut/noxx-apartmani_113096

166. Ibid.

167. Gökhan Özartan and Ali Çoşkun, "Ahşap Kullaniminin Artirilmasi İçin Masif Ahşap Sektörü Durum Analizi", Boğaziçi University, 2021.

168. AAP MEF, AAP Waste Research Book. Accessed June 2, 2024. https://www.yumpu.com/en/document/read/66395952/aap-waste

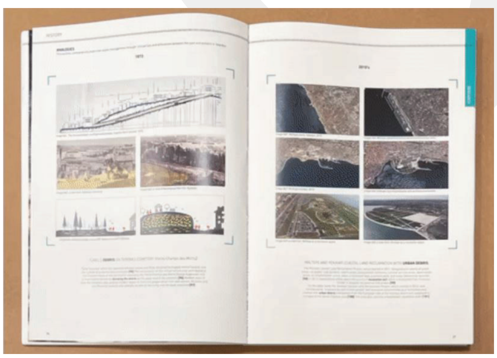


Figure 37: AAP Waste Research Book, 2022. Source:AAP MEF.

and activities We asked the question of how waste or, in other words, non-metabolised materials could be managed in other ways, through alternative realities recognising the responsibility of disposal in the process of accumulation. To reconstruct the spatial network of relations in the anthroposphere, the first place to start is at home. When non-metabolised materials are circularly managed within a network, waste becomes a secondary source or a property. It is also a legacy that passes from generation to generation. The concept of waste changes its meaning when it becomes traceable and it has owners who are responsible for where it ends up on Earth. In the context of Istanbul, rapid urbanisation began to grow along its peripheries and landfills moved to the same peripheries, remaining out of sight for most residents. [169] As a legal dumping site beginning in the 1960s, Ümraniye was one of the city's unsanitary dumping sites. With the 1970s, informal settlements began appearing around it. Latife Tekin, deriving inspiration from the magical realism movement in literature, portrayed the context of informal settlements of Istanbul in the 1960s in her novel titled Tales from the Garbage Hills (Turkish: Berci Kristin Çöp Masalları). The novel re-creates the informal settlements of squatters who earn a living from the waste in slum areas and their relationships with wasted materials in Istanbul.[170] The same relationships were also portrayed with different mediums by Artıkişler Kolektifi in a documentary titled Surplus of Istanbul. [171]

Therefore, the main story that we produced as a part of our design process in creating Yoo, Bence Güzel Pavilion begins with the Ümraniye landfill explosion in 1993. This event was accepted as a breaking point because it shaped the waste management policies of the time. The role of local solidarity in managing waste and networks among neighbours with local businesses and other places all came together with the concept of "waste" to transform material flows from cradle to cradle.

The urban mining approach aims to recirculate materials that are believed to have reached the end of their lives. In this case, neighbourhoods with local businesses and local communication networks may serve as incubators while considering ideas for urban mining practices in the context of Istanbul.

In the social contract of a speculative neighbourhood, individuals are responsible for every object they own rather than relying on the existing spatial and organisational equivalents of waste management that we use today.[172]

To understand the concept of waste more fundamentally, we must recognise

169. Öyküm Hüma Keskin, Ezgi Toprak, Seçil Türkkan, "İstanbul'Un Çöpleri (i): Dünden Bugüne İstanbul'un Çöp Derdi- Teyit." Teyit, 2021. Available at: https://teyit.org/dosya/istanbulun-copleri-i-dunden-bugune-istanbulun-cop-derdi

170. Latife Tekin,"Berci Kristin Çöp Masalları",Can Sanat Yayınları, İstanbul, 2021.

171. Hürriyet Daily News, "Video Platform Artıkişler Kolektifi Redefines Waste." April 21, 2014. https://www.hurriyetdailynews.com/video-platform-artikisler-kolektifi-redefines-waste-65294.

172. MEF University, Alternative Architectural Practices Waste. The Big Bang . YouTube. YouTube, 2022. Available at: https://www.youtube.com/watch?v=zRheOxeI51k that what we call waste has a necessary and functional position as soon as we acquire it. As a result of the choices of its user, it becomes something that has lost value with disposal and accumulation, something that needs to be removed from sight because of its ambiguity. However, what we call waste can often be a secondary resource within a circular economy. In this new model at the neighbourhood scale, new lines of business and mediating spaces can occur.(Figure 38)

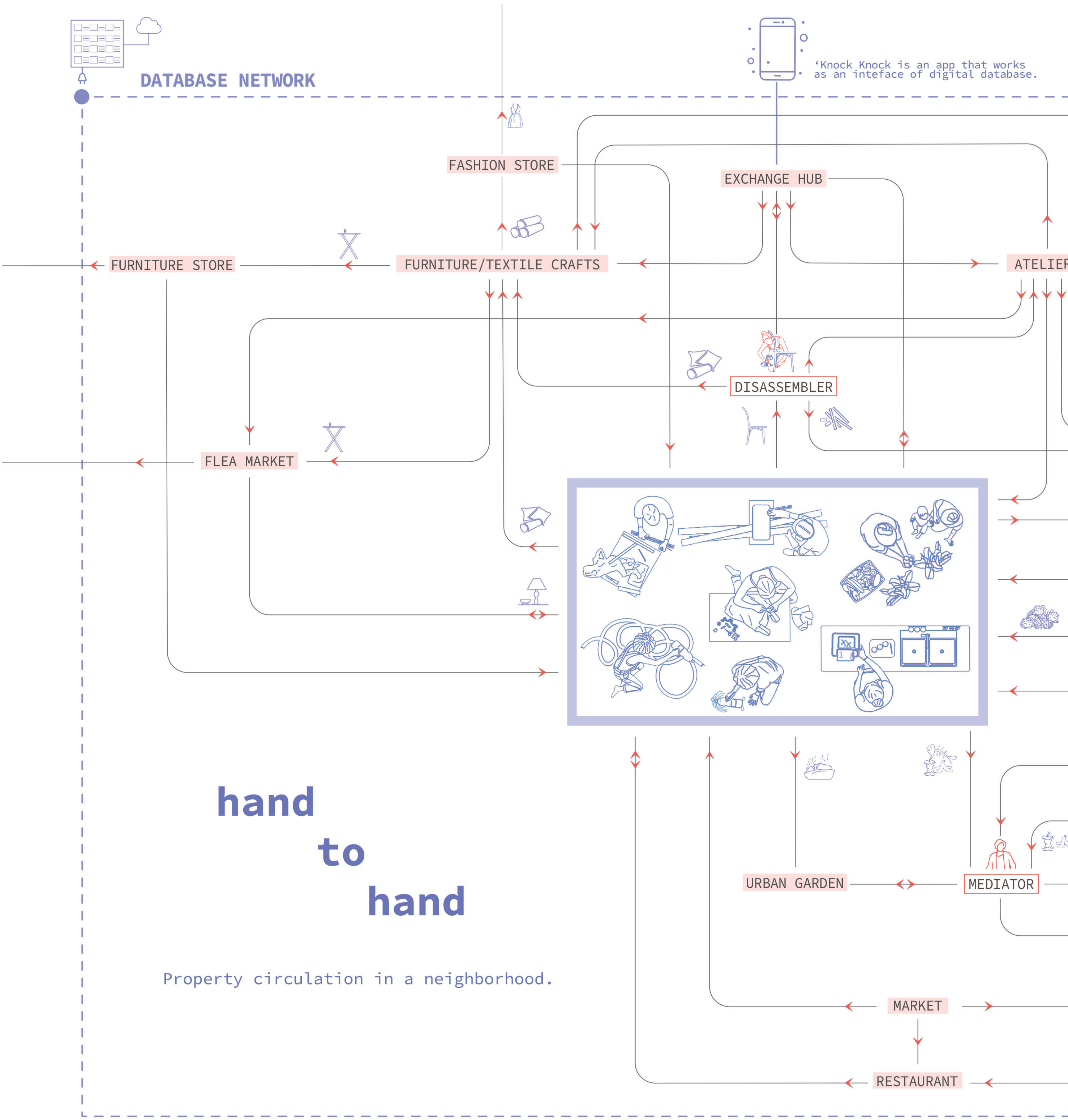
In the micro-network that we proposed, these "depreciated" materials deserve a second chance and are flowing within a relational network that allows reusable items such as furniture to be accessed by different users. To ease this flow, new professional groups such as disassemblers separate "waste" into modules and meaningful parts without deforming the nature of the material. In addition to the fact that antique shops and flea markets have

Figure 38: Exchange hub and carpenter of speculative neighbourhood, 2022 (Image produced by AAP Waste team for Oslo Triennale Neighbourhood Index)

a significant role in the lifecycle of goods, disassembled parts that leave the house in one piece or furniture and other objects that can be disassembled into elements can be stored and classified by material type and measurements in inventory spaces called exchange hubs. Significant items in the inventory, which can be monitored through a mobile application called Knock Knock!, will be easily found and purchased by new users when needed.

To summarise, in addition to existing roles in a neighbourhood such as artisans, carpenters, and tailors who already provide maintenance services allowing the reuse of things, some new businesses will arise, such as the Exchange Hub and the Rental Hub, to store items listed in the Knock Knock! mobile application database. (Figure 39) These new spaces will facilitate storage of secondary resources and meet the temporary needs of the people in a circular flow. All of these new places or expanded functions of existing places in the neighbourhood could encourage the development of a culture of reuse from a wider perspective. By tracing and storing information about the materials, these relational infrastructures can divert materials from landfills and circulate them as resources in the local economy.

Therefore, the design process of Yoo, Bence Güzel Pavilion arose from consideration of this alternative reality with the following question: In a circular city that has equipped its neighbourhoods to mine their wastes in a closed loop through cooperation and connectedness, what will be the reflections on architectural production and the construction industry?



hand to hand

Property circulation in a neighborhood.

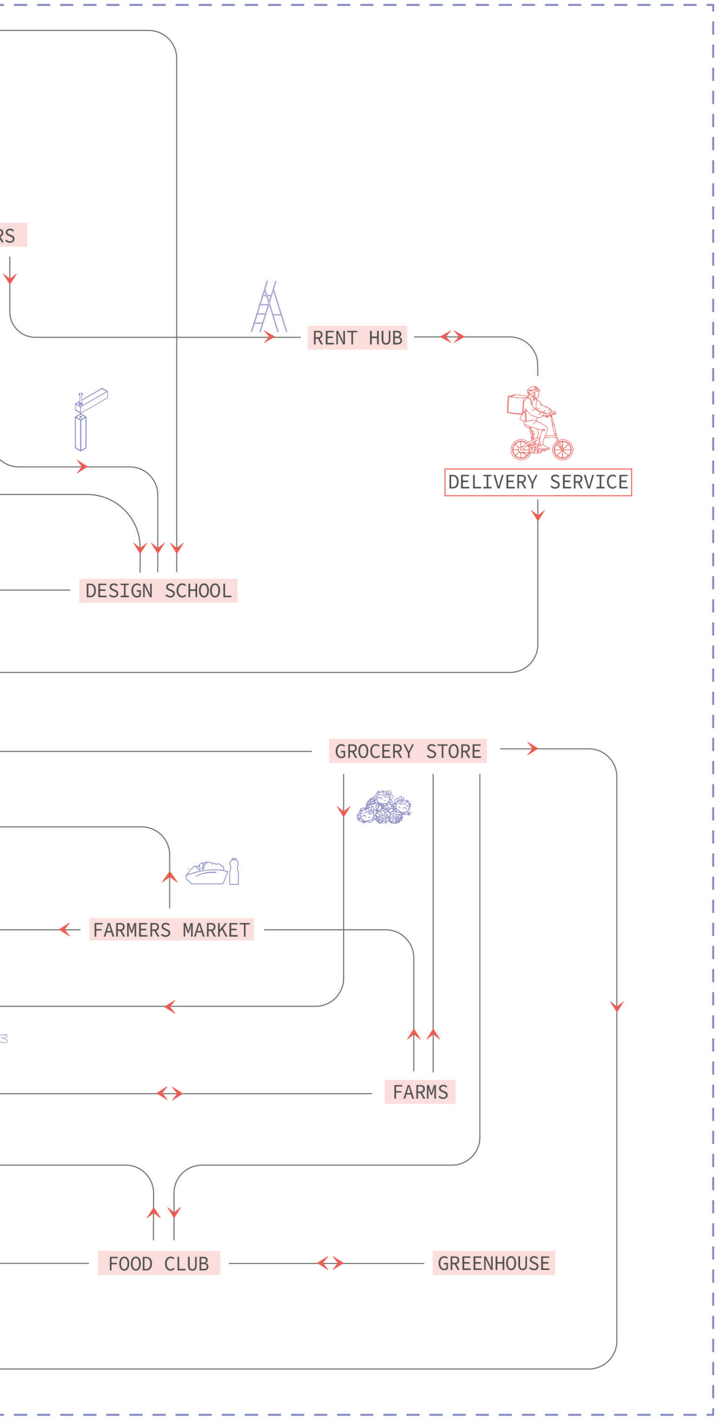


Figure 39: Neighbourhood Network, Source: AAP, 2022.

The Process of Yoo, Bence Güzel Pavilion

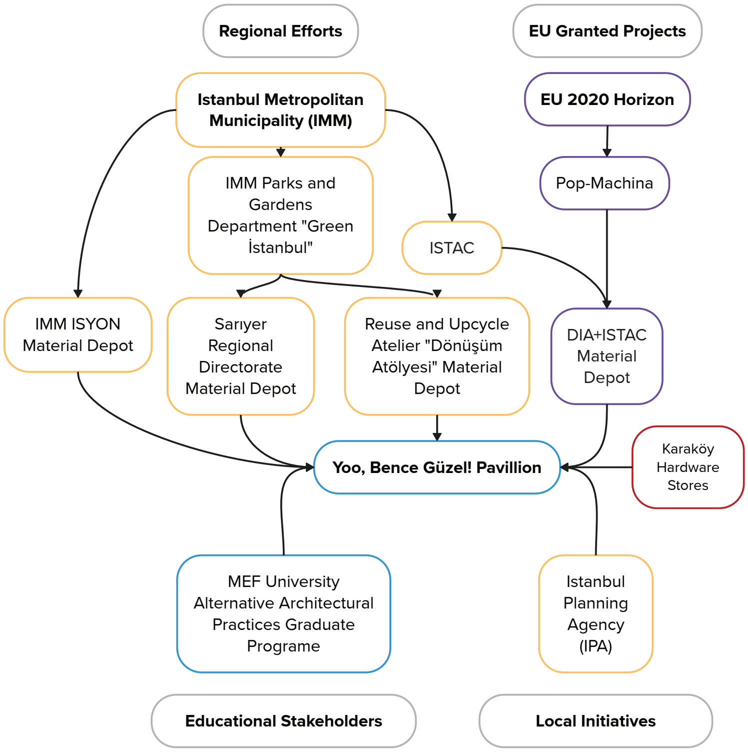


Figure 40: Relations diagram of making Yoo,Bence Güzel Pavillion, prepared by the author,2024

Yoo Bence Güzel Pavilion (Figure 42) translated as the "Nah, I Think It's Beautiful!" Pavilion, was constructed from discarded materials through a participatory process at the end of a three-week implementation as a product of year-long research and design processes.

The main struggle of reintroducing scrap materials into a new lifecycle was gaining access to the scrap materials. Currently, materials disposed of and dispossessed by consumers, dropped into bins or left on pavements or outside doorsteps, are overwhelmingly collected by formal or informal waste workers in Istanbul. In particular, waste materials with any potential for reuse or recycling are collected by municipal waste workers or waste pickers in Istanbul. The collected materials diverted from landfills are largely gathered in the warehouses of the Istanbul Metropolitan Municipality (IMM) Regional Directorate of Parks and Gardens and İSTAÇ. (Figure 40) The information network underlying this storage was explored based on personal communications of the relevant manager and solid waste workers. Since these

Figure 42: Yoo, Bence Güzel Pavilion, AAP MEF, 2022

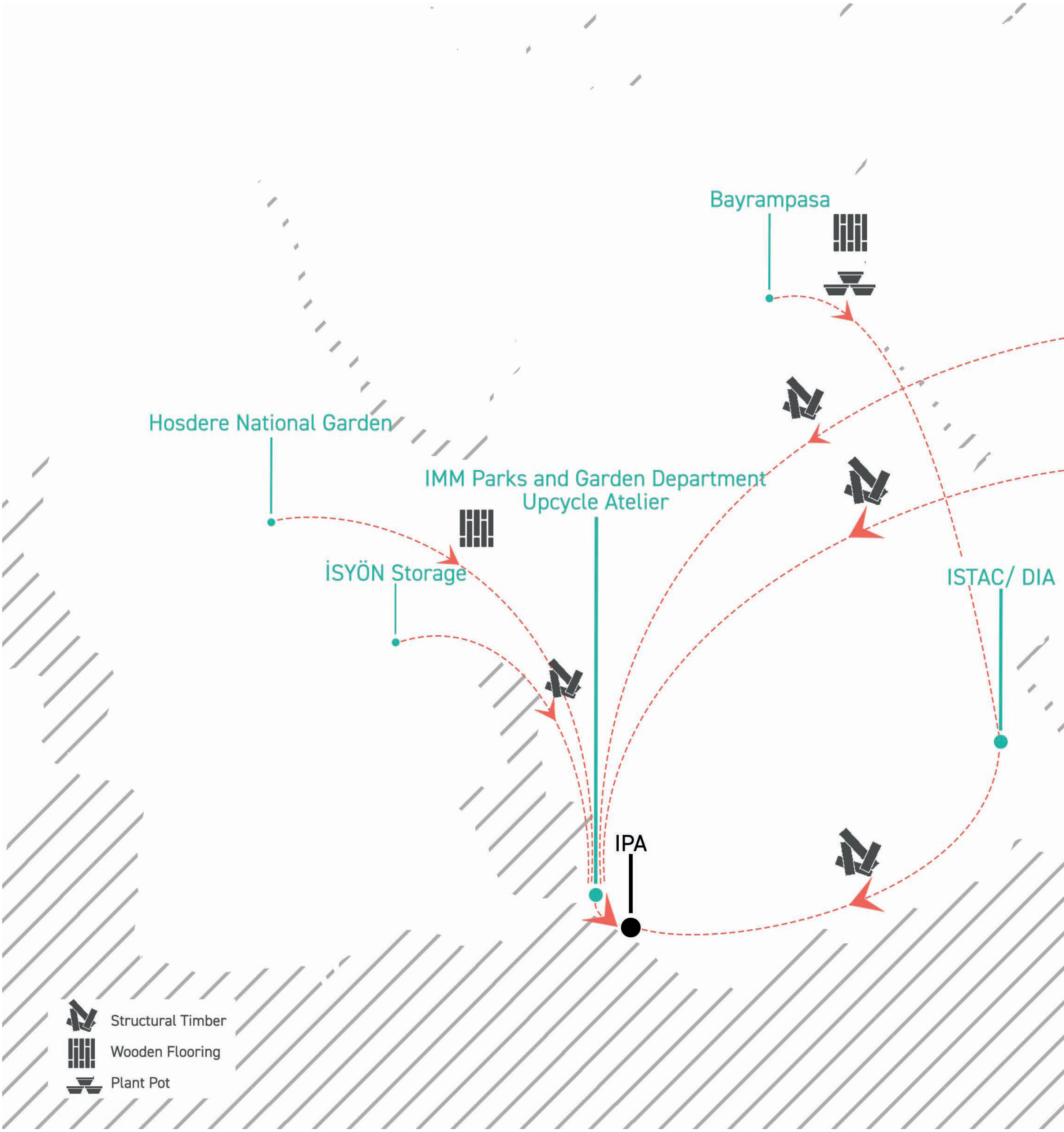
materials were already discarded by their last consumers, they were used to meet the municipality's internal needs, such as furniture or waste bins. At the same time, the DİA Istanbul (Turkish: Döngüsel İşler Atölyesi) makerspace near this material depot was a part of the Pop-Machina project funded by the European Union's Horizon 2020 programme. The main aim of Pop-Machina Istanbul, among seven pilot cities in Europe, was to introduce the circular economy to the public by supporting makers with technical equipment and local communities with DIY projects.[173] The IMM's Yeşil İstanbul Dönüşüm Atölyesi ("Green Istanbul Reuse and Recycle Hub"), which was established to provide maintenance service for urban equipment of the municipality and divert it from landfills, [174] was the main contributor to Yoo, Bence Güzel Pavilion in terms of material harvesting. Materials were mined from different locations and institutions while limiting the distance to these sources to a radius of 30 km. (Figure 41) The utilised warehouses contain various ranges of materials that are not only collected from the edges of garbage dumps but are removed from public spaces, parks, and gardens because they are partially damaged or non-functional, being replaced with new materials. The warehouses also contain materials left over from temporary events, such as political rallies, large fairs, biennials, or exhibitions, and materials that have become waste as a result of the breaking or pruning of materials in public spaces, on roadsides and streets, or in forests (Figure 43, Figure 44).

Figure 43: AAP Waste Research Book, 2022.

Figure 44: Fieldtrip to IMM Green İstanbul Reuse and Recycle Hub (Yeşil İstanbul Dönüşüm Atölyesi), AAP MEF, 2022.

173. IBB, "Pop-Machina Projesi.", Accessed August 30, 2024. https://frd.ibb.istanbul/pop-machina/

174. Kübra Durgun and Kenan Saluğu, "Kentte Farklı Bir Dönüşüm Hikayesi: Yeşil İstanbul Dönüşüm Atölyesi" İPA Kent Gündemi Journal 302, İleri Dönüşüm,2022. Available at: https://ipa.istanbul/wp-content/uploads/2022/07/302_KENT_KUBRA-DURGUN-1.pdf


Bayrampasa
Hosdere National Garden
IMM Parks and Garden Department
Upcycle Atelier
İSYÖN Storage
ISTAC/ DIA
IPA
Structural Timber
Wooden Flooring
Plant Pot

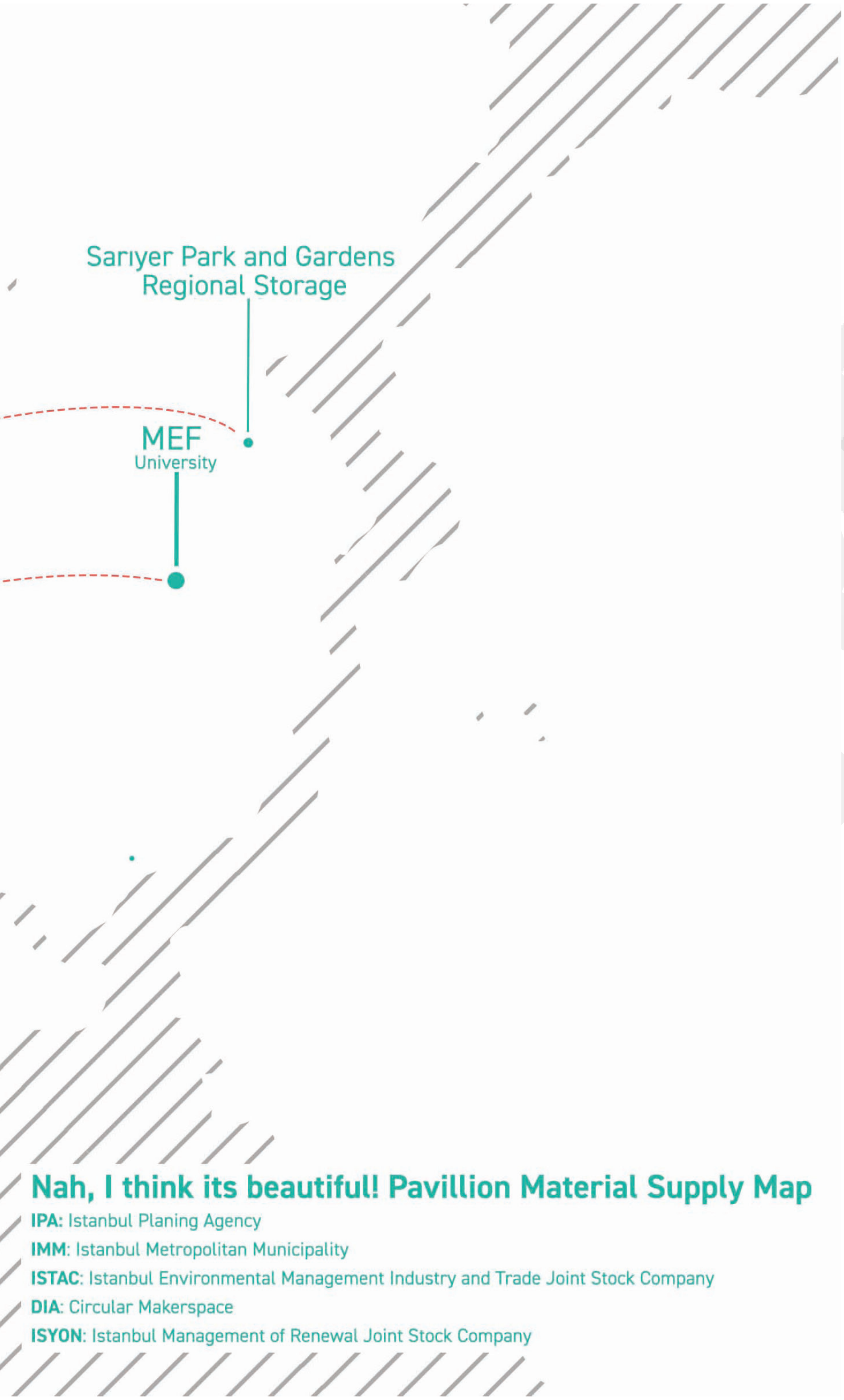


Figure 41: Material flow map of the Yoo, Bence Güzel Pavilion, AAP MEF, 2022.

Figure 45: Processing the leftover materials for reuse, AAP MEF, 2022.

According to information gathered during the material harvesting process via an informal network of communication among municipal employees, these materials hibernate in storage until new possibilities for their use arise.

Taking the available material stock into account as a design input, together with contextual and functional considerations, is a significant difference between traditional design processes and urban mining. This input in design consideration evoked the challenges of the lack of a systemic approach in the construction industry, intended to minimise labour power and time expenses for the feedback between material supply and design. If the anonymous materials accumulated in these warehouses were to be categorised and registered in an open-source database such as the harvest map of the Superuse Studios (oogstkaart.nl), they would be more accessible for harvesting for projects in the design phase. Without such a database, extra work is needed to access the scrap materials, take the measurements of the materials that might be suitable for the design, and create drafts of how the materials could work together. Moreover, because of the anonymity of their ownership and possible future lifecycles, some materials we had already measured and modelled in the design process subsequently disappeared because of the lack of traceability of the material stock. Especially on larger scales, this can create extra loss of time and labour within the context of the lack of a systematic approach since scrap materials do not have any standards, lack recorded data on their physical properties, and are ambiguous.

Our strategy for mining the materials entailed pairing the available material sizes with the designated elements to minimise downgrading. To cope with the ambiguity and anonymity, we assigned codes to the materials to show their place in the design(Figure 46). In this second pairing process, it was important to preserve the physical form of the materials as much as possible and minimise waste as much as possible while bringing the materials to a certain standard to reuse them. Challenges in this process arise from the need to reduce waste as well as to not downcycle the material before its next potential use. Although sensitivity was shown in this regard, the matching was done manually and the margin of human error did lead to unwanted waste in the process. To avoid such error, the use of algorithmic and digital methods would be an option. Producing technologies to optimise these processes and reduce the margin of error can facilitate the spread of urban mining and reuse in the construction industry and architectural design, aligned with circular economy principles.

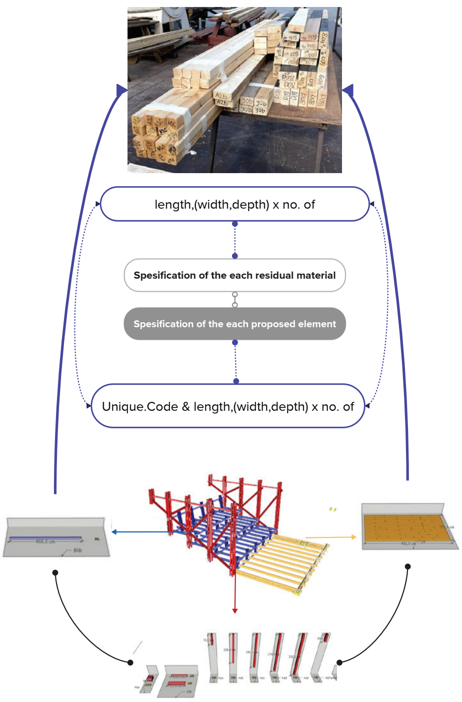


Figure 46: Modularising and grouping diagram of the Yoo, Bence Güzel Pavilion, produced by the author, 2024.

In a country like Türkiye, where the scope of the construction industry and the supply of materials are economically limiting, the proliferation of urban mining and reuse scenarios can be considered as an important opportunity. Considering the quality of the existing building stock and the prevalence of conventional construction methods, one step to be taken in this regard is to evaluate the quality of recovered materials and create a digital library, classifying them according to their properties.

For new buildings, it is possible to make future projections such as planning the operation or intervention processes throughout the building's lifecycle with a centralised BIM model by creating a digital twin of the building. In the future, creating digital identities of materials from waste material stocks could make scrap materials available for use in the design process in digital libraries, like a product family. This suggestion, which is not feasible for current warehouses of ambiguous materials without standards, can be facilitated with 3D LiDAR scans and QR codes.

Another significant design decision for Yoo, Bence Güzel Pavilion was the inclusion of demountable bolting, compression with bolts without damaging the existing structure, and avoidance of the use of adhesive chemicals on the wooden components to prevent contamination of the soil and rainwater. With the same aim, the joints were made by screwing due to the temporary nature of the pavilion (Figure 47). This design was selected to preserve the physical integrity of the used materials if the pavilion is dismantled. One important shortcoming in architectural design is a lack of consideration of how to reintroduce materials for future lifecycles.

Figure 47: Compressed connector pieces stabilized with bolts, AAP MEF, 2022.

Mining the C&D Waste: Urban Mining Perspectives from North America, Europe and Asia

03

This chapter investigates precedents of urban mining in architecture and the construction industry around the globe. The aim is to cultivate insights that would address the challenges we encountered in Istanbul during the making of Yoo, Bence Güzel Pavilion. The socio-economic backgrounds of the considered countries are given to help understand the systems underlying the maturity levels of their networks, policies, and methods for circularity in the construction industry. These precedents, collected in a literature review, were selected from among projects involving strategies for both the urban scale and the building scale (Figure 28). Efforts made at the urban scale aim to provide a basis for the building scale with incentives and legal frameworks.

However, legal frameworks have no meaning if they are not supported with alternative networks and businesses intended to maintain the lifecycles of reclaimed materials at the building scale. At the same time, tools and methods to accelerate the transition to circular construction also make significant contributions in applying the strategies framed by incentive regulations and supporting networks. All together, these considered regional and urban scales create a solid basis for an architect to explore the many ways of bringing together available materials at the building scale.

As another layer of investigation on a regional scale, the selection of examples in light of the importer and exporter roles of the countries in the waste trade provided further insight for a comparison of the maturity levels of their processes and roles in the global waste trade. In this chapter, the methods and tools of these countries for applying strategies for urban mining at the building scale will be discussed at both urban scale and regional scale. Overall, the aim of this chapter is to provide detailed information about the strengths and opportunities of urban mining.

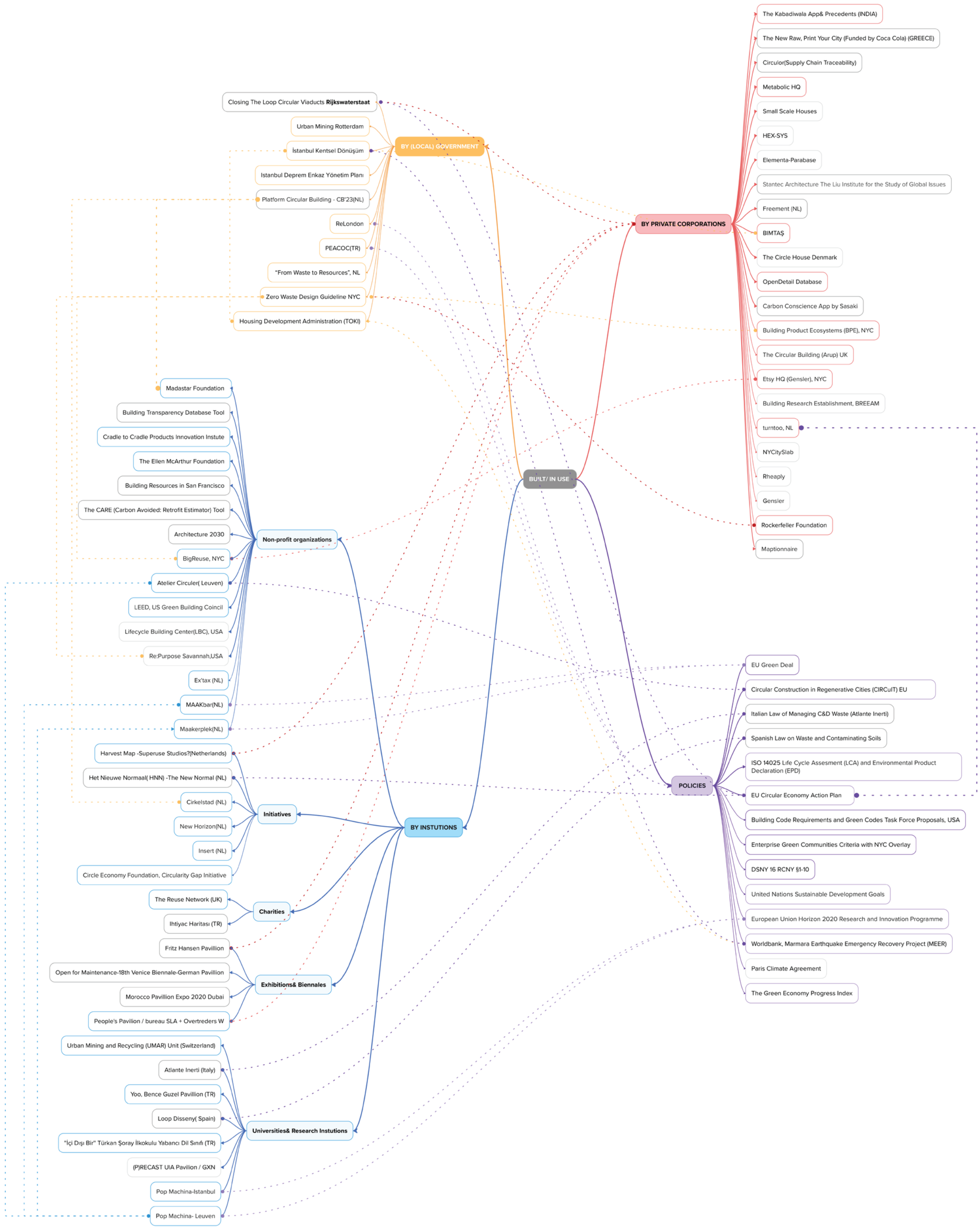


Figure 48: Modularising and grouping diagram of the Yoo, Bence Güzel Pavilion, produced by the author, 2024.
The dashed lines indicate the connections of projects in the context of their production, colour-coded according to the types of entities that funded them or played a role in the projects. Examples excluded from the scope of this study are represented in grey.

Urban Mining Perspectives from North America

Having the largest share in the exporting of solid waste in the global waste trade, the United States is one of the countries developing strategies for a circular economy transition. Considering that the construction sector contributes 4% to the GDP of the United States, it can be said that the construction sector has an important share in the economic development of the country.[175] Annually, the United States generates 600 million tonnes of C&D waste, a majority of which comes from demolition activities.[176] Thus, legislation and policies in the United States, such as the Federal Sustainability Plan, which aims to reduce greenhouse gas emissions in buildings, along with state-level initiatives like landfill material restrictions and extended producer responsibility programmes, are instrumental in encouraging sustainable practices in the construction industry.[177]

175. Anthony Johnson, "Council Post: Using Construction as an Economic Indicator." Forbes, August 17, 2023.

176. United States Environmental Protection Agency, "Advancing Sustainable Materials Management: 2018 Fact Sheet," December 2020. Available at: https://www.epa.gov/sites/default/files/2021

177. Felix Heisel, Alexandra Ciobanu, and Joseph McGranahan, "Industry and Literature Review of Urban Mining Applications in the United States: Gaps and Drivers for Implementation towards a Circular Industrialized Construction Economy." Circular Economy 2, no. 1 (March 1, 2024). https://doi.org/10.55845/cqkg4853

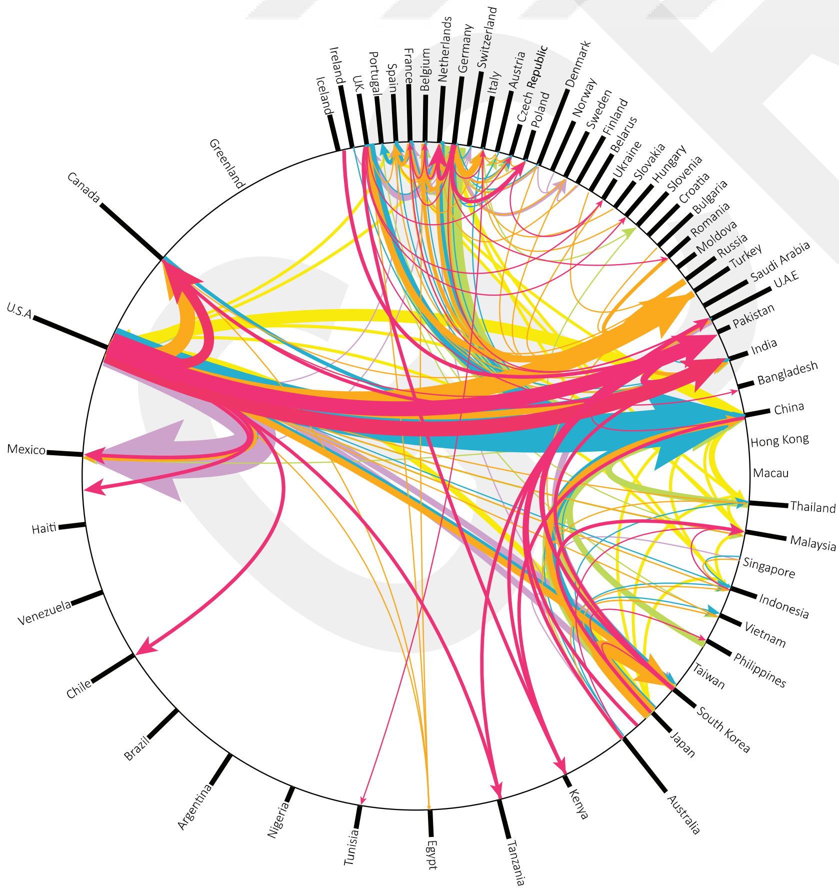


Figure 49: Global Waste Trade | Source: Laboratory LISST, University of Toulouse-Jean Jaurès / CNRS, Production Mucem 2017 (Image taken from the book The Architecture of Waste,2021)

Figure 50: C&D Waste in Material Recovery Facility, NYC. Source: Zero Waste Design Guidelines, 2017.

178. Sean Ross, "New York's Economy: The 6 Industries Driving GDP Growth." Investopedia. Accessed May 30, 2024. https://www.investopedia.com/articles/investing/011516/new-yorks-economy-6-industries-driving-gdp-growth.asp

179. US Zero Waste Design, "Design strategies and case studies for a Zero Waste City", Accessed May 30, 2024. Available at: https://www.zerowastedesign.org/wp-content/uploads/2017/10/ZeroWasteDesignGuidelines2017_Web.pdf

180. Ibid.

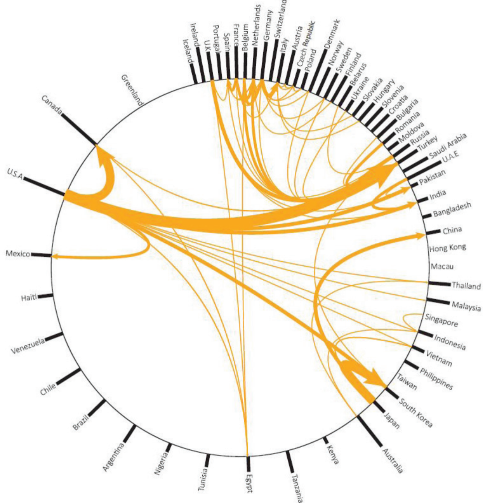


Figure 51: Global Metal Scrap Trade |Source: The Architecture of Waste,2021.

The purpose of these regulations is to help minimise environmental impacts by diverting specific materials from landfills, promoting recycling, and fostering resource efficiency through the adoption of circular economy principles. On the other hand, the United States is the biggest exporter in the global waste trade, shipping most of its metal waste to Türkiye (Figure 49, Figure 51).

For the implementation of the circular economy with urban mining in the United States, various levels of legislation and regulations are in place to support the recycling of waste in terms of both pre-consumer construction waste and post-consumer construction waste as described above. These legislative arrangements include the introduction of policies such as the Buy Clean Procurement Policy to reduce greenhouse gas emissions during construction, an emphasis on appropriate deconstruction methods to facilitate material recovery from decommissioned buildings, the establishment of re-grading and certification policies for recovered materials to facilitate their use in new construction projects, sector-wide stakeholder engagement, and the integration of technological advances to efficiently process and reuse recovered materials (Figure 50). These efforts collectively aim to promote sustainable practices, reduce environmental impact, and advance circular economy principles in the construction industry.

New York City (NYC)

New York City (NYC), constituting the third largest economy in the United States after the states of California and Texas, is one of the cities with the largest economies in the world with a GDP of $1.78 trillion in 2023.[178] In terms of waste management, NYC aims to send zero waste to landfills by 2030, with goals such as increasing urban recycling, reducing waste generation, and promoting a circular economy approach to waste management. In 2016, the Zero Waste Design Guidelines, prepared with funding from the Rockefeller Foundation as a basis for the City of New York's efforts to achieve zero waste by 2030, specified legal regulations and strategies for construction and demolition waste in addition to strategies for household and institutional waste.[179]

AAccording to these guidelines, legal regulations on achieving zero waste emphasise strategies to prevent or reuse C&D wastes, which constitute more than 25% to 45% of solid waste in NYC and contain chemicals that can be considered toxic. As mentioned in a report published in 2016, NYC generates approximately 7,500 tonnes of C&D waste per day, although this cannot be precisely measured due to poor tracking and registration at transfer centres.[180]

Within the scope of the rules coded as DSNY 16 RCNY, the companies that will remove C&D waste are determined by the authorisation of NYC's Business Integrity Commission. In addition, the Housing and Preservation Department of the city government uses the Enterprise Green Communities Criteria NYC Overlay to mandate a certain amount of credit in the categories of "Recycled Content of Materials," "Regional Materials," "Certified, Salvaged, and Engineered Wood Products," and "C&D Waste Management" in new affordable housing projects. Another regulation, the Building Code Requirements and Green Codes Task Force Proposal, requires that asphalt and ceiling tiles, floor coverings, and large quantities of wood from demolition be separated on-site and diverted into circulation. Although not legally required, LEED v4 credits are also available for the reintroduction of 50% to 75% of C&D waste back into circulation. [181] As these percentages are calculated by weight, the recovery of steel and concrete is relatively more important. However, even if it is advantageous to recycle steel or iron, the largest volume of global waste trade comprises metal waste exports from the United States, mostly to Canada and Türkiye[182] (Figure 51).

In addition to credits for demolition waste, LEED v4 entails further assessments to develop strategies for the environmental and health impacts of the selected materials as well as energy and water consumption in the future lifecycle of the building. Since the expenses of the legal and technical infrastructures developed for a "Zero Waste" construction industry and the cost of landfills in New York are quite high,[183] the economic advantages of using materials in closed cycles outweigh the ecological advantages. For cost reasons, if C&D waste is pre-consumer waste, i.e. generated as a result of demolition activities, the materials are separated on-site and taken directly to recycling agents, waste-to-energy facilities, and cement factories or to landfills outside the city if they cannot be separated. In the establishment and operation of this closed loop, various initiatives, organisations, and private companies provide services to fill the gaps in the dismantling and reuse business.

181. United States Environmental Protection Agency, "Advancing Sustainable Materials Management: 2018 Fact Sheet," December 2020.

182. Caroline O'Donnell and Dillon Pranger, "The architecture of waste: Design for a circular economy", (Abingdon: Routledge, 2021)

183. Ibid.

Business Initiatives in NYC: BigReuse and Building Product Environment (BPE)

In the context of NYC, service-based private companies such as Building Product Ecosystems (BPE) and community-based non-profit initiatives such as BigReuse can be given as relevant examples.

BPE and similar networking companies in the construction industry are particularly important for bridging the communication and connectivity gap to ensure the establishment of closed loops. The fact that stakeholders within the construction industry are aware of each other through BPE's website provides the relational infrastructure needed to start new lifecycles of donor buildings or second-hand building materials.[184] At the same time, BPE is also an interface for bringing together R&D efforts to replace cement, the main ingredient in concrete, which is the largest part of C&D waste by volume, with post-consumer ground glass or pozzolan.[185] Such networking is also critical in the process of sourcing and scientifically testing construction materials from existing material stocks. While sharing this database as an open source may facilitate the harvesting of materials, services, and labour in closed loops, it is unclear what benefits and criteria are provided for inclusion in the list of stakeholders (Figure 52).

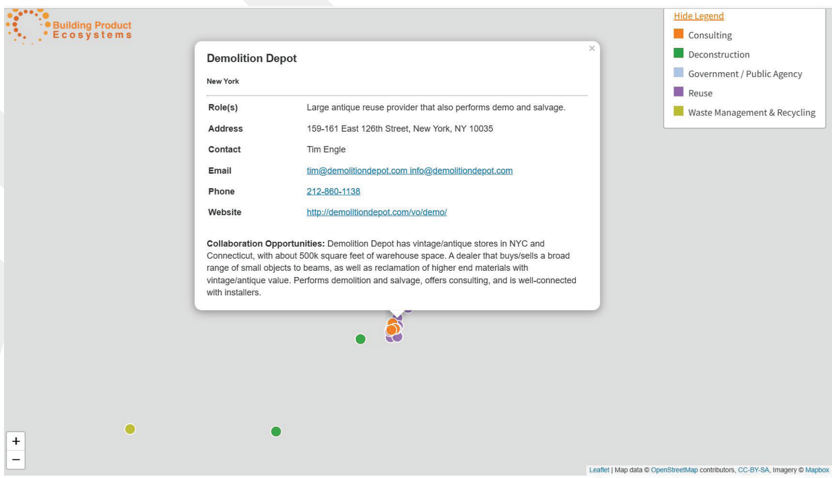


Figure 52: Interface of the Building Product Ecosystems (BPE) Map Source: buildingproductecosystems.org

During construction of the Etsy Headquarters building in NYC, BigReuse was involved in the collection of more than 90% of construction waste materials from nearby construction projects, including old furniture and reclaimed wood and industrial doors.[186] (Figure 53)

184. Building Product Ecosystems LLC, "Regional Reuse Resources.", Accessed May 31, 2024. https://www.buildingproductecosystems.org/regional-reuseresources

185. Future of Construction, "Urban Mining' to Reinvent Concrete" Accessed May 31, 2024. https://www.futureofconstruction.org/solution/urban-mining-to-reinvent-concrete/

186. Lauren Shanesy, "Etsy's Green Headquarters Is a Showcase for Sustainable, Healthy Design." LoopNet, July 16, 2020. Available at: https://www.loopnet.com/learn/etsys-green-headquarters-is-a-showcase-for-sustainable-healthy-design/1436776866/

Besides producing legislation and technical strategies focusing on the management of both pre-consumer and post-consumer C&D waste, there are also design strategies and businesses to avoid or cope with construction waste generation and make construction activities "zero waste."

Catherine Commons Deconstruction Project, Ithaca, NY

As mentioned briefly in previous chapters, deconstruction can be a more sustainable method for buildings at the end of their lifecycles. However, due to various limitations such as labour power, time, and budget, deconstruction is not a commonly preferred method compared to demolition by developers, contractors, and clients.

The Catherine Commons Deconstruction Project was proposed in Ithaca, NY, as part of the new development of 360 residential units requiring the demolition of eleven existing residential buildings dating back to the early 20th century [187] (Figure 54) As a result of toxicity assessments, it was found that asbestos was present in several parts of the buildings.[188] The safe removal of toxic materials was subsequently performed with the involvement of experts.[189]

For one of these eleven buildings, the deconstruction expenses were funded by an Engaged Cornell Public Purpose Grant with the involvement of the Cornell University Circular Construction Lab.[190] Deconstruction of that building was achieved with the efforts of 57 volunteers and stakeholders including the Cornell SC Johnson College of Business, Laborers Local 785, Finger Lakes ReUse, the Building Deconstruction Institute, and Trade Design Build[191] (Figure 59)

The process of panelised deconstruction was planned with a 3D building scanning method using ScanR ("Scan for Reuse"). This method operates through a combination of salvage and deconstruction surveying with LiDAR and photogrammetry to help stakeholders and local governments catalogue their material stock[192] (Figure 55). For the project described here, it was also used to adapt computational design tools and software programmes to calculate salvaged materials' physical properties and quantities for reuse, recycling, and disposal, including the rate of diversion from landfills, to improve strategies in the process of reclaiming materials with deconstruction.[193]

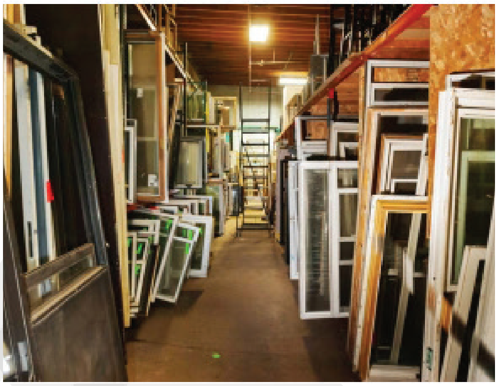


Figure 53: BigReuse Inventory, Disassembled Windows, NYC. Source: Zero Waste Design Guidelines, 2017

186. Lauren Shanesy, "Etsy's Green Headquarters Is a Showcase for Sustainable, Healthy Design.",2020

187. Townbridge Wolf Michaels Landscape Architects, "Preliminary Site Plan Review Application Report: Catherine Commons",Ithaca, NY, 2021.

188. Ibid.

189. Ibid.

190. Circular Construction Lab, "Catherine Commons Deconstruction Project" , Cornell AAP, 2022. https://labs.aap.cornell.edu/ccl/decon

191. Cornell University, "Unbuild Better: A Case Study in Deconstruction." YouTube,2022. https://www.youtube.com/watch?v=Ejjd6E_7SsQ

192. Felix Heisel, Joseph McGranahan and Andrew Boghossian," ScanR: A composite building scanning and survey method for the evaluation of materials and reuse potentials prior to demolition and deconstruction", IOP Conference Series: Earth and Environmental Science, 2022. DOI: 1078. 012012. 10.1088/1755-1315/1078/1/012012

193. Ibid.

194. Ibid.

195. Ibid.

Figure 54: Deconstruction of 20th century house, 2022. Credit: Felix Heisel.

In some local municipalities of the United States, such as Boulder, Cook County, Seattle, or Palo Alto, deconstruction and salvaging processes are demonstrated through Salvage & Deconstruction (S&D) surveys. These salvage surveys are mainly provided by local governments as data sheets in pdf format.[194] In the "Material Inventory" section of S&D surveys, complementary work involves interpreting LiDAR scans with qualitative and quantitative data of the building components.[195]

Juxtaposing the S&D survey and LiDAR scans enables one to obtain volumetric measures based on the materials and their proportions in the building. This knowledge can be used by contractors to assess their strategy in reclaiming materials while providing a basis for researchers and owners to calculate the embodied carbon of the building[198] (Figure 56).

Additionally, panelised deconstruction enabled the reclaiming of approximately 8164 kg of structural elements excluding flooring, staircases, radiators, and windows in five days.[197] The other significant result of this project was its promotion of the circular economy of reclaimed materials in local material networks to serve for only local communities' use [198](Figure 57).

This perspective, which promotes the closing of the loop in local circles, also reflects the involvement of local communities in such projects. This method, generally not preferred because of the financial and labour-

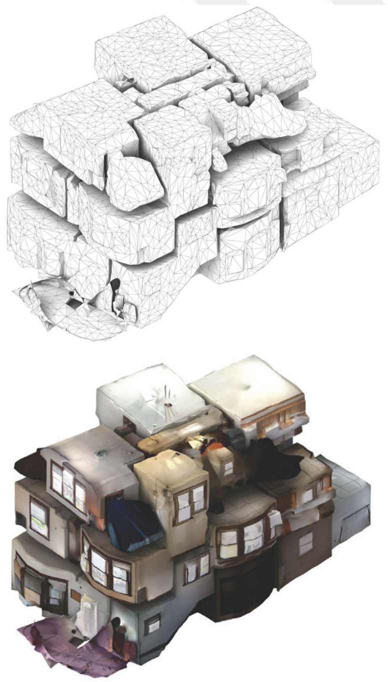


Figure 55: Output of a PolyCam scan of the building visualized in Rhinoceros3D. Mesh (up) and Photogrammetry Texture (down), Source: Heisel et al, 2022

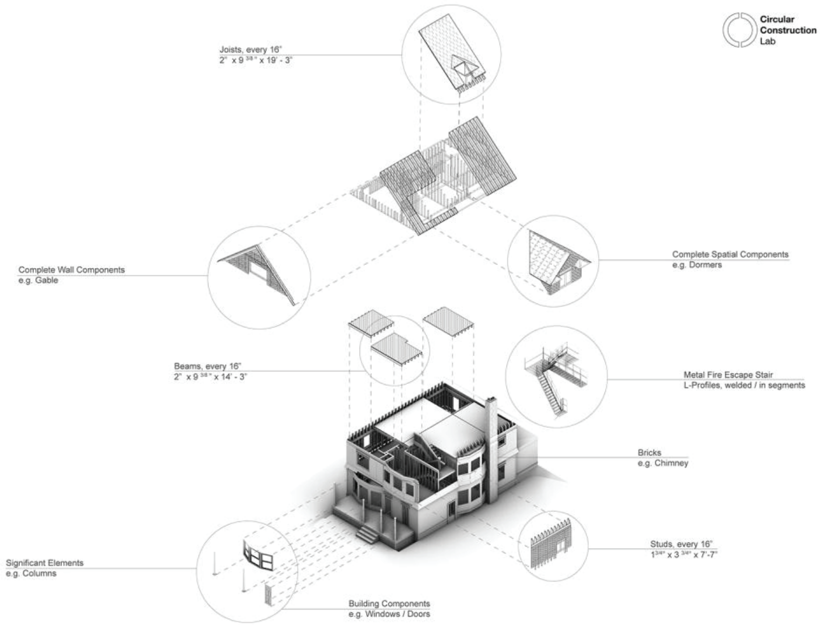


Figure 56: Exploded diagram of the components in the project. Source: Circular Construction Lab AAP Cornell, 2022.

196. Heisel et al, "ScanR: A composite building scanning and survey method for the evaluation of materials and reuse potentials prior to demolition and deconstruction", 2022.

197. James Dean, "Unbuild Better: A Collegetown Case Study in Deconstruction." Cornell Chronicle, February 16, 2022. https://news.cornell.edu/stories/2022/02/un-build-better-collegetown-case-study-deconstruction

198. Cornell University, "Unbuild Better: A Case Study in Deconstruction." YouTube,2022. https://www.youtube.com/watch?v=Ejjd6E_7SsQ

199. Heisel et al, "Carbon, economics, and labor: a case study of deconstruction's relative costs and benefits compared to demolition", Journal of Physics: Conference Series, Volume 2600, Circular design, re-use & recycle,2023. DOI: 10.1088/1742-6596/2600/19/192003

200. Ibid.

intensive limitations, becomes more problematic if salvaged materials are transferred to the global market because carbon emissions will accordingly be increased.

Another contribution of this particular deconstruction project to urban mining was the provision of reliable data to compare demolition and deconstruction, since ten other similar buildings were demolished while the deconstruction project was taking place. The main subjects of these comparisons were carbon emissions, costs, and labour force.[199]

Data were collected from demolition contractors and the processes of deconstruction, including the costs of labour, equipment, foundation removal, transportation, and tips. Although the initial costs of deconstruction were higher than those of demolition services, in the long run the salvaged materials will offset the cost difference with the reuse of materials and reduced carbon emissions.[200]

It is not possible to generalise on these conclusions for other building types or say that this method can always offset its initial costs in the long term. In this particular case, the initial cost offset may be a result of the building's embodied timber percentage, which is probably higher compared to contemporary buildings, especially considering market prices and the historical value of the timber reclaimed from the building. In general, it can be said that the Catherine Commons Deconstruction Project is a valuable precedent that provides insights and methods for how sustainable deconstruction can be applied on several scales for different types of buildings in other countries (Figure 58).

Figure 57: Material depot of the disassembled building components,2022 Image credit: Joseph McGranahan

Figure 58: Material depot of the disassembled building components,2022 Image credit: Joseph McGranahan

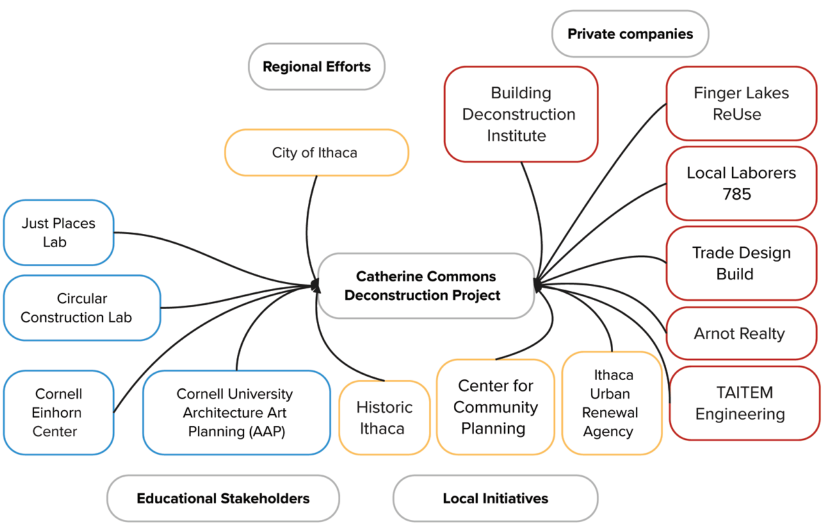


Figure 59: Stakeholder map of Catherine Commons Deconstruction Project, produced by the author, 2024.

Urban Mining Perspectives from Europe

Netherlands

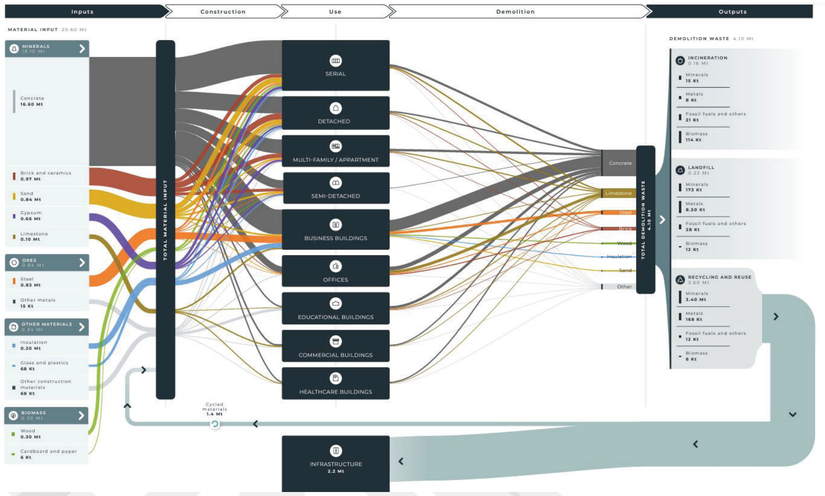


Figure 60: Netherlands Construction Industry Material Flow Analysis,2022| Source: Metabolic HQ

The Netherlands is the seventeenth largest economy in the world and the fifth largest economy in the European Monetary Union (i.e. the Eurozone), with a GDP of just under $1 trillion according to 2022 data.[201] The construction industry accounts for 4.9% of the country's GDP,[202] which is a relatively important share of the overall growth of the country.

Despite internal efforts in the Netherlands to achieve a circular economy, waste management, and climate sensitivity, this country sends out 150 truckloads or about 3000 tonnes of metal waste every day, with 80% of the scrap metal collected from the waste streams of the country going to Türkiye. [203] It also imports scrap metal waste from other countries such as Germany and Belgium and then re-exports it to non-European countries. In 2020, together with Türkiye, China and India as countries with weak regulations and legislation on waste trade, recycling, and carbon emissions were importing scrap metal waste and, consequently, carbon emissions from the Netherlands.

The construction industry plays an important role in the Dutch economy in terms of resource consumption and employment opportunities for 685,000 people. The circularity of metabolic flows and industrial activities in the country is said to be about 24.5%.[204] At the request of the Dutch government in 2022, the Circularity Gap Report, prepared by a mixed team including private companies and foundations such as the Circle Economy

201. International Trade Administration U.S. Department of Commerce, "Netherlands- Market Overview." Accessed June 1, 2024. Available at: https://www.trade.gov/country-commercial-guides/netherlands-market-overview

202. United Nations Economic Commission for Europe, "Share of construction in GDP data portal" Accessed June 1, 2024. https://w3.unece.org/PXWeb/en/Table?IndicatorCode=8

203. Robin Pascoe, "The Netherlands Is a Major Exporter of Scrap Metal- 150 Lorry Loads a Day." DutchNews.nl, September 16, 2020. Available at: https://www.dutchnews.nl/2020/09/the-netherlands-is-a-major-exporter-of-scrap-metal-150-lorry-loads-a-day/

204. Circularity Gap Reporting Initiative, "Netherlands- Circularity Gap Reporting Initiative." Accessed June 2, 2024. https://www.circularity-gap.world/netherlands

205. Ibid.

Cooperative and Metabolic HQ, was prepared for the built environment and the construction industry, analysing current metabolic flows and providing a roadmap for the transition to full circularity by 2050. The reason for analysing and strategising the transition to circularity through the construction industry and the built environment was explained by the fact that the construction industry and its metabolic flows are responsible for one-third of carbon emissions and 40% of solid waste production while reusing 8% of discarded construction materials[205] (Figure 60).

According to MFA, the report also stated that, with the Circular Economy Implementation Programme prepared for 2019, certain actions were taken to realise long-term circularity targets by 2023. One of these actions was to introduce a variety of schemes for demolition plans that allow the use of secondary materials in new buildings constructed from 2018 onwards, as well as the utilisation of the reuse of salvaged materials. Support for this transition is also explained by the fact that EU-level taxes for carbon emissions are expected to rise from 2025 onwards. Another strategy to facilitate the transition to a circular economy is making secondary materials more economically attractive. This could be achieved by shifting taxes from labour to raw resource extraction, a concept promoted by the Netherlands-based Ex'tax initiative. Such a policy change would not only encourage the use of recycled materials but would also create sustainable jobs.

The Urban Mining of Rotterdam

As the second largest city in the Netherlands, Rotterdam plays an important role in the Dutch economy and is a centre for international trade and logistics.[206] The City of Rotterdam is actively involved in various urban development projects, sustainability initiatives, and circular economy programmes. This includes efforts to reduce waste, promote recycling, and support sustainable construction practices.[207] In most cases, urban mining efforts for large-scale investments and strategies are put out to bid and assigned to private corporations in the Netherlands by local governments. The Urban Mining of Rotterdam is a sample research project commissioned by the Municipality of Rotterdam and prepared by a mixed team of experts and professionals from organisations such as Metabolic HQ, Circle Economy Spring Associates, Superuse Studios, and BlueCity (Figure 61)

206. Metabolic, "The Urban Mining of Rotterdam." Accessed May 20, 2024. https://www.metabolic.nl/publications/rotterdams-urban-mine/

207. Ibid.

208. Ibid.

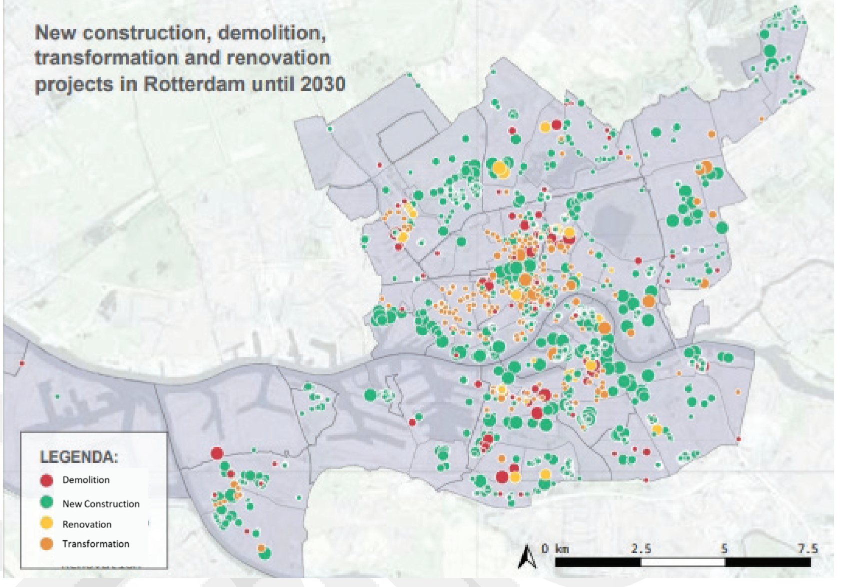


Figure 61: Planned Construction, Demolition, Transformation and Renovation Rotterdam by 2030
Source: Metabolic HQ

In the project's report, it is noted that although a significant amount of construction and demolition waste is generated in Rotterdam, only a small percentage (5%) of that waste is recycled. The vast majority of C&D waste is downcycled; 85% of construction rubble is downcycled.[208] For these reasons, Rotterdam has developed strategies to raise awareness of the environmental impacts of C&D waste in the city, particularly greenhouse gas emissions, air pollution, resource depletion, and waste management challenges, and to move towards a sustainable and environmentally sound urban environment by promoting sustainable waste management practices.

The concept of urban mining in Rotterdam focuses on the extraction of valuable materials from the built environment, including buildings, infrastructure, and products. Urban mining strategies include the identification and recovery of reusable materials from construction and demolition projects, renovation activities, and maintenance processes. It is emphasised that mapping demolition, renovation, and transformation projects to identify material quantities, types, and opportunities for material recovery and reuse is critical in planning urban mining strategies.

Superuse Studios and Harvest Map

In establishing the importance of mapping for urban mining, the Netherlands-based architectural firm Superuse Studios has made quite a critical contribution with the online material map they created. For this reason, Superuse Studios constitutes an important precedent for creating systematic approaches to design with waste materials and the mining of waste materials(Figure 63). They coined the term "harvesting" to refer to the collection of leftover materials for reuse at the locations where those materials have been disposed of.[209] The online material map at oogskaart.nl (Figure 62) serves as a database of available anthropogenic material stocks and an important tool to help architects and designers access nearby reclaimed building materials.[210]

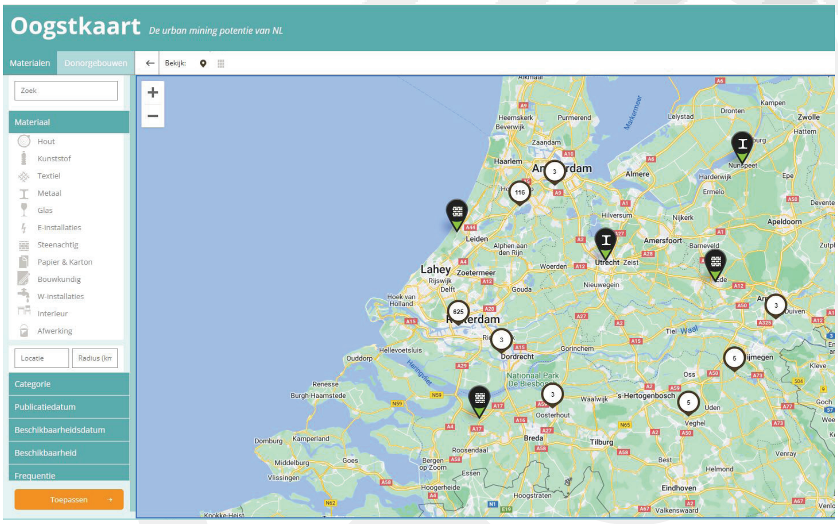


Figure 62: Harvest map. Source: oogstkaart.nl

The map is a useful network for harvesting high-quality materials used for a short time and disposed of rapidly, like materials from exhibitions and fairs; materials at the end of their lifecycles, like billboards and windmill blades; production wastes and production outputs with appropriate quality and scalability; C&D wastes such as doors, window frames, and facade panels; and dead stock products that have been made obsolete[211] (Figure 64)

This harvesting map can be described as a relational infrastructure that links actors of the construction industry while making waste construction materials accessible and reusable. Superuse Studios has also integrated the reuse of such materials in their design processes with seven design strategies (Figure 63).

1.Harvesting Materials
2.Reusing&refurbishing old buildings
3.Circular Materials (Reusable, renewable, recycled)
4.Circular Building Design Process
5.Demountable Construction
6. Material-driven Design
7.Permits and Warranties

Figure 63: Strategies of Superuse Studio for sustainable architecture. Source: superuse-studios.com

209. Superuse Studios, October 27, 2023. https://www.superuse-studios.com/about-us/

210. Ibid.

211. Ibid.

212. Superuse Studios, October 27, 2023. https://www.superuse-studios.com/about-us/

213. Ibid.

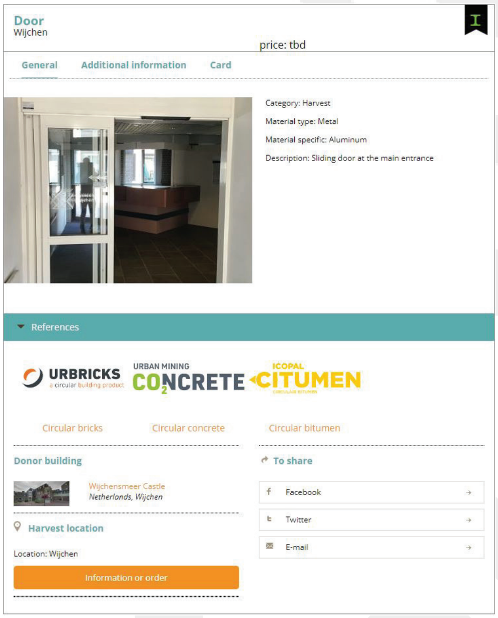


Figure 64: A door identity for Harvest, oogskaart.nl

The first strategy is harvesting building materials from sources such as nearby industrial areas or donor buildings. This first strategy consists of an initial design proposal with a specific harvest map showing nearby materials and also analysing the context for adapting the usage of existing materials to new proposals as the second strategy, since the demolition of the adaptable existing material also has environmental and economic consequences. As a third strategy, the choice of materials is made with hierarchical preferences, such as preventing unnecessary material use, ensuring future reusability of the materials and reuse of existing materials and building components, use of renewable or biobased material, use of recycled materials, and, as a last choice, use of conventional materials if there are no other options available. Following this hierarchy of choice and prioritising options for reuse will not only decrease the carbon emissions and carbon footprints caused by new material production, transportation, and logistics but also gives a second chance to existing materials and eliminates the energy needed to recycle, dispose of, or incinerate waste while preventing pollution caused by by-products.[212]

After gathering harvested materials, a material passport is prepared, specifying the materials contained in the building and information that can be used for lifecycle assessment for their potential reuse in future. As other main strategies, designing projects with demountable construction details and material-driven design methods that track the potentials of materials already available in early design phases are considered in the initial phases of Superuse Studios' design processes (Figure 65). Overall, it is important to complete processes in such a way that all stakeholders agree on responsibilities to be undertaken together with the customer and contractors, especially due to the lack of an intermediate mechanism that guarantees the safety and life of reclaimed materials, using both common sense and the opinion of an external party.[213]

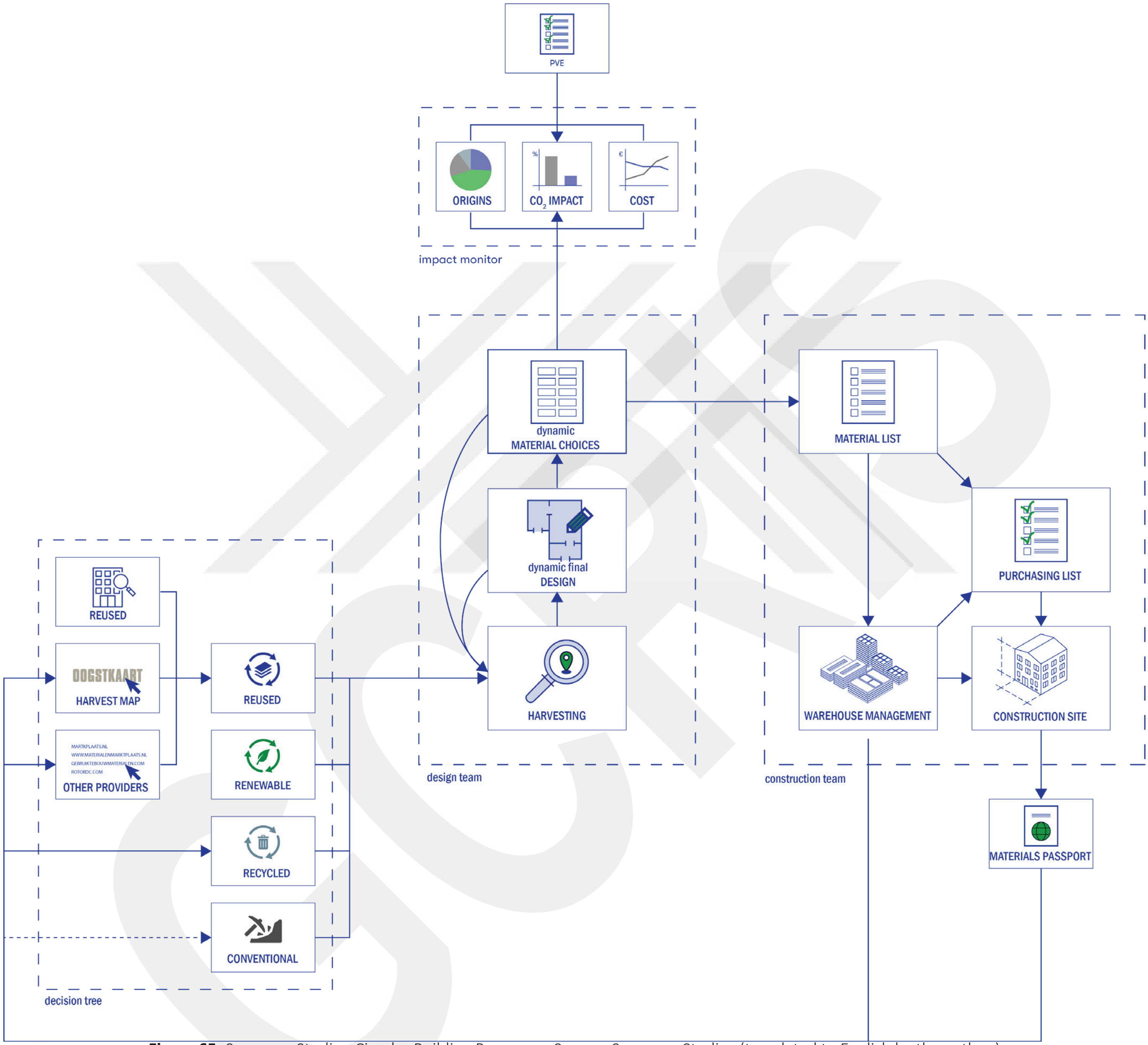


Figure 65: Superuse Studios-Circular Building Processes. Source: Superuse Studios (translated to English by the author.)

214. Andreas Luco, “People’s Pavilion / Bureau SLA + Overtreders W.” ArchDaily, April 29, 2019. https://www.archdaily.com/915977/peoples-pavilion-bureau-sla-plus-overtreders-w

215. Nicole Gevers, “Dutch Design Award Voor Het People’s Pavilion.” New Horizon, September 13, 2019. https://newhorizon.nl/actueel/urban-mining/dutch-design-award-voor-het-peoples-pavilion/

216. Arup, “People’s Pavillion.”, Accessed June 2, 2024. https://www.arup.com/projects/peoples-pavilion

People’s Pavilion / bureau SLA + OvertredersW

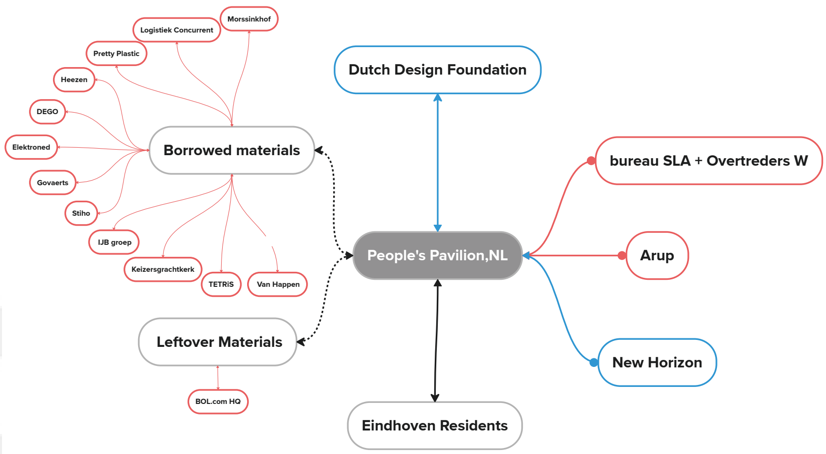


Figure 66: Material and immaterial flows: stakeholder relations in the making of the People’s Pavilion, where blue presents initiatives funded by institutions and red lines present those funded by private companies. Produced by the author, 2024

The People’s Pavilion, a temporary meeting space built in 2017 during the Dutch Design Week in Eindhoven and designed for disassembly, offers a real-life example of how circular economy principles can be applied in architectural design. Aligning with the design brief calling for a temporary space, the materials included wooden beams, facade elements, and even concrete “100% borrowed” from local suppliers and returned to their owners at the end of Dutch Design Week as well as Eindhoven residents’ plastic waste used for the recycled facade tiles. [214]

Arup, which undertook the structural design of the project, brought together the materials collected in cooperation with the urban mining initiative New Horizon (Figure 66). I In details developed based on “circular” materials procured from the Urban Mining Collective[215] database, connection details were planned in a reusable way without disturbing the physical integrity of the collected materials. The prefabricated concrete foundation piles used in the project were joined with steel bars recovered from a demolished office building, while the composite timber beams were stabilised with ratchet straps[216] (Figure 67, Figure 68).

Figure 67: People’s Pavillion, 2017 | Source: Archdaily

Excluding the glass facade from a demolished office building and the floor covering from the renovation of BOL HQ, the lighting, glass roof, and other interior elements were borrowed from suppliers.

Constructed using recycled materials and salvaged components from demolished buildings, this structure constitutes a significant example of circular design strategies. However, its use of plastic, a material with long-term ecological concerns for recycling and reuse, presents a challenge. In this

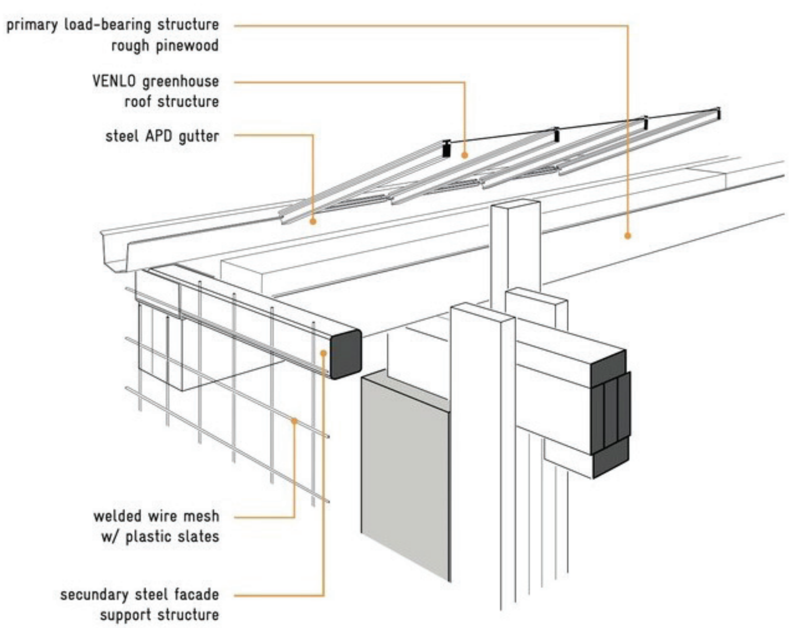


Figure 68: Dry Connection Details of People's Pavillion | Source: Archdaily

respect, by promoting plastic recycling, it also promoted the consumption habits that feed the plastic industry.

The definition of "circular" was left unclear on this project's website. Furthermore, donor information for the reclaimed material was not provided as open data in the New Horizon's Urban Mining Collective database, making it difficult to determine how and where the materials were procured or the carbon footprint created by the logistics. In the long run, the transformation of urban mining into a kind of waste trade with materials being collected globally by companies may increase inequality in other parts of the world as well as causing token climate sensitivity.

Zürich, Switzerland | UMAR Unit

Zurich, the largest city in Switzerland, is the industrial, financial, and cultural centre of the country and one of the most cosmopolitan and dynamic cities in Switzerland. The City of Zurich, which signed the Circular City Declaration in 2022 with the goal of achieving net-zero carbon by 2040, particularly focuses its circular economy strategies on the construction sector, sustainable construction materials, reuse of existing components, and the recycling of concrete[217] (Figure 69).

Figure 69: The Urban Mining and Recycling (UMAR) Credit: Zooey Braun

217. Circular Cities Declaration, "Zurich." Accessed May 20, 2024. https://circularcitiesdeclaration.eu/cities/zurich

218. Ibid.

In addition to a focus on urban mining of the existing building stock, the City of Zurich encourages circular construction methods for new urbanisation efforts in the future in accordance with the principles of the circular economy.[218] The Urban Mining and Recycling (UMAR) Unit designed and constructed at NEST (Next Evolution of Sustainable Technologies) of Empa Dübendorf (Swiss Federal Laboratories for Material Science and Technology) [219] stands out as an important precedent for futuristic construction methods in this sense.

Figure 70: Construction process, placement of modular and demountable Units Source: nest-umar.net

The building is a real-life experiment of how buildings could be used as material banks in future cities.[220] The UMAR Unit is a particularly important precedent because of the efforts to calculate and measure the circularity and reusability of building materials and plan their subsequent lifecycles. It consists of the integration of prefabricated and reversible units designed with dry connection details in a reinforced concrete structure(Figure 70) The prefabricated units allow the minimisation of construction waste. The research team focused on two primary material categories and their respective process strategies. The first category involved raw materials extracted from geological ores, such as petroleum-based plastics or metals, emphasising the importance of appropriate connection details and detachability to facilitate reusability, which they termed "technological metabolism." The second category included biologically natural, biodegradable, or compostable materials, which they referred to as "biological metabolism."[221]

In this respect, the UMAR Unit offers a construction approach that will facilitate the provision of a circular economy in cities in the future through reuse and recycling strategies. Designing buildings as material banks emphasises the temporary use of materials for specific functions and requirements, assigning materials to another building after the first building's use purpose reaches its end and allowing the materials to be reused when the day comes while preserving their value. Although the project had the valuable intention of calculating circularity in design processes and lifecycle assessments with the processing of data embedded in the methods, materials, and other details, it excluded factors such as production methods, logistics, and carbon footprints of the materials used from those circularity calculations(Figure 71) Thus, it seems that there are aspects that need to be developed and studied more, such as connection details that will ensure demountability, the possibility of increasing initial production costs, and the fact that demountability limits design and usage flexibility.

Figure 71: A part of Interface of Madastar Database showing the circularity indicators of UMAR Source: Madaster, Heisel et al.

219. Felix Heisel and Sabine Rau-Oberhuber, "Calculation and Evaluation of Circularity Indicators for the Built Environment Using the Case Studies of UMAR and Madaster." Journal of Cleaner Production 243 (2020): 118482. https://doi.org/10.1016/j.jclepro.2019.118482

220. Ibid.

221. Urban Mining and Recycling (UMAR), "Biological or Technical Metabolism." Accessed January 23, 2024. http://nest-umar.net/portfolio/biological-or-technical-metabolism/

Leuven, Belgium

As noted above, Belgium is one of the countries with an export role in the metal waste trade. In 2018, France, Germany, and the Netherlands imported 96% of Belgium's waste exports.[222] However, Belgium's low-value ferrous metals and plastic wastes are mostly imported by Türkiye. According to 2020 data, 34% of the total solid waste generated belonged to the construction sector.[223] In line with the European Green Deal, Leuven aims to be climate-neutral by 2030.

According to Leuven's roadmap for a circular city by 2030, the political framework for transitioning to circularity in Leuven involves strategies related to urban metabolism while integrating circularity into purchasing policies, optimising policy instruments to support circularity, collaborating with learning networks, and monitoring complementarity with various policies and programmes. In addition to the establishment of the European Green Deal in 2020, the Flemish region in which Leuven is located already had a set of policies on managing solid waste.

The Decree of 2012 on the management of material cycles and waste, known as the "Materialendecreet" or "Material Decree," is an important legal instrument regulating the management of material cycles and waste including C&D waste in the Flemish region of Belgium.[224] This decree sets out detailed provisions aimed at promoting sustainable waste management practices.

One of the key components of the Material Decree is the implementation order known as the VLAREMA, which provides specific regulations and guidelines for the implementation of the Material Decree, focusing on various aspects of waste management including waste transport, reporting, selective collection, and extended producer responsibility.

In addition to these policies, key objectives of Leuven's transition to a circular city include promoting circular business practices, developing circular construction techniques, encouraging product recovery and reuse, and developing sustainable consumption behaviours to promote sustainability and innovation in the urban environment.

222. OECD Environmental, "Performance Reviews: Belgium 2021" Accessed June 2, 2024. https://www.oecd-ilibrary.org/sites/1c14a6aa-en/index.html?itemId=%2Fcontent%2Fcomponent%2F1c14a6aa-en

223. Ibid.

224. European Commission, "Screening Template for Construction and Demolition Waste" Accessed June 2, 2024. Available at: https://ec.europa.eu/environment/pdf/waste/studies/deliverables/CDW_Belgium_Factsheet_Final.pdf

225. European Union Pop-Machina "Leuven Circulair" Accessed June 2, 2024. https://pop-machina.eu/leuven-circulair/

226. Ingrid Schroder, Reham Elwakil, and Koen Steemers. "Hybrid Makerspaces and Networks for the Circular City: A Case Study of Leuven, Belgium." Buildings 14, no. 1 (January 5, 2024): 137. https://doi.org/10.3390/buildings14010137

227. Ibid.

Pop Machina Leuven

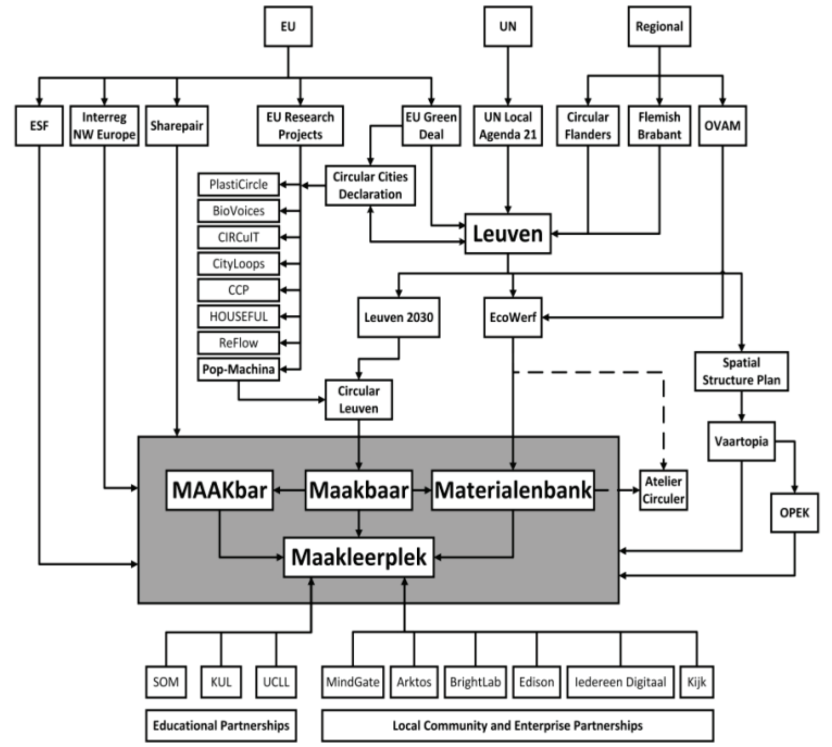


Figure 72: A network of relationships that facilitate the circular maker activities in Leuven Source: Schoreder et al. 2024

As a part of the EU Horizon 2020 Programme, the project Pop-Machina was launched in seven pilot cities in Europe to enhance communication between the maker movement and the circular economy (Figure 72). By combining the reuse and recycling of materials with the maker movement, it aims to reduce waste production and produce innovative and environmentally sensitive products with the power of collaborative production while creating a community.

As part of the strategy for going climate-neutral by 2030, Pop-Machina Leuven focuses on reducing the logistics route by sourcing materials from shorter distances and cultivating a cradle to cradle approach to production and consumption habits. [225]

In Leuven, the Maakleerplek, MAAKbar, and Materialenbank are the three main production spaces integrated into the city for the transition of the urban metabolism towards circularity[226] (Figure 73) The Maakleerplek functions as a coworking makerspace, providing facilities for organisations, schools, artists, and residents to collaborate and create together, while

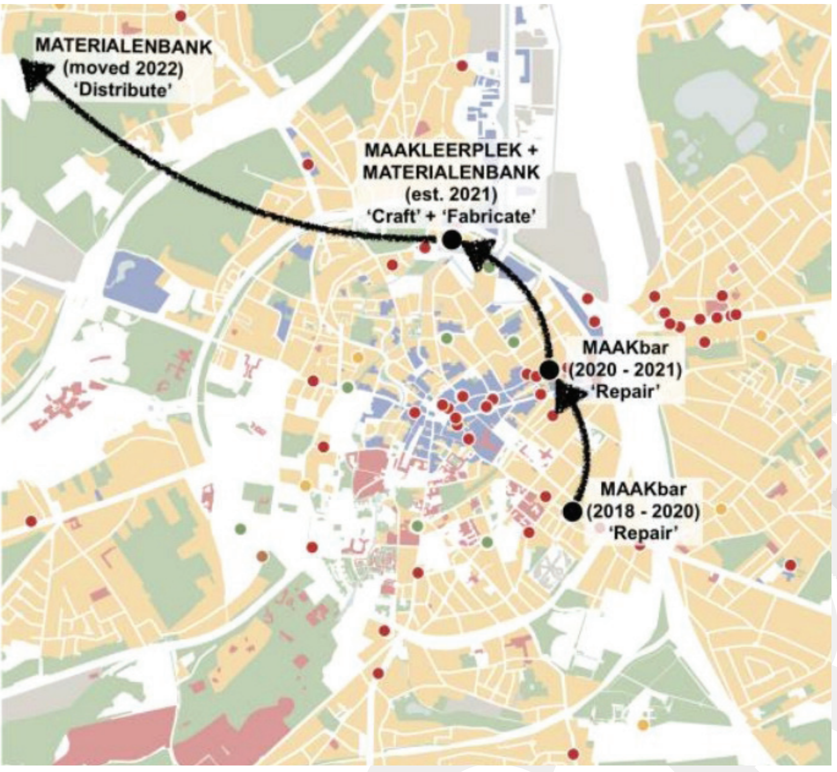


Figure 73: Map of Leuven, distribution of MAAKbar, Maakleerplek and Materialbank Source: Schoreder et al. 2024

MAAKbar, a volunteer organisation of makers, operates as a public shopfront for circular makers' initiatives, focusing on repair cafés and community engagement. Materialenbank provides recycled materials and operates as a web-based network for recovered building materials[227]
(Figure 74)

Looking at the approach to increasing connectedness and information flows for circular strategies, the focus of this project can be understood in the context of the city's 2030 and 2050 visions. However, it can be said that the incentives given for circular entrepreneurship also contribute to the level of development and impact of the project. In other pilot cities, unfortunately including Istanbul, it can be observed that the planning of the sustainability of circularity fails in raising public awareness, the area of impact is debatable, and approaches aimed at producing products from discarded materials are being adopted to introduce society to the circular economy. It is possible to say that the political framework already established by the country and local governments and the importance of this project due to the targets set for 2030 have had important shares in the level of development of the project and the effort to establish a sustainable circular economy.

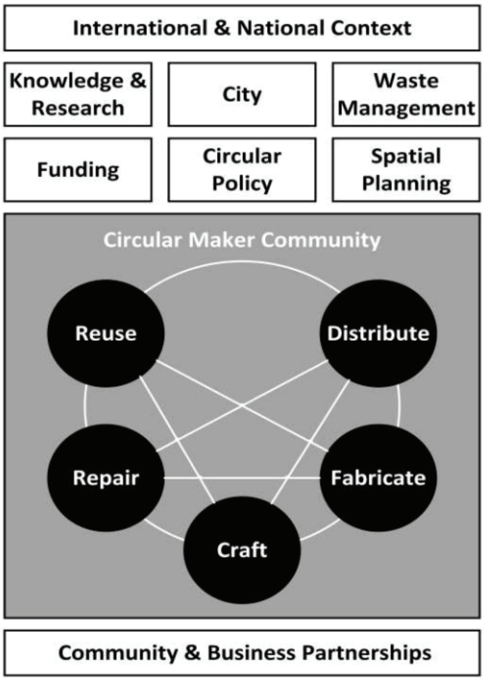


Figure 74: Contextual factors and stakeholders for circular urban ecology, Source: Schoreder et al. 2024

Urban Mining Perspectives from Asia

China

In China, approximately 57% of the population lives in urban areas and it is expected that this proportion will increase to 67% by 2030.[228] As the biggest manufacturer and one of the largest waste importers of the world, China has a significant effect on carbon emissions. In fact, until serious restrictions were placed on waste imports with the “Green Fence Policy” in 2013 and the “National Sword Policy” in 2017 banning 24 types of solid wastes from being imported and reducing the contamination rate from 5% to 0.5%, China was the biggest importer of the global waste trade.[229]

The decision to ban the solid waste trade was not only related to the finding that imported materials were contaminated with “large amounts of dirty waste and even hazardous waste””[230] and linked to rising labour costs triggered by China’s internal waste problems.[231] This was a duplicating effect even more because of the increasing demand for new housing and infrastructure related to rapid urbanization. In line with the increasing density and demand for housing in urban areas, China produces 2.4 million tonnes of construction waste annually. This amount accounts for 40% of the total municipal waste generated.

The effect of the solid waste trade was amplified by the increasing demand for new housing and infrastructure related to rapid urbanisation. In line with increasing population density and demand for housing in urban areas, China produces 2.4 million tonnes of construction waste annually. This amount accounts for 40% of the total municipal waste generated.

As in many countries, there are few formal recycling programmes relative to the volume of waste generated and so a considerable proportion of recycling processes are carried out informally, in ways similar to those seen in Türkiye. However, the recycling rate for construction waste is less than 5%, which is much lower compared to European countries.[232] Moreover, in China, the current disposal method for C&D waste is disposal in open areas and landfills, which occupy very large areas and lead chemical compounds to leak into the soil and groundwater via rainwater, posing a serious ecological threat.[233]

228. Ellen MacArthur Foundation, “The circular economy opportunity for urban and industrial innovation in China”, 2018.

229. Colin Staub, “China’s Slightly Laxed Limit Does Little for Paper”. December 5, 2017. Accessed May 26, 2024. https://resource-recycling.com/recycling/2017/12/05/chinas-slightly-laxed-limit-little-paper/

230. Ibid.

231. Caroline O’Donnell and Dillon Pranger, ”The Architecture of Waste Design for a Circular Economy”, 2021.

232. Shi et al., “Site selection of construction waste recycling plant”, Journal of Cleaner Production, Volume 227 (2019):42.

233. Burkart et al., Assessing groundwater vulnerability to agrochemical contamination in the Midwest US. Water Sci. Technol. 39 (3),(1999): 103–112. https://doi.org/10.1016/S0273-1223(99)00042-6

234. Wang et al., “Cradle-to-Cradle Modeling of the Future Steel Flow in China.” Resources, Conservation and Recycling 117 (February 2017): 45–57. https://doi.org/10.1016/j.resconrec.2015.07.009

On the other hand, since the implementation of the Green Fence Policy has imposed stricter quality controls on imported scrap, the overall supply of high-quality recyclable materials has decreased. For example, secondary steel production is less than the primary production because of the limited availability of scrap in China.[234]

In the short term, this policy could encourage the creation of appropriate infrastructure and organisations to recycle waste by intensifying competition for domestic scrap, although potentially increasing recycling costs by changing market dynamics. In that case, it would be inevitable that secondary production would affect market demand and, in the long term, the flow of produced materials throughout their lifecycles. In addition, the existing production of low-quality scrap steel will continue on a global scale.

The entry of low-quality scrap into China, which requires more energy for recycling and causes carbon emissions, is restricted. Thus, countries with lower levels of economic and regulatory development still face many problems. In this sense, organising a similar policy on a global scale would not only protect vulnerable populations and endangered species from the negative impacts of the global waste trade but would also reduce the carbon footprint globally. In the early 2000s, the importance of circular economy policies was officially understood in China within the context of integration of environmental sustainability with economic growth.[235] However, China's transition to a circular economy has not been easy as the country struggles with environmental pollution caused by industry while European countries and Japan focus instead on 3R strategies and product legislation.[236]

235. Ru Chen, "China's Circular Economy Policies: Review and reflection." Circular Innovation Lab, Circular Press, Issue Nb.4, 2023.

236. Ibid.

237. Kerstin Unfried and Feicheng Wang, "Importing Air Pollution? Evidence from China's Plastic Waste Imports." SSRN Electronic Journal, 2022. https://doi.org/10.2139/ssrn.4078240

Figure 75: A development in Chanza, China a Tier 2 city. Source: The Guardian, 2017.

Figure 76: A retired teacher in Shaoyang whose house is demolishing. Source: The Guardian.

This is not surprising considering the global waste import rates of China between 2001 and 2018,[237] wwhile Japan and European countries remain at the top of the rankings for waste exporters globally.

On the other hand, China has been improving its international and internal policies in recent years, beginning with a ban on plastic imports, to cope with the hazardous effects of the global waste trade and industrial production. The adaptation of circular economy strategies in industry has had a significant role in this improvement. Strategies have been adopted in China at macro, meso, and micro levels related to the goals stated in recent Five-Year Development Plans to "promote resource conservation and recycling by setting targets to ensure national resource security". [238] At the macro level, the focus is on national-scale regulations, development plans, and regional networks for disposal and recycling of waste, while the meso focus includes regional and sectoral collaborations such as eco-industrial parks and circular supply chains. The micro level primarily targets sustainability in consumption-based production.[239]

It seems that priority in green economic development is being given to addressing the causes of environmental pollution while shifting material networks. Since China's circular economy strategies involve creating symbiotic relationships across different scales, a development scale is used for cities based on GDP contributions, relationships with industries, and population.[240] This classification is called the "city archetype" and it is used to apply tailor-made circular strategies for each city. For example, Ningbo, as a Tier 2 city, [241] was affected by the "property boom" in Tier 1 cities[242] (Figure 75, Figure 77). That boom created high demand for construction activities in Ningbo, leading to the demolition of old villages (Figure 76) On the other hand, government incentives encourage designs for longevity with the extension of the lifecycles of both materials and buildings. As another strategy, the government advocates modularisation and prefabrication for both materials and buildings.

The Chinese government set a goal of 30% of new buildings being prefabricated with modular off-site construction by 2026.[243] Other strategies for Tier 1 and Tier 2 archetypical cities include designing sharable and reusable buildings, promoting green and eco-effective buildings, using smart building technologies to reduce waste, offering incentives for public-private partnerships, and providing education and training for the construction industry's stakeholders.[244]

238. Ru Chen, "China's Circular Economy Policies: Review and reflection.", 2023.

239. Biwei et al., "A review of the circular economy in China: Moving from rhetoric to implementation". Journal of Cleaner Production, 2013.DOI: 42. 215-227. 10.1016/j.jclepro.2012.11.020

240. Arup& Ellen McArthur Foundation. "The Circular Economy: Opportunity for Urban & Industrial Innovation in China,2019." Available at: https://www.arup.com/globalassets/downloads/insights/the-circular-economy-opportunity-for-urban-industrial-innovation-in-china.pdf

241. China Briefing, "China's City Tier Classification Defined." , August 15, 2019. Available at: https://www.china-briefing.com/news/chinas-city-tier-classification-defined/

242. Yawen Chen and Ryan Woo, "Real estate booms in China's small cities, but construction outpaces demand" Reuters, 2017. Available at: https://www.reuters.com/article/us-china-economy-smallcities/real-estate-booms-in-chinas-small-cities-but-construction-outpaces-demand-idUSKBN1AF01A/

243. Central Government of the People's Republic of China, General Office of the State Council of the People's Republic of China, "Guidance Opinion on Promoting Prefabricated Buildings", 2016.

244. Arup, "The Circular Economy: Opportunity for Urban & Industrial Innovation in China,2019. Available at: https://www.arup.com/globalassets/downloads/insights/the-circular-economy-opportunity-for-urban-industrial-innovation-in-china.pdf

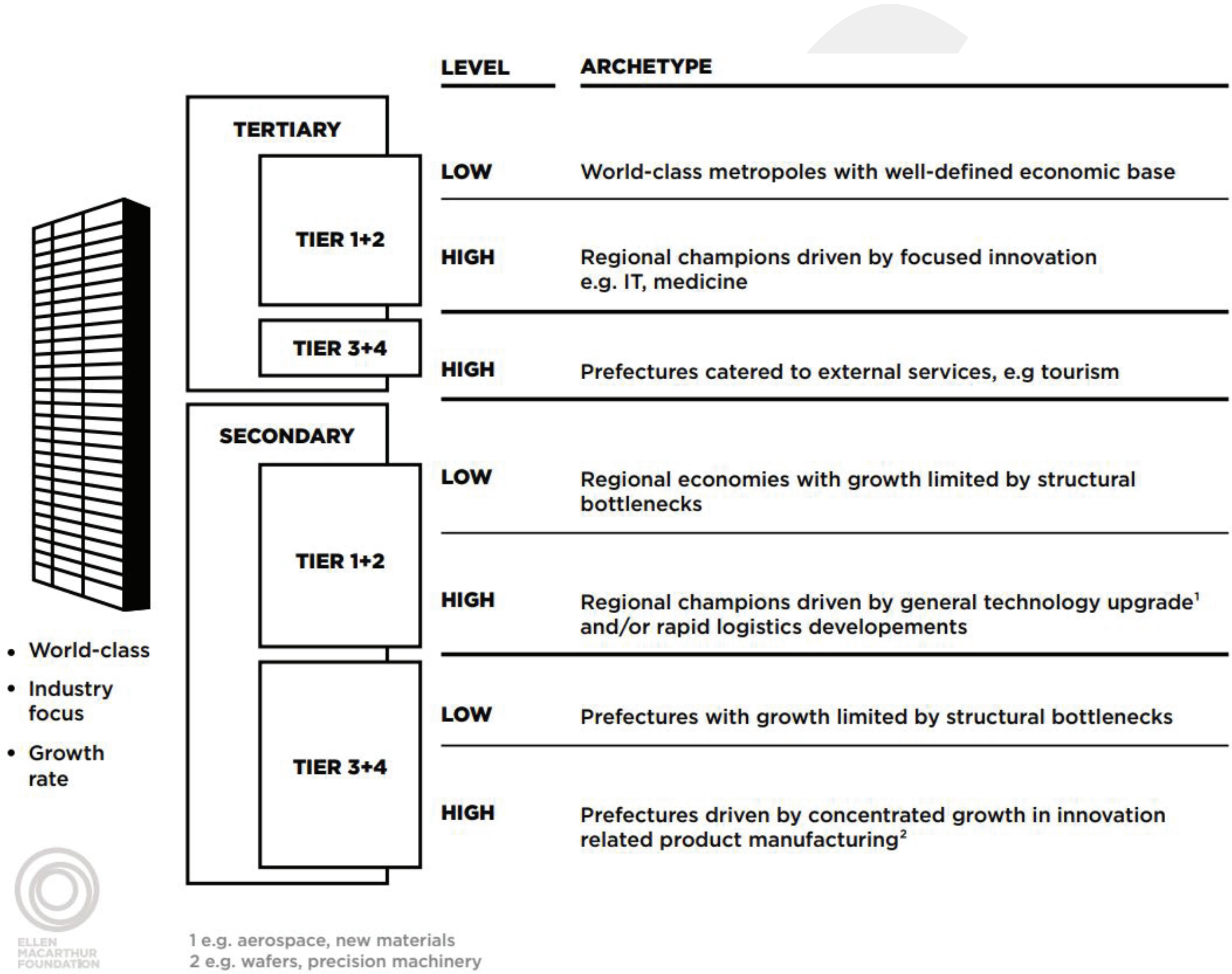


Figure 77: :City Archetypes Source: Ellen McArthur Foundation.

Ningbo Historic Museum

Figure 78: Ningbo Historic Museum, 2009 Source: Archdaily

In the early 2000s, historical villages in China were being demolished to accommodate new developments because of rapid urbanisation. Ningbo was one of these historical villages, which led to concerns about losing cultural heritage and local identity. [245] As a response to the demolitions, the Amateur Architecture Studio based in Hangzhou, China, cultivated an experimental approach for supplying the materials of the Ningbo Museum(Figure 78). They reclaimed the bricks from the villages demolished nearby and reused.[246] They reclaimed and reused bricks from nearby demolished villages.(Figure 79) This technique is developed by the Chinese craftsmen within limiting conditions as a recovery method after natural disasters such as typhoons.[247] Bricks and tiles from the demolition debris of the villages were collected and stacked by craftsmen to repair their damaged homes, arising from the need to reuse materials to recover from disasters' destructive results.

The co-founder of the Amateur Architecture Studio, Wang Shu, had worked on the wapan technique for many years before the Ningbo Museum and he preferred scrap tiles not just for the local identity they embodied; he also preferred them for the quality of the material and the low price.[248] The architects adapted this traditional technique with contemporary materials and techniques such as reinforced concrete.[249] In a way, adapting the wapan technique for large-scale applications under current building regulations was necessary(Figure 80).

245. Bruce White, "Formulating a Critical Regionalism-Based Framework for Contemporary Tourism Development in Rural China." Order No. 28490844, University of Hawai'i at Manoa, 2021. Available at: https://www.proquest.com/dissertations-theses/formulating-critical-regionalism-based framework/docview/2572619674/se-2

246. Ibid.

247. Elizabeth Golden, "Traditional Materials Optimized for The Twenty-First Century" In CHANGE, Architecture, Education, Practices. 2012 ACSA International Conference Barcelona. Available at: https://www.acsaarch.org/proceedings/International%20Proceedings/ACSA.Intl.2012/ACSA.Intl.2012.11.pdf

248. Wang Shu, "Architecture with Hands," (lecture, Rice University, Houson,TX, October 12, 2011)

249. Elizabeth Golden, "Traditional Materials Optimized for The Twenty-First Century", 2012.

However, transforming the stacked, dry connection technique to a more composite system corrupts the core idea of the technique: reusability. Of course, considering the general approach, it was not intended to respond to the lifecycle of materials or circularity. Nevertheless, it stands as an important showcase of the possibilities of contemporary architectural technology and the reuse of demolition materials.

Figure 79: Traditional wapan technique Source: Wei Pheng et al.,2016

At the same time, this choice of material for this project was considered by some to be a response to the prohibition of solid clay bricks because of carbon emissions.[250] Although that ban implies that traditional clay brick production is inappropriate for the mass production required by the modern built environment, this project remains an important precedent for reusing existing materials scrapped from other buildings at the ends of their lifecycles with different motives such as respecting cultural heritage and local identity. Due to the standardisation and global influence that modern culture provides, the sustainability of the traditional knowledge of building techniques and local culture can easily be lost.

This sustainability encompasses eco-efficient properties of architectural production such as natural material use, sourcing from nearby areas, and regionally appropriate ventilation, rain control, and temperature regulation.[251] However, even if it is not referred to directly as the urban mining of demolition waste, as Wang Shu claims, from a western perspective, it cannot be ignored that these methods can serve the same purpose of addressing resource depletion. Thus, this project can be considered as an example of how architectural technology is able to propose new languages while resembling traditional methods to ease the circular transition in the construction industry.

250. Ronald G. Knapp, China's Old Dwellings (Honolulu: University of Hawai'i Press, 2000): 116.

251. Wang Shu, Chen Xiaorong, "Wang Shu: 'The Sustainable Architecture "system" Has Developed into a Movement.'" The UNESCO Courier, 2024. Available at: https://courier.unesco.org/en/articles/wang-shu-sustainable-architecture-system-has-developed-movement

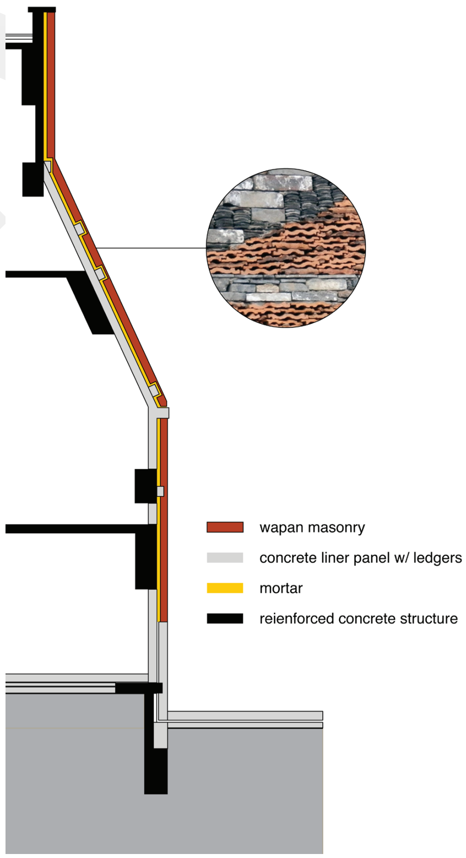


Figure 80: Ningbo Museum wall section Source: Elizabeth Golden, 2012.

C-LAB Urban Mining Taiwan

Figure 81: Taiwan Contemporary Culture Lab, Source: Taiwan Ministry of Culture

Figure 82: Participators harvesting the demolition rubble of the wall Source: C-LAB

C-LAB, officially known as the Taiwan Contemporary Culture Lab, offers a platform for experimentation and dialogue across the fields of contemporary art, technology media, and social innovation, engaging various initiatives, architects, designers, and the community within the framework of urban development and sustainability.[252] The site at which C-LAB is located was formerly a military base, having belonged to the Ministry of Defence Air Force Command Headquarters of the Republic of China since 1950. It was repurposed to create a new cultural ecosystem by the Ministry of Culture of Taiwan in 2018.

Transformation of the site was realised in two steps, first inviting the groups and researchers to the site for repurposing the existing buildings and then inviting international partners to be a part of the renovation.[253]

252. Taiwan Ministry of Culture, "From Airbase to Culture Laboratory: An Unwalled Space for All." 2020. Available at: https://www.moc.gov.tw/en/News_Content2.aspx?n=467&s=15704

253. Ibid.

254. Ibid.

255. Emma McLaughlin, "Urban Mining Trilogy at C-Lab Investigates Circular Material Reuse." ArchDaily, January 17, 2019. Available at: https://www.archdaily.com/927263/urban-mining-trilogy-at-c-lab-investigates-circular-material-reuse

256. Wen-Yih KUO, Pin-Jan,CHEN,Yu-Ching, Li, "Regenerating Red Bricks: Post-Mining Circular Material R&D", Open C-LAB, Urban Mining, Experimental Architecture& Environmental Art, 2019-2020

After the repair and renovation of the site, C-LAB officially opened with the demolition of the walls surrounding the area.[254] Following the demolition of the walls, C-LAB organised a workshop to reuse the rubble from the demolished walls in a new lifecycle[255] (Figure 81, Figure 82) Alkaline-activated bricks were produced from red brick dust with an alkaline activation method.[256] This method offers a promising binder for recycling mineral-based waste such as mining waste, cement-based waste, and bricks.[257] The alkaline activation allows for geopolymer formation, which results in material with high compressive strength and fire resistance. This hybrid material has even been discussed as the future's sustainable material choice to replace concrete (Figure 83).

The plan for C-LAB was to catalogue the material percentages and material types of 22 main buildings for the future demonstration of a micro-circular city and as a material bank to temporarily stop the circulation of materials. Therefore, an inventory was created for each material in C-LAB to be used in case of repair and reuse needs.[258] On the other hand, a group of researchers focused on the New Office Building and conducted research in terms of the "reverse dismantling of architecture" [259] (Figure 84) Reverse dismantling is a method that involves deconstructing a building or structure in a manner that prioritises the recovery and reuse of materials rather than demolishing it. This team argued that choosing demolition over disassembling around the world reflects a tendency arising from the time-consuming assessment process of building parts and elements for disassembly purposes. In the context of the C-LAB site, several buildings had reached or exceeded

Figure 83: Material data bank: Recycled red bricks from the walls. Source: ArchDaily.

257. Hindavi R. Gavali and Rahul V. Ralegaonkar, "Design Development of Sustainable Alkali-Activated Bricks," Journal of Building Engineering 30 ,2020. https://doi.org/10.1016/j.jobe.2020.101302

258. Liou Shuenn-Ren and Chen Pi Cheng, "Overtuned! "Dismantling" Design Thinking", Open C-LAB, Urban Mining, Experimental Architecture& Environmental Art, 2019-2020.

259. Zhu et al., "Material Classification and Reuse Framework Based on the Reverse Dismantling of Architectural Design: A Case Study in TCCLab", Sustainability 2022, 14, 14809. https://doi.org/10.3390/su142214809

260. Ibid.

261. Ibid.

262. Ibid.

Figure 84: New Office Building, Taiwan Contemporary Culture Laboratory, Source: Zhu et al.

50 years of service life. It was also noted that reinforced concrete buildings in Taiwan have shorter service lives because the usage of sea sand leads to corrosion of the internal steel. In such circumstances, maintenance or repair of these buildings is unfeasible as repair costs reach up to 28% of new construction costs.[260] The reverse dismantling method presented in the study described here involved a systematic approach to deconstructing buildings, focusing on the careful removal and classification of materials to maximise their reuse potential.[261]

These researchers established a comprehensive framework that included project information, shearing layers, a material bank, and recycling processes, emphasising a hierarchical order of disassembly (Figure 87).
The results demonstrated that this approach significantly improved the accuracy of material classification and modelling for dismantling, yielding a 37.59% increase in precision compared to traditional methods [262] (Figure 85, Figure 86).

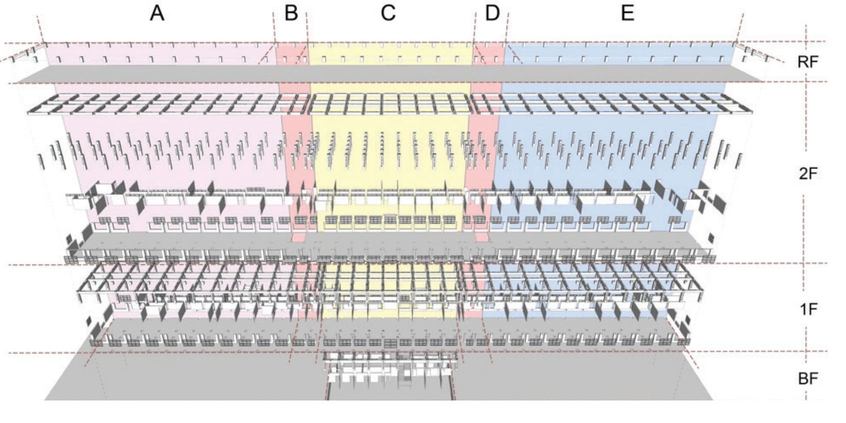


Figure 85: Digital model of the building for disassembly, Zhu et al.

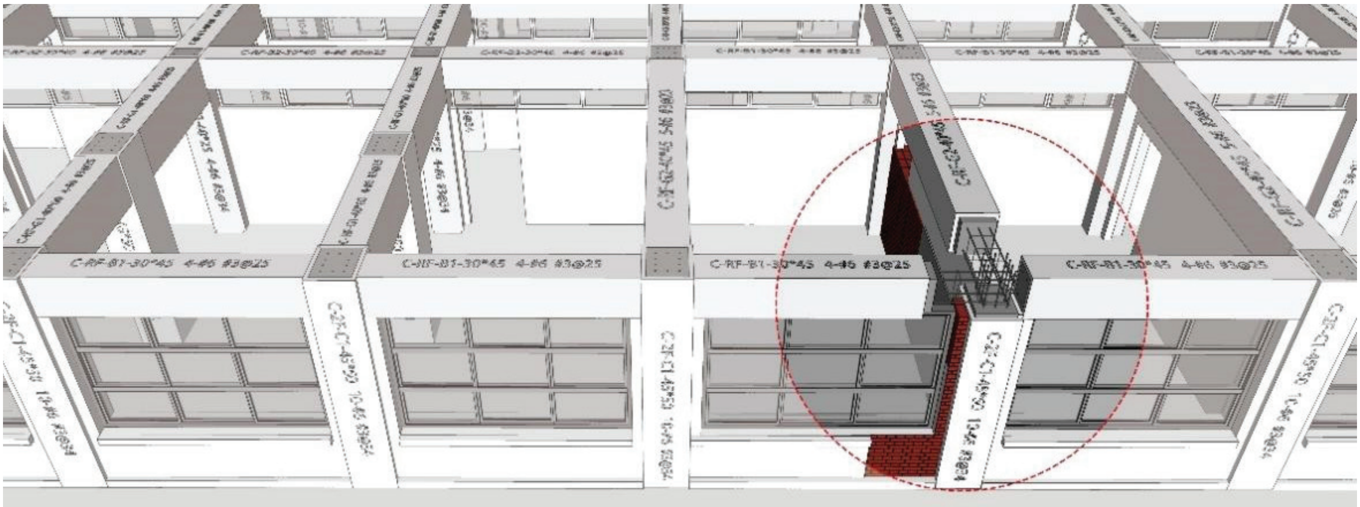


Figure 86: Classification numbers and components of the building, Zhu et al.

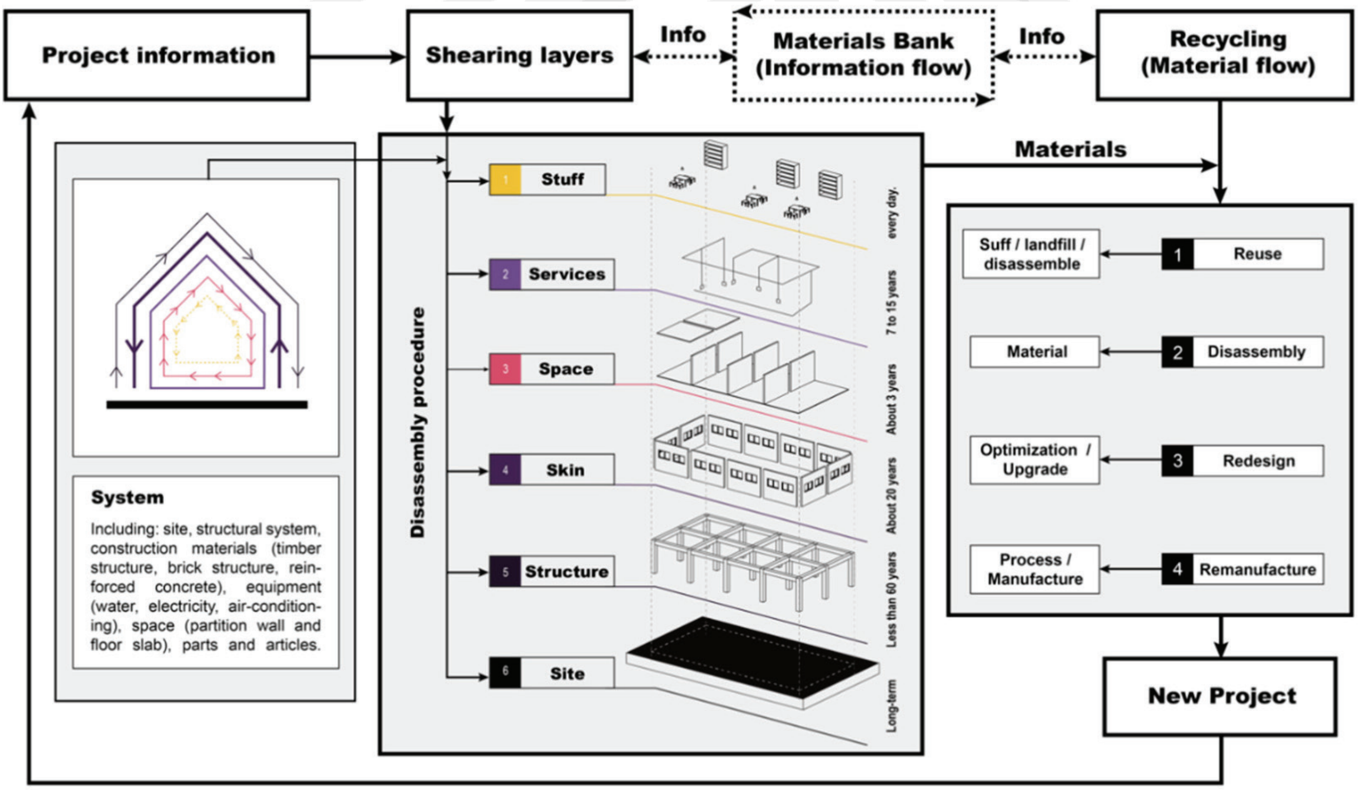


Figure 87: Processes of disassembly and reuse, Source: Zhu et al.

Discussion

In our experiences with Yoo, Bence Güzel Pavilion, it was realised that building materials typical viewed as waste are potential resources for the construction industry. The most important observation was the systemic lack of design and implementation processes due to difficulties in accessing materials and the unknown properties of the available materials. Questions about what tools and platforms could facilitate the processes of architects and other stakeholders in reusing wasted construction materials led me to recognise that C&D waste is strongly connected to larger problems such as resource scarcity, global warming, and carbon footprints. Viewing the existing built environment as a resource and reducing waste production in the construction industry are undertakings that will have many different global repercussions. Given that the construction industry has a 37% share in waste generation, the emergence of the concept of urban mining can be considered as a response to resource scarcity, the climate crisis, environmental pollution, and the harmful impact of waste on biodiversity and natural resources at both local and global scales. Moreover, urban mining stands out as a potential answer to the increasing costs and economic constraints in the construction sector, unlocking the economic value of so-called waste materials.

Therefore, the research presented here began with a repository of examples across scales based on the questions that arose from my personal experience with the reuse of C&D waste. While collecting examples, I realised that the circular economy and urban approaches in architecture and the built environment cannot be separated from public and institutional stakeholders or from relationships and policies established at local, urban, and regional scales.

From a geographical perspective, I noticed an increased concentration of examples of circular economy in the construction industry in North European countries. At this point, shifting to a regional scale, I wanted to compare the collected cases around the world while considering global waste trade flows. Since the global waste trade, which reinforces the problems described here on a global scale, provides a suitable basis for understanding the flows of materials classified as waste, I focused on expanding the sample pool in line with the largest waste-importing and waste-exporting countries. Accordingly,

263. Yeni Arayış. "İPA: İstanbul'da 1.3 Milyon Riskli Konut Var." Yeni Arayış, August 21, 2024. https://www.yeniarayis.com/haber/ipa-istanbulda-13-milyon-riskli-konut-var-7007

practices and approaches from around the world were chosen based on circular economy strategies, related legal frameworks, and their applications at different scales regardless of the country's level of economic development. For this reason, cases were considered at different scales from cities that contribute significantly to the national economies of their countries. With this filtering, I aimed to create a retrospective response to our experiences in the context of Istanbul and evaluate the potentials and limitations of urban mining at various scales for Istanbul in light of these cases.

To evaluate urban mining practices as they are encountered worldwide within the specific context of Türkiye, it was crucial to consider Istanbul's own urban mining potential and constraints. This involved examining the steps of material harvesting, identification, storage, reuse, and dismantling alongside the design process of Yoo, Bence Güzel Pavilion. For example, considering that 20% of Istanbul's existing building stock was evaluated as being dangerous in the event of the expected earthquake[263] because of the lack of accountability and transparency and weak regulative control in construction activities, creating circular loops in the material flows of the construction industry does not seem to be a priority in Turkish construction practices at first glance. However, this constraint highlights how vital it is to extend the circular approach from building scale to regional scale in Türkiye considering the removal of earthquake debris that has affected living beings of the Mileyha Wetland and recovery efforts in cities affected by earthquakes and their resulting debris.

On the other hand, the main potential in Istanbul, namely the existing material stocks and available labour power, can shift some of the existing constraints in İstanbul. Developing processes to keep track of existing material sources in the city, such as those in the material depots of public institutions, or ensuring the appropriate inspection of construction activities with a comprehensive regulative framework could be a reasonable starting point. Moreover, creating new businesses to improve the communication, transparency, and accountability of stakeholders according to the established regulations would also be a valuable step in building on the city's potential for a more sustainable and resilient built environment while creating new business opportunities in Istanbul.

In evaluating different approaches and strategies in North America, Europe, and Asia on the regional scale, it can be seen how the socio-economic conditions of countries affect the maturity level of their circular economy applications. This thesis has addressed the importance of legal frameworks and alternative networks that support urban mining, and how they can affect the lifecycles of recovered materials. The third chapter has accordingly emphasised the role of strategies and tools for urban mining in achieving circular economy goals in the construction sector by analysing the positive and negative aspects of examples around the world and their contexts. Additionally, by considering the strengths, opportunities, and challenges faced by applications in each region, this chapter has offered insight for Istanbul's urban mining.

Projects on various scales in New York state were selected for analysis. These projects have included networks, businesses, and new spaces necessary for reusing building materials at the end of their lifecycles within urban infrastructure while discovering architectural methods at the building scale. Although the projects described are generally carried out by corporate companies, they are products of multi-stakeholder urban networks. For example, Building Product Ecosystems (BPE) is a private company bringing together stakeholders in the US construction industry, providing the necessary large-scale communication for material harvesting. On an urban scale, BigReuse is a business initiative whereby salvaged materials are stored to be reintroduced into the cycle, providing a spatial example. On the other hand, the Catherine Commons Deconstruction Project offers an example of tools and methods for disassembling a building that has reached the end of its lifecycle into reusable parts.

Taken together, these cases selected from the United States represent a system that operates across scales, using materials that have either reached the ends of their lifecycles or are being harvested to start a new lifecycle.
Similarly, projects on different scales involving urban mining were examined from the Netherlands, which is the second largest waste exporter after the United States. Harvest Map, for example, is a digital interface on a regional scale that enables architects and contractors to harvest materials and resources while acquiring information about donor building types and the physical properties of buildings that have reached the ends of their lifecycles. Harvest Map stands out as an important example of the circulation of salvaged materials in urban areas as it contains the identity information and location of building materials to prevent them from becoming waste.

On an urban scale, the Urban Mining of Rotterdam project is a preliminary study on urban mining conducted by private companies at the request of public institutions. This project is important as it incorporates methods and a roadmap for the qualitative and quantitative management of C&D waste on an urban scale. On the other hand, the People's Pavilion is an important example at the architectural scale, illustrating the development of steps for the reuse and dismantling stages of urban mining, as well as ways to bring materials together for reuse.

Another global waste exporter, Belgium, has established the Atelier Circulair as output of the Pop-Machina project, which was funded by the European Union's Horizon 2020 programme, as an important example of re-establishing circular flows of salvaged materials on both regional and urban scales in the city of Leuven. At the same time, since Istanbul is also among the Pop-Machina pilot cities with its DİA Istanbul makerspace, Leuven serves as a valuable example for comparison to Istanbul regarding networks that can be established on an urban scale with support from the European Union.

As another case, the UMAR Unit, established as an experimental project in Zurich, Switzerland, is an important example of the design for disassembly method, which aims to use buildings as material banks of the future. The registration of a building in the Madaster platform in the form of its digital twin provides a dataset for evaluating the circularity of the building and also keeps a digital record of its materials in case reuse is needed in the future. In this way, stakeholders who have access to the Madaster platform can obtain records of these materials. Although this is an important example for future design and construction methods, it has been criticised for not sourcing materials from nearby sources and for the platform's lack of transparency in information sharing as an open source for researchers.

As the world's largest waste importer between 2000 and 2018, China constitutes a significant benchmark for comparison with Türkiye and Istanbul. After imposing bans on the waste trade, China transferred that title of world's largest waste importer to Türkiye. According to the reports summarised in this chapter, China is now shaping its urban mining strategies with future-oriented legal regulations in the built environment.[264] Such research promotes legal regulations for more responsible production related to environmental pollution from recycling and manufacturing industries, as well as modular and prefabricated construction methods to reduce waste generation. In addition, legal restrictions have been imposed on the mass production of materials made from natural resources, such as traditional bricks. In urban transformations driven by factors such as growing population density and

264. Ru Chen, **"**China's Circular Economy Policies: Review and reflection." Circular Innovation Lab, Circular Press, Issue Nb.4, 2023.

increasing urbanisation, demolition waste does become waste material even though it is a culturally and economically valuable material, as seen in the villages around Ningbo. In this context, although it was not originally built with concerns about urban mining or the circular economy, the Ningbo History Museum presents a new way of building by adapting a traditional construction method for the reuse of nearby demolition waste. In this sense, the Ningbo History Museum is a significant example showing that approaches developed by prioritising vernacular architecture over environmental concerns in urban mining and sustainable construction can also be a circular economy strategy.

Taiwan, another major waste importer, also offers a significant example for Türkiye and Istanbul in terms of its building stock and the quality of materials used in existing buildings. While the exported materials of the examined countries are generally relatively light natural materials such as structural lumber, Taiwan was examined as a country with building stock quality more similar to that of Türkiye. The C-LAB, opened to the public after the transformation of an old military base, was studied as a pilot project for urban-scale adaptable urban mining strategies. By applying digital methods, material technologies, and organisational structure at the urban scale for the demolition or selective demolition of buildings at the ends of their lifecycles, the research conducted at C-LAB provides a good foundation for understanding how to deal with Taiwan's building stock, which is mostly made of cement and steel.

	Türkiye	USA			Netherlands			Belgium	Switzerland	China	Taiwan
Role in Global Waste Trade	importer	exporter			exporter			exporter	importer	importer	importer
Fund Type	non profit	private	private	mix	non profit	private	private	non profit	non profit	private	mix
Strategies	Yoo,Bence Güzel Pavillion	Big Reuse	BPE	CCD	Harvest Map	Peoples Pavillion	Urban Mining Rotterdam	Atelier Circuler	UMAR	Ningbo	C-LAB
Material Sourcing Database		x	x		x			x			
Material Passport									x		
Design for Disassembly	x					x			x		
Prefabricated									x		
Reused materials	x	x		x	x	x			x	x	x
Sourcing available materials	x					x				x	x
Dry connection details	x					x			x		
Urban Mining ecosystem		x	x	x	x	x	x	x	x		x
MFA							x				
Sustainable demolition				x					x		x

Figure 88: Investigated projects strategies comparison, produced by the author, 2024

Conclusion

Motivated by questions arising from experiences with Yoo, Bence Güzel Pavilion, Chapter 3 aimed to evaluate the potentials of various strategies for reuse and closed-loop systems in North America, North Europe, and Asia. By examining the relevant legal frameworks, alternative urban networks, and building-scale tools and methods, insights were sought for the development of a viable urban mining strategy for Istanbul.

By examining top-down strategies like regulatory frameworks and bottom-up initiatives by businesses, institutions, and urban networks and architectural practices worldwide, and filtering this information through the lens of Yoo, Bence Güzel Pavilion, this research has identified potential opportunities and constraints for urban mining in Istanbul. Comparing countries based on their roles in the waste trade revealed varying levels of maturity in discussions about the circular economy and urban mining. Furthermore, comparing both urban-scale and building-scale strategies in countries and cities with similar or different economic and socio-cultural backgrounds provided an opportunity to analyse the examples while considering their specific contexts. Within the framework of examples examined from three different continents, the level of economic development, environmental sensitivities, and legal frameworks on waste management emerged as the most important factors differentiating these approaches.

In conclusion, there are some globally common tendencies seen in cases of the urban mining of buildings. These tendencies include the development of strategies to address processes that start with the discarding of the existing building stock for any reason, while another approach focuses on developing strategies and infrastructures for the incorporation of future building stock into metabolic streams. At the end of the life of the existing building stock, there is a tendency to create organisational infrastructures for harvesting, classifying, and storing materials by promoting reuse, while technical approaches are used to ensure the possibility of the use of the building stock of the future as a material bank. Urban mining networks, businesses, and digital databases established to support the transition to a circular economy in the construction industry constitute the technical pillar of this transition (Figure 88, Figure 89).

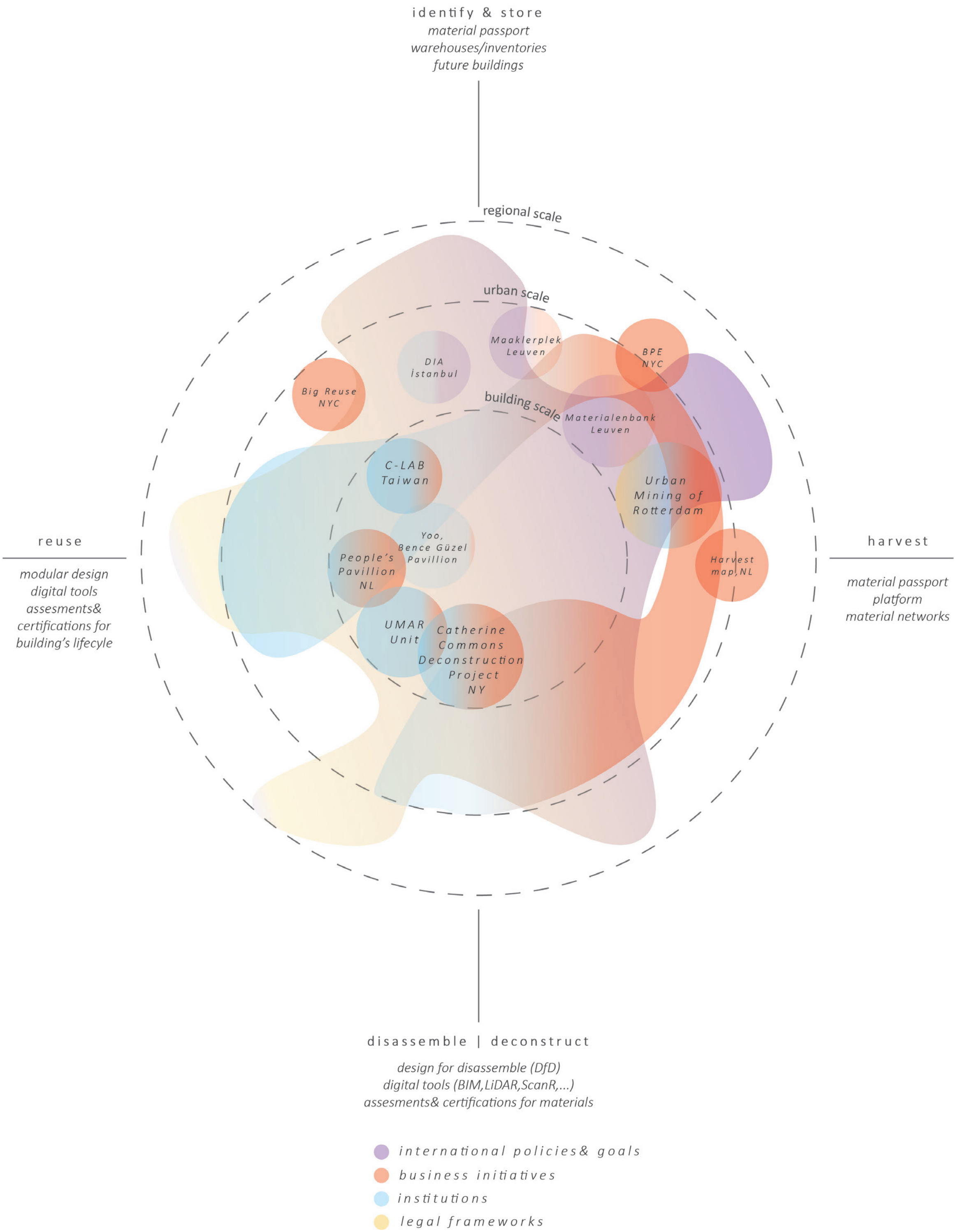


Figure 89: Distribution of examined cases based on urban mining strategies (harvest, identify, reuse and disassemble) between scales(Regional, urban, building), produced by the author,2024

This comparison has allowed us to see the limitations and opportunities in studies on urban mining, reusability, and recycling, which are typically discussed as responses to economic or ecological problems. In particular, the role of countries in the waste trade is a manifestation of all these factors. Considering the motivations of both importers and exporters in the global waste trade, it could be argued that the anonymisation and accumulation of the materials described here, leading to their status as waste and the creation of waste as a problem, is perhaps affecting the commodification of waste to an even greater extent than resource scarcity.

In this context, in countries that attract attention with their import or export shares in the waste trade, it is also seen that circular economy strategies instrumentalised against climate change, carbon sensitivity, and resource consumption problems are being adopted via top-down policies, local governments, and the public. From the perspective of the waste trade, many countries stand out with discourses on sustainability themes that serve political and economic agendas rather than environmental concerns.

Although the infrastructures developed for urban mining are generally understood as being incentivised by legal frameworks, they create deficits and corruption due to the lack of traceability and transparency of processes and data. Therefore, it is critical to reflect on the relational infrastructures of urban mining and forms of reuse.

Istanbul is the hub of Türkiye's production and service industries, including the construction industry, as well as the centre of the country's labour force. It stands out with its metabolic flows arising from both material and intellectual productions, its ever-increasing population, and its contributions to the Turkish economy. For these reasons, construction activities, together with emerging spatial requirements, can be identified as one of the most common ways in which capital flows are provided. C&D wastes resulting from activities such as construction or the repair, renovation, or demolition of the existing built environment, wherein capital flows, labour power, and material flows are embedded, increase the pressure from the city's population. The waste in these processes not only destroys natural areas and habitats but also creates an ecosystem that is more likely to collapse under long-term pressure. Moreover, given the nature of the city's existing building stock and the geographical reality of earthquakes, it is crucial to develop strategies and relational infrastructures for the urban mining of C&D wastes and their reintroduction into circulation to rebuild the city in a more disaster-resistant manner before a new disaster occurs or to facilitate a return to normality after a disaster. On the other hand, to develop strategies to cope with the demolition waste produced by urban renewal efforts, transparency is needed to acquire the data of planned demolitions and urban plans made by governmental bodies. Making this information available to the public could improve the accuracy and implementation outcomes of diverse studies.

Projections

Closing the loop at the local scale is crucial; otherwise, the economic value embedded in wasted materials can create unfavourable conditions for other countries that lack strict legal frameworks and policies regarding the waste trade, as seen in the former case of China and in the case of Türkiye.

China stands out as a particularly important example for Türkiye in terms of its current position in the global waste trade. China had imported more than half of all global waste between 2000 and 2018, but that created hazardous conditions for the country alongside internal waste generation. Therefore, most of China's current sustainability strategies can be studied as a response to the environmental pollution caused by the intense work of the recycling industry with a desire to improve the legal framework for a sustainable built environment and responsible industrial production.

The United States and North European countries, which have significant roles in the global waste trade as exporter countries, have more systematically mature precedents for urban mining because of their economic independence from the waste trade and stricter legal frameworks. This maturity level of urban mining strategies cannot be considered separately from the fact that these countries have scaled back on heavy industrial recycling or incineration efforts to avoid hazardous effects such carbon emissions in the context of the global waste trade. However, their strategies for urban mining and closing the loop in their cities are of crucial importance for Istanbul, offering valuable insights and models.

The main strategy for closing the loop and mining cities can be understood as an inclusive and holistic approach to bridge different scales, with local governments and businesses developing alternative urban networks and complementary design strategies, methods, and tools at the building scale within networks for harvesting and increasing the accessibility of available materials.

Considering the implications of the examples of urban mining considered here at both urban scale and building scale in the context of Istanbul, potentials and constraints can be summarised as follows:

Potentials for İstanbul, Türkiye

One major questions that arose was how harvesting processes for scrapped construction materials could be facilitated in Istanbul, making those materials accessible during the design phase and preferable for both consumers and stakeholders in the construction industry. This line of inquiry also considered the significant role of informal labour power, such as dismantlers (çıkmacılar) and informal waste pickers, in the recycling industry. An inclusive approach towards these professions has potential value for efforts to mine the built environment of Istanbul.

In addition to the labour force of informal workers, their networks and storage systems also offer opportunities for the harvesting of building materials in Istanbul.

Currently available spaces such as vocational technical high schools can also be adapted for the educational side of new job opportunities such as dismantling, classifying, and identifying harvested materials while contributing to the city as a hub for circular production.

Additionally, improving the recording and classification of the scrap materials of the inventory stocks and warehouses of public institutions would provide a significant material resource for digital platforms for mining the city.

The economic conditions creating economic dependency on wasted building materials may be a potential incentive for reusing and circulating materials in Istanbul, Türkiye.

Besides labour power, a second significant source of potential in Türkiye is land surface area. Promoting the production of sustainable and circular materials such as wooden products and timber has the potential to shift construction away from its dependency on both concrete and steel. Supporting stakeholders of the industry in investing in the sustainable production of industrial forests is another viable strategy for Türkiye.

Distributing the material diversity of the built environment could be another key strategy for addressing the dominant positions of concrete and steel in the built environment. Distributing material proportions more evenly could also help in constructing earthquake-resistant building stock.

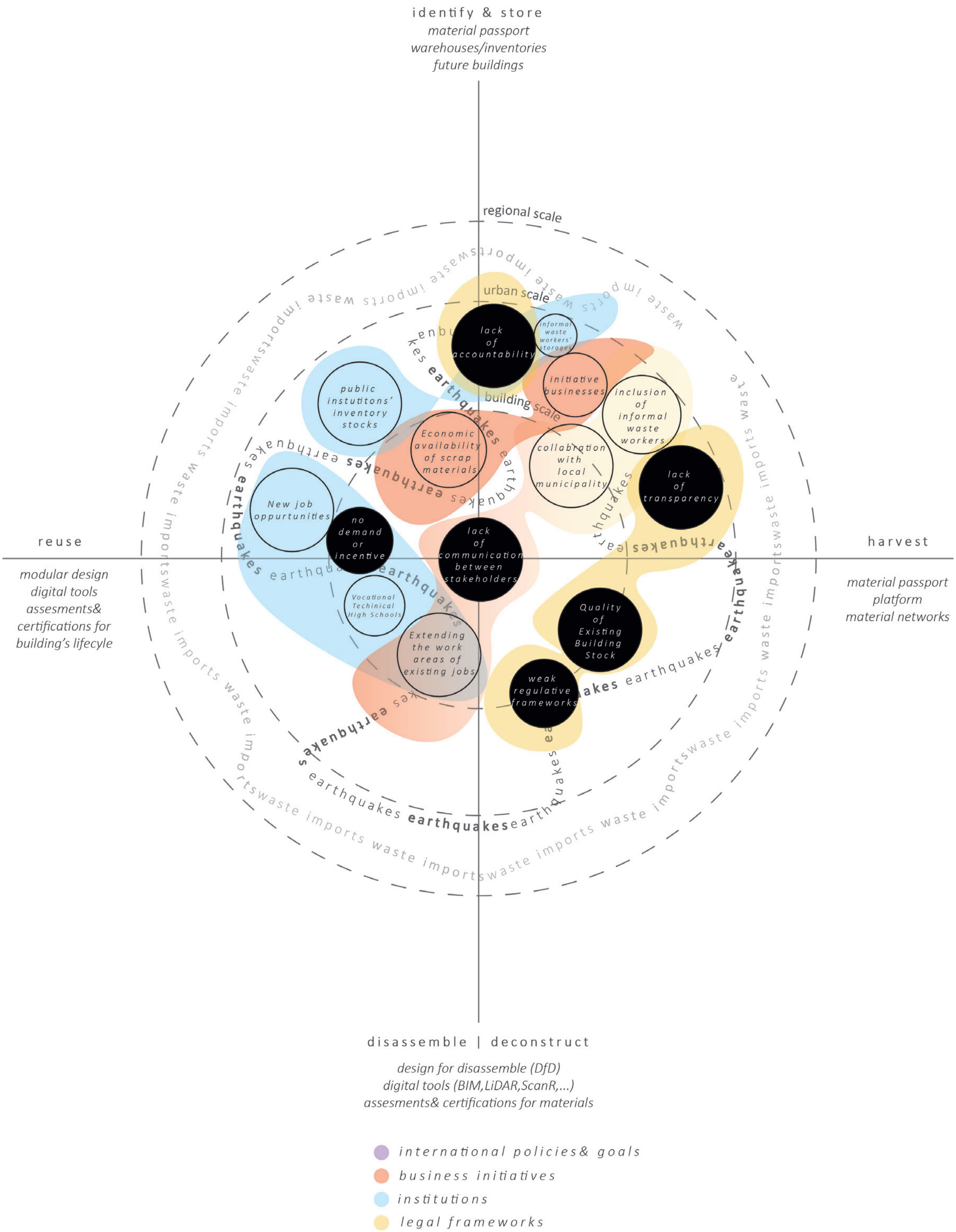


Figure 90: Potentials and Constraints in İstanbul, produced by the author,2024

Türkiye's membership in international groups or conventions on net-zero carbon emissions offers opportunities to adapt urban mining strategies for the existing building stock and could potentially inspire the publication of new regulations and incentives for new construction projects, as seen in China and the Netherlands.

Constraints in İstanbul, Türkiye

The lack of financial support and incentives for responsible industrial production can be considered a major constraint in efforts to close the loop in Istanbul.

The lack of policies on sorting on different scales, the lack of analysis on recycling or reuse between different scales, and the lack of communication between top-down interventions and bottom-up applications are further constraints for urban mining in İstanbul.

The ongoing generation of C&D waste containing concrete and steel with carbon embodied in production cycles in the cement and steel industries will be a challenge and a constraint in efforts to achieve a sustainable and climate-resilient built environment.

As a reality of seismically active areas, Türkiye is still struggling to build earthquake-resilient buildings and cities. The dysfunctional qualities of the existing non-resilient building stock may pose constraints to the circulation of C&D waste. This situation warrants serious research and assessment to identify the specific conditions of each building's material and structural components.

The lack of transparency and accountability in urban renewal processes also can be considered as a constraint for Istanbul in terms of assessing material flows and planning strategies for urban mining.

Responding to these potentials and constraints in Istanbul will be necessary to ensure long-term strategies and goals for closing the loop in this city. However, improving the legal framework and increasing incentives could be taken a starting point for top-down changes. Creating platforms to bridge activities involving circular construction methods and tools at the building scale is equally important (Figure 90).

Furthermore, a recent manifesto presented by KoozArch at the World Congress of Architects held in Copenhagen in 2023 also emphasises the role of the architect as a translator between languages of architecture.[265]

265. Federica Zambeletti, "Building Words: New Languages for Architecture." KoozArch, 2023. Available at: https://www.koozarch.com/essays/building-words:-new-languages-for-architecture.

266. Ibid.

The language of architecture as referenced here is not limited to discussions of style, function, aesthetic properties, or the composition of materials/forms and solids/voids. It includes words to reconnect with the planet without merely creating self-referenced products of art and science. In other words, considered apart from local and global issues, the "language of architecture must embrace words, spoken and written, existing and yet to be coined." [266] For example, words such as "archtivist" can redefine the position of architects, while the term "emergy" refers to metabolic transformations in the construction ecology, as described in Unless: The Seagram Building Construction Ecology (Figure 91).

Overall, to address these constraints and potentials in Istanbul, creating systems and networks to improve information flows as well as material flows remains a crucial step. However, all of the efforts should be supported by a shift in Türkiye's position in the waste trade before it creates irreversible environmental damage.

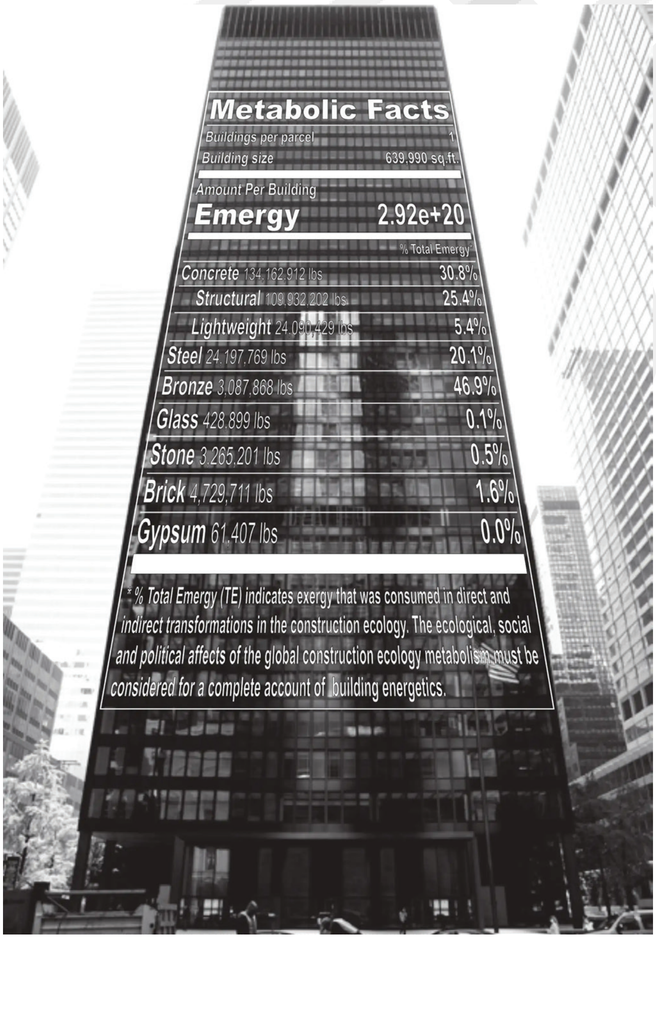


Figure 91: Kiel Moe, Unless: the Seagram Building Construction Ecology, New York, NY: ACTAR, 2020.

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