# Matchmaking between supply and demand of reclaimed construction products using online platforms

Understanding the added values for the construction actors

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## ABSTRACT

This master thesis investigates the matchmaking between the offer and demand for reclaimed construction materials. The research will especially look at the potential of online matchmaking platforms to enhance the reuse of reclaimed construction materials within the circular construction sector. Previous studies claim that to understand something as complex as the reclaimed material flows of the construction industry, it is necessary to think systematically about all the construction actors and not individually. The studies also say it is necessary to increase knowledge and competence in reusing reclaimed construction products, unlock data and information for the authorities, and inform the construction actors about the circular economy method. This means that all construction actors need to systematically look at the reuse of reclaimed materials and understand the benefits for all construction actors in the process. In this study, the goal is to analyze and map the added value of each construction actor in using online platforms for the matchmaking of supply and demand for reclaimed construction products.

For this research, other existing studies about the topic were analyzed, research was done, and a total of 28 interviews were conducted with different construction actors, including architects, manufacturers of new materials, clients, authorities, and reuse advisors. The interviewed construction actors provide insights into current reuse motivations and challenges, the influence of timing in a construction project on the use of an online matchmaking platform, and the nice-to-have and must-have features of such a platform. This study identifies the challenge of synchronizing the supply and demand of reclaimed construction materials due to timing mismatches. The study also identifies the need for storage solutions, either physical or virtual, to effectively bridge the gap between supply and demand for reclaimed construction products.

The research encompasses a visual analysis of existing online matchmaking platforms. Data were collected on various platforms, examining the practice of their main function (matchmaking of reclaimed construction materials) and their additional services offered. For doing this, different parameters of the platforms were analyzed, such as the offered logistics support, the business models, the additional information they provide about circularity, etc. The study categorizes these platforms based on the practice of their primary functionality and describes the different additional services offered on those platforms. The findings indicate that logistic support is critical for the practical application of reclaimed construction materials reuse. These findings help in better understanding the current state of online platforms for reclaimed materials and offer strategic insights for improving their role in the Belgian reuse sector.

Eventually, the thesis ends with a systematic proposition for a multi-benefit material scouting process using an online matchmaking platform. This proposition underscores the necessity for a systematic approach that considers the interrelationships among all construction actors rather than isolated efforts. This proposition provides an overview of the added value of using an online platform to match the supply and demand of construction materials for all construction actors. An added value for the construction actors, by definition, is the increased usefulness or worth of using an online matchmaking platform for reclaimed construction materials. This added value can be economical, but it can also offer the construction actors a more enjoyable or positive experience with their construction materials. Based on the interpretation of the interviewed construction actors, a proposition for a new construction actor, which is the matchmaking platform with the possibility of scouting reclaimed materials and offering logistic support and other features, is proposed.

KEYWORDS: REUSE / ONLINE MATCHMAKING PLATFORMS / CONSTRUCTION MATERIALS

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# 1. INTRODUCTION

The construction sector nowadays is responsible for over 30% of the extraction of natural resources and 25% of the solid waste generated worldwide.[1] To understand where those numbers come from, it is important to look at how the construction sector is dealing with the extraction of natural resources and the generated waste. Two different approaches will be discussed next.

The first approach, mostly used in the construction sector nowadays, is a linear economic model approach. This model extracts resources from the planet and converts them into construction materials. The construction materials are used by the consumers of the construction, and at the end of their lives, the materials are disposed of as waste. Fig. 1 shows the material flow of this linear economic model, which follows the grey and dark-green arrows.

However, over the last decades, a growing trend in the construction sector towards a different approach, called the circular economy model approach, has become visible. This model tries to reduce the number of extracted resources and disposed waste by keeping resources in use as long as possible. The approach is to create a closed-loop system in which the construction materials are reused or recycled at the end of their lives. The goal is to convert waste into resources and achieve a consistent or increasing stock of natural resources.

By reusing and/or recycling construction materials at the end of their lives, the circular economy approach has positive impacts on the global problem mentioned at the beginning of this chapter. This approach will reduce the number of extracted resources as well as the number of disposed solid waste. This approach solves the problem of resource scarcity as well as the problem of the authorities of cities that must manage solid waste. Besides all of this, a circular economy will reduce carbon emissions, embodied carbon, and energy put into the project and even create positive local employment potential. The circular economic model is indicated by the three different light-green arrows in Fig. 1. The arrow that goes from demolition to production denotes material recycling. The other two arrows represent material reuse. Further on, the focus of this research will be on the circular economic model. More specifically, on the reuse sector, not the recycling sector. To be even more precise about the focus of this research, only professional construction actors will be considered. A professional construction actor is defined as an individual or organisation that has any influence in the construction project's process.

[1] Gabriel Luiz Fritz Benachio, Maria do Carmo Duarte Freitas, and Sergio Fernando Tavares, “Circular Economy in the Construction Industry: A Systematic Literature Review,” *Journal of Cleaner Production*, 2020.

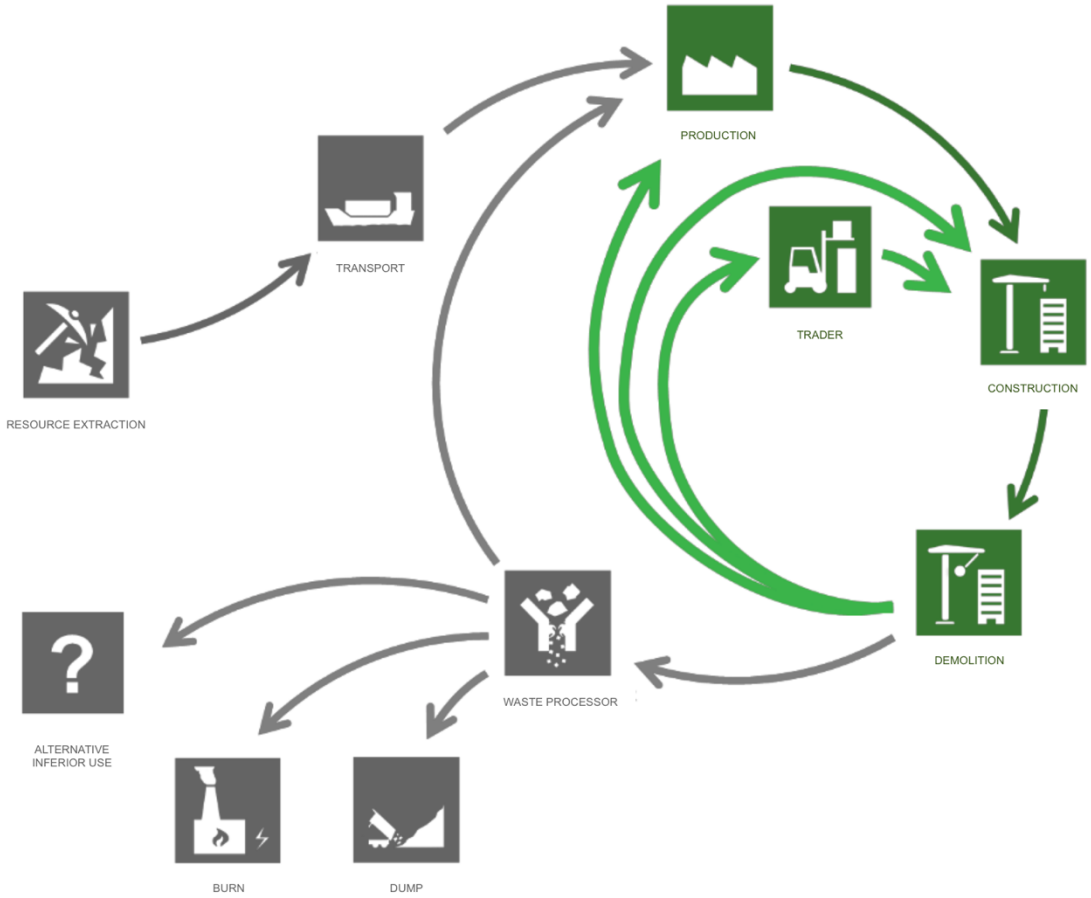


*Fig. 1. Material flow of linear and circular economic model of the construction sector.*[2]

## 1.1. State-of-the-art

The following subchapters analyze the existing literature related to this research that can help to better understand where the construction sector is standing right now on behalf of this topic. The scope is to summarize and categorize existing knowledge about matchmaking between the supply and demand of reclaimed construction products using online platforms. This pre-knowledge is needed to better understand the encountered problems and possible solutions. Based on this, the master thesis can be further developed. For this chapter, it was also looked at in other countries than Belgium, as they provide valuable insights. The next sub-chapters synthesize the most recent knowledge and problems regarding the reuse of reclaimed construction products using online matchmaking platforms.

### 1.1.1. Lack of standardized methods and practices

A report about urban mining was made by Wim Debacker et al., (2021) in Belgium by different establishments working together. The report analyzes urban mining in Flanders and Brussels. Different case studies of demolitions or reconstructions of buildings are therefore analyzed in

[2] Slager Bas and Jansen Gijsbert, "ONDERZOEK VOORWAARDEN GEBRUIK BOUWMARKTPLAATSEN," 2018.

this area. By doing so, flows of different stone materials (such as bricks and concrete) as well as non-stone materials (such as flat glass, glass wool, plasterboard, and PVC) are framed. After doing this research (analyzing different case studies and framing all these material flows), the authors of the report are eventually able to identify problems with the actual material flows and propose different methods and practices for the practitioners on the construction site as well as the authorities of the construction sector. One of the important suggestions of this report towards a circular economy system is to increase knowledge and competence in the reuse of reclaimed construction products. [3]

A systematic literature review of the circular economy in the construction sector made by Benachio Gabriel Luiz Fritz et al., (2020) in Brazil and has as objective to find the most recent development in the circular economy in the construction sector. To do this, the three researchers analyzed a total of 45 articles related to the circular economy in the construction sector. The following subjects were analyzed: development of Circular Economy, reuse of materials, material stocks, Circular Economy in the built environment, LCA analysis, and material passport. After analyzing all those articles, the conclusion is that there is a general good awareness of the need to change from the linear economy model to the circular economy model. The main problem seems to be the practitioners who lack standardized methods and practices to implement this circular economy model. The study declares research still needs to be done on developing standard practices for the reuse of construction materials. The three researchers, therefore, made a table with all the standard practices they found in the 45 analyzed studies. [4]

In a research done in 2017, the barriers to the reuse of construction waste materials in Australia are tried to be overcome. The research was done by Jungha Park and Richard Tucker and is a review of literature from 2007 to 2017. During that period 17 relevant studies were found and analyzed by the authors. The authors aimed to identify the obstacles created by institutional barriers that were present when trying to reuse construction products. To do so, the authors analyzed five different construction actors. The five different construction actors are homeowners, architects, contractors, developers, and legislative bodies. Two suggestions were given for a future better approach to reuse in Australia. The suggestions are sector-wide education and training about construction waste management to all analyzed construction actors and increased communication between architects and contractors.[5]

### 1.1.2. Need for a systematical view

The authors of the report on urban mining in Flanders and Brussels suggest thinking systematically when trying to understand something so complex as the reclaimed material flows of the construction industry. They suggest looking at the connection and interactions between all the construction actors and not only looking at one construction actor because it will not be one specific construction actor who can make the shift to a circular economy

[3] Wim Debacker et al., "Urban Mining van gebouwen. Naar het creëren van waarde via het sluiten van materiaalstromen," March 2021.
[4] Benachio, Freitas, and Tavares, "Circular Economy in the Construction Industry: A Systematic Literature Review."
[5] Jungha Park and Richard Tucker, "Overcoming Barriers to the Reuse of Construction Waste Material in Australia: A Review of the Literature," *International Journal of Construction Management*, 2017.

possible. Systematically means to not only look at one specific construction actor and think that one can solve the problem by itself. Systematically means to look at all the construction actors at the same time and analyze the relations between them.[6]

### 1.1.3. Need for storage space

In the systematic literature review of the circular economy in the construction sector made by Benachio Gabriel Luiz Fritz et al., (2020), it is shown that it is possible to create a material stock on a large scale (such as a city) if the data of the materials are available. For the material stocks, further research is suggested to see if the amount of possibly reusable materials is consistent enough. Another suggested possible research can look at whether there will ever be enough data on the material available to create those material stocks on a large scale.[7]

### 1.1.4. Lack of interest in the reuse of construction products

In the report on urban mining in Flanders and Brussels it is suggested to unlock data and information for policy and inform the public/demand about the circular economy method. [8]

The research of Jungha Park and Richard Tucker about overcoming barriers to the reuse of construction waste material in Australia concludes that problems come from outside of the construction sector. Problems are mostly lack of interest and demand from clients and the attitudes towards reuse practices. The most important advice for the authorities is that legislation should be well implemented so that all states in Australia are required to implement reuse strategies. The authors suggest more effective legislative and financial incentives for all parties, improved waste management facilities on- and off-site, and extended implementation and extended producer responsibility on the construction materials.[9]

### 1.1.5. Hurdles in using online matchmaking platforms

Online marketplaces of reclaimed construction materials in the Netherlands were analyzed in 2018 by Bas Slager and Gijsbert Jansen. The authors first explain what exactly is considered an online marketplace. They describe it as an internet application where a supply of construction products can be published or searched by multiple construction actors. The supply of construction products can be bought. The construction actors using the online marketplace can be architects, construction companies, structural engineers, architectural consultants, municipalities, demolition companies, or building material dealers. 33 of those different

[6] Debacker et al., “Urban Mining van gebouwen. Naar het creëren van waarde via het sluiten van materiaalstromen.”
[7] Benachio, Freitas, and Tavares, “Circular Economy in the Construction Industry: A Systematic Literature Review.”
[8] Debacker et al., “Urban Mining van gebouwen. Naar het creëren van waarde via het sluiten van materiaalstromen.”
[9] Park and Tucker, “Overcoming Barriers to the Reuse of Construction Waste Material in Australia: A Review of the Literature.”

construction actors were interviewed for this study. The authors eventually identified current problems with online marketplaces and proposed some solutions. [10]

The study showed that the most involved and active users of online marketplaces are currently architects and construction companies. For structural engineers, architectural consultants, municipalities, and demolition companies, there is great interest but still little practical usage. Building material dealers themselves often already work with an advanced internet environment that has many similarities with an online marketplace for new materials. [11]

An online marketplace user argues that the platforms are not user-friendly. It takes a lot of time to find and buy reclaimed materials from such an online marketplace which makes it very expensive for professional actors. Therefore, today there is only little use of such platforms by professional actors. If the user of an online marketplace sees that the quest to search for reclaimed materials is not worth the time/money, the user will often quit very early in the quest.[12]

### 1.1.6. Existing tools to enhance the matchmaking between the offer and demand of reclaimed construction materials

The authors of the study made in 2018 about online marketplaces of reclaimed construction materials in the Netherlands proposed to work towards a way to be able to display on one platform all products offered by many existing online marketplaces. The scope of a meta platform is to make the quest for reclaimed construction materials more efficient. This should not necessarily be a central database, as databases will probably be linked to specific user requirements, which means that it is not available to everyone. But a method to make the desired data available from one central search website just as shown in **Error! Reference source not found.**. However, developing this instrument (meta platform) also requires that there is a demand for a large flow of reclaimed material. [13]

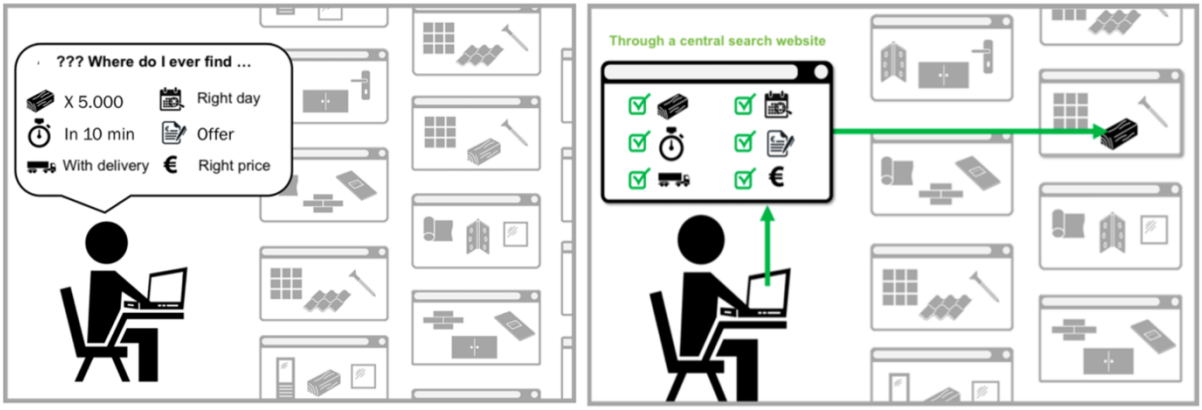


*Fig. 2. Central search website for all online platforms of reclaimed construction materials.[14]*

[10] Bas and Gijsbert, "ONDERZOEK VOORWAARDEN GEBRUIK BOUWMARKTPLAATSEN."
[11] Bas and Gijsbert.
[12] Bas and Gijsbert.
[13] Bas and Gijsbert.
[14] Bas and Gijsbert.

The Interreg North West Europe (NWE) program encourages cooperation between different countries to make north-western Europe a key economic player, more attractive to work and live in, and a place with high levels of innovation, sustainability, and cohesion. Different initiatives were developed under this project, which started in 2014. The more interesting one for this research is the FCRBE project, which stands for "Facilitating the Circulation of Reclaimed Building Elements". This project aims to promote the reuse of building materials to foster a circular economy within the construction sector. Output from this project documents to assist the undertaking of reuse strategies in a building project; documents helping project owners, public authorities, and any organization involved in setting, monitoring, and reporting on recovery and reuse rates in construction and renovation projects for buildings and outdoor developments; a collection of 7 booklets addressing diverse topics related to the reuse of building materials; six guides on reuse for specialized trades: general contractors, finishing companies, woodworkers, roofers, demolishers, and infrastructure contractors; a selection of 11 case studies that successfully dealt with insurance issues for reused building materials; documents that explore different facets of reuse; and other useful websites and video's concerning the circulation of reclaimed building elements.

A more concrete example of the Interreg North West Europe (NWE) program is the research made together with Embuild. This report is about digital trading platforms for construction products in North-Western Europe, focusing on France, Belgium, Luxembourg, and the Netherlands. During this research, 48 digital platforms offering reclaimed construction materials were analyzed. Different types of platforms were then identified by the authors. The parameters on which the platforms can differ from each other can be their business models, target audiences, the focus on connecting buyers and sellers or the focus on showcasing physical stores, the amount of detailed product information, or other offered features such as categorization, and filtering options of the reclaimed construction products. The study also considers two non-trading platforms: Opalis, which helps users find professional sellers of reclaimed materials, and Smart Symbiose, which connects companies for material reuse beyond the construction sector. Overall, the report suggests that digital platforms play a significant role in facilitating the reuse of construction materials. However, addressing trust concerns, improving data management, and fostering collaboration are crucial for further market development. In Fig. 3, a SWOT matrix can be found of the analyzed digital platforms made by the authors explaining the strengths, weaknesses, opportunities, and threats of using a digital platform to deal with reclaimed construction materials.[15]

[15] Interreg NWE and Embuild, "Analysis of Digital Trading Platforms for Construction Products in North-Western Europe," 2022.

| Strengths | Weaknesses |
|---|---|
| - Managing multi-locations stocks<br>- Fluidifying logistics and optimizing storage spaces<br>- Offering guarantees<br>- Working as a network of actors | - Digital platform as an auxiliary activity<br>- Avoiding the all-digital<br>- Non coordinated cross-publications |
| **Opportunities** | **Threats** |
| - An entry door to other services<br>- Favorable context to circular economy | - Too many sollicitations<br>- A fluctuating market not mature enough<br>- Keeping a physical contact |

*Fig. 3: SWOT matrix of the analyzed digital platforms.* [16]

Another example of the Interreg North West Europe (NWE) program is the digital deconstruction (DDC) project that ended in September 2023. The goal of the DDC project is to inform about tools that can make circular construction achievable. Those tools are 3D scanning, Building Information Modelling (BIM), digital databases for materials and building, and blockchain technology. The DDC project aims to define the most sustainable and economical approach to deconstructing building materials. This is done by publishing information about pioneering case studies and the technologies that were used in those.[17]

Research about 4D-BIM to enhance construction reuse and recycle planning was done in 2020. The research took place at the University of Texas at Austin in the Department of Civil, architectural, and Environmental Engineering and was published by Beatriz Guerra, Fernanda Leite, and Kasey Faus. The research is about applying 4D-BIM for construction waste reuse and recycling planning. This tool can help discretize construction waste generation into quantities for reuse and recycling and plan on-site concrete waste reuse opportunities. Two case studies of the working tool are demonstrated during the research made in Central Texas.[18]

At the department Laboratoire de Mécanique Multiphysique Multiéchelle of Centrale Lille, research was done by Wassim Al Balkhy, Safa Dardouri, Samer BuHamdan, Zakaria Dakhli, Thomas Danel, and Zoubeir Lafhaj about an RFID platform for the management of construction materials. The researchers present a platform that uses Radio Frequency Identification (RFID) together with a Global Positioning System (GPS) to track and localize construction materials on construction sites. The research shows a case study where it is shown that this platform is helping contractors and construction managers to plan better and save time and cost.[19]

[16] Interreg NWE and Embuild.

[17] Consten Paul et al., "Digital Decontruction NO. 4," *Digital Deconstruction- Advanced Digital Solutions Supporting Reuse and High-Quality Recycling of Building Materials: Interreg NWE, Buildwise.*, 2023.

[18] Beatriz C. Guerra, Fernanda Leite, and Kasey M. Faust, "4D-BIM to Enhance Construction Waste Reuse and Recycle Planning: Case Studies on Concrete and Drywall Waste Streams," *Waste Management*, 2020.

[19] Safa Dardouri et al., "RFID Platform for Construction Materials Management," *International Journal of Construction Management*, 2022.

Some of the tools, mentioned earlier, that could help the construction actors to enhance the reuse of construction materials, such as RFID, can be categorized as reverse logistics. Two different types of logistics are possible: reverse logistics and logistic support. Both reverse logistics and logistic support play important roles in facilitating the reuse of construction materials, but they address different stages in the process. Reverse logistics encompasses the tools and practices that manage the upstream flow of materials. Logistic support for reclaimed construction materials, on the other hand, focuses on the downstream flow of materials that have possibly already undergone refurbishment and are ready for reuse.[20]

## 1.2. Research goal

The existing literature analyzed the hurdles encountered by the construction actors when trying to reuse construction materials, proposed solutions, and described the tools that the construction actors could use to enhance the reuse of construction materials.

Nowadays, the matchmaking between the offer and demand for reclaimed construction materials can be realized in a variety of ways. The match may be conducted by a reclaimed materials dealer, an online platform, or construction actors contacting each other by phone or email. This study will analyze matchmaking between the offer and demand of reclaimed construction materials using an online matchmaking platform. For this research, only professional construction actors will be considered.

This research further aims to strengthen already existing knowledge about platforms that facilitate the matchmaking between the offer and demand of reclaimed construction materials after the renovation or demolition of constructions in Belgium. One of the biggest hurdles is the match between offer and demand and the storage of the reclaimed construction products between the moment of acquisition or reservation and the eventual execution of the new construction.

The contribution of this research to the already existing knowledge is by proposing a systematic multi-benefit material scouting process where the added value of using an online matchmaking platform is explained for each construction actor on its own and at the same time shows the benefit of all the rest of the construction actors. This scheme aims to be a tool to let the construction actors think systematically about the process and gain more trust in it by better understanding it.

## 1.3. Research question

The principal research question of this paper will be the following:

What are the added values for different professional actors of the building sector in using an online platform that facilitates the matchmaking between the offer and demand of reclaimed construction products in Belgium?

[20] M. Reza Hosseini et al., "Reverse Logistics for the Construction Industry: Lessons from the Manufacturing Context," *International Journal of Construction Engineering and Management*, 2014.

But before being able to answer the principal research question, different sub-questions will be answered first. The paper will start with a discussion of the existing material reuse flows. Further on, existing matchmaking platforms will be analyzed and categorized. Finally, the answer to the research question will be given in a systematical multi-benefit material scouting process where the added value of a matchmaking platform for different construction actors is explained.

### 1.3.1. Today's material scouting practices: drivers and hurdles

- What are today's practices of matchmaking between the offer and demand of reclaimed construction products? How do professional actors offer or find reclaimed construction products?

- What is the motivation for the construction actors to reuse construction products?

- What are the hurdles for the construction actors to find a new destination for existing construction products or to scout them for implementation in a project?

### 1.3.2. Reuse through online matchmaking platforms

- What are the existing online matchmaking platforms used by construction actors to facilitate matchmaking between the offer and demand of reclaimed construction products?

- At what stages of a construction project are these digital matchmaking platforms used by the different actors?

- What are the needs and expectations of the construction actors concerning these platforms? More specifically, what aspects or features do the actors consider as nice-to-have and which as must-have?

### 1.3.3. Proposing a multi-benefit material scouting process

- What are the added values for different professional actors of the building sector in using an online platform that facilitates the matchmaking between the offer and demand of reclaimed construction products in Belgium?

## 1.4. Research methodology

Next, the different steps of the research will be explained, and they will follow the same chronology as the sub-questions mentioned before. The research can be divided into three big steps. In the first two steps, data will be gathered through interviews and visual analysis. The interviews were semi-structured. This means there was a general outline (main questions), but slight deviations depending on the candidate's responses were possible. All candidates were asked the same questions. Combining the insights from the State-of-the-art,

the interviews, and the analysis, in the third step, the principal research question will be tackled through the proposal of a material scouting process. In this proposal, the added value of the digital matchmaking platform is highlighted for the different actors.

This research only considers professional construction actors. The 8 different construction actors considered during the research are as follows:

| |
|---|
| Client |
| Architect |
| General contractor |
| Demolition contractor |
| Reuse advisor |
| Dealer of reclaimed materials |
| Authorities |
| Producer of new materials |

*Table 1: Construction actors considered during research.*

### 1.4.1. Today's material scouting practices: drivers and hurdles

In Chapter: Today's material scouting practices: drivers and hurdles, the first category of sub-questions was investigated. To do this, interviews were organized with the 10 construction actors from Table 2. Those construction actors are mostly from Belgium, and some are from the Netherlands. All the interviewed construction actors already had experience with off-site reuse of construction materials, involving a form of material scouting.

| N° | Construction actor | Company |
|---|---|---|
| 01 | Reuse advisor | Sweco |
| 02 | Reuse advisor | SuReal |
| 03 | Reuse advisor | Rotor |
| 04 | Reuse advisor | Rotor |
| 05 | Reuse advisor | Rotor |
| 06 | Reuse advisor | Insert |
| 07 | Reuse advisor | Drees & Sommer |
| 08 | Reuse advisor | BuroBoot |
| 09 | Architect | Uantwerpen |
| 10 | Students in architecture | Ugent |

*Table 2: Today's material scouting practices: drivers and hurdles interviewed construction actors.*

Each of the interviewed construction actors was asked the next three questions:

- What are today's practices of matchmaking between the offer and demand of reclaimed construction products? How do professional actors offer or find reclaimed construction products?

- What is the motivation for the construction actors to reuse construction products?

- What are the hurdles for the construction actors to find a new destination for existing construction products or to scout them for implementation in a project?

In Table 2 it is visible that the construction actor number 10 is described as: “students in architecture”. An extra word of explanation is needed to better define this construction actor who isn’t as ordinary as the others. The construction actor is described as one, but underneath this actor, there are four students in architecture from the University of Gent who contributed together with an architect and a client to the construction of a pavilion in Zwijnaarden, Belgium. This pavilion is made of reused construction materials. This project is a pilot effort. The students needed to scout for reclaimed materials and propose to the client. Structural materials needed testing before being used, but the time frame wasn’t large enough and the students didn’t have the right tools, so they tested the materials with simpler methods, such as putting bags of sand on the beams, to see if the beams supported enough load. The students reused as many construction materials as possible and tried to cut out as little material as possible to avoid building waste. The students assembled the pavilion in such a way that the pavilion is demountable so that the reclaimed construction products that were used can be disassembled and reused in the future.

### 1.4.2. Reuse through online matchmaking platforms

In the chapter: Reuse through online matchmaking platforms, the second category of sub-questions was investigated. To do this, two different approaches were used. The first approach is analysis. Interviewing is the second approach.

First, an analysis of existing online matchmaking platforms was done. The construction actors use the platforms to facilitate matchmaking between the offer and demand for reclaimed construction products. In total, 42 platforms from different countries (Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden, United Kingdom, United States, and Switzerland) were visually analyzed one by one. In contrast to the interviews, here other countries are included to learn from them in the Belgian context. Based on the analysis made in Chapter 2 and additional identified aspects during the visual analysis, highlighting the differences between the platforms, the platforms were parametrized and categorized in an Excel table. The Excel table was then used to create graphics to compare and analyze the data. The different characteristics of a platform were linked together, and thus different connections were sought. In this first step, the next sub-question was investigated:

- What are the existing online matchmaking platforms used by construction actors to facilitate matchmaking between the offer and demand of reclaimed construction products?

Secondly, interviews with the 18 construction actors from Table 3 were created and organized based on the analysis of existing matchmaking platforms. Those construction actors are from Belgium. All the interviewed construction actors already had experience with off-site reuse of construction materials, involving a form of material scouting.

| N° | Construction actor | Company |
|---|---|---|
| 01 | Architect | Bureau Bouwtechniek |
| 02 | Architect | Bureau Bouwtechniek |

| | | |
|---|---|---|
| 03 | Architect | Bureau Bouwtechniek |
| 04 | Architect | MAKER |
| 05 | Architect | Cuypers&Q |
| 06 | Architect | Studio Tuin en Wereld |
| 07 | Producer of new materials | Beddeleem |
| 08 | Producer of new materials | AGC |
| 09 | Producer of new materials | Wienerberger |
| 10 | Client | Colruyt |
| 11 | Client | Nextensa |
| 12 | Client | LeefGoed |
| 13 | Authorities | Stad Mechelen |
| 14 | Authorities | Stad Sint-Niklaas |
| 15 | Authorities | Leefmilieu Brussel |
| 16 | Reuse advisor | B2asc |
| 17 | Reuse advisor | Drees&Sommer |
| 18 | General contractor | Democo |

*Table 3: Reuse through online matchmaking platforms interviewed construction actors.*

Each of the interviewed construction actors was asked two questions:

- At what stages of a construction project are these digital matchmaking platforms used by the different actors?

- What are the needs and expectations of the construction actors concerning these platforms? More specifically, what aspects or features do the actors consider as nice-to-have and which as must-have?

As a partner in this research, Bureau Bouwtechniek NV assisted in creating a contact list of possible interviewees. They contacted 18 people in total for an interview. Bureau Bouwtechniek NV is a company based in Antwerp, Belgium. The company engages in project support (i.e. executive architect), technical consultancy, facade engineering, and circular construction, and most relevant to this research, they are currently investigating the feasibility of a new digital matchmaking platform called Harvest Bay.

### 1.4.3. Proposing a multi-benefit material scouting process

The last step consists of analyzing the collected data throughout the research and trying to formulate a response to the research question. The analyzed data comes mostly from Chapters: 2.2; 2.3; 3.3 and 3.4. A response to the research question will be formulated by giving a matchmaking process based on the real construction project chronology. This is a proposal for a material scouting process, following a material trajectory from the decision to extract this construction product from a building until its integration into a new building, emphasizing the possible added value of a digital matchmaking platform in this process for the different involved construction actors. The proposed process is a chronology of construction phases that take place. For each phase, the added value of using a matchmaking platform for different involved construction actors will be discussed.

# 2. TODAY'S MATERIAL SCOUTING PRACTICES: DRIVERS AND HURDLES

This chapter will give insights into the following sub-questions:

- What are today's practices of matchmaking between the offer and demand of reclaimed construction products? How do professional actors offer or find reclaimed construction products?
- What is the motivation for the construction actors to reuse construction products?
- What are the hurdles for the construction actors to find a new destination for existing construction products or to scout them for implementation in a project?

## 2.1. Existing matchmaking methods

Each of the interviewed construction actors was asked the following question: What are today's practices of matchmaking between the offer and demand of reclaimed construction products?

All of the interviewed construction actors, listed in Table 2 by numbers, answered the same question. After analyzing the answers, four main categories of reuse practices and matchmaking between the offer and demand of reclaimed construction products were recognized. The four different main categories are listed below in  followed by the numbers of the construction actors that use that practice for matchmaking between the offer and demand of reclaimed construction products.

| Matchmaking method | | Construction actors using it (N°) |
|---|---|---|
| Online database … | … of reclaimed building materials. | 01; 02; 03; 06; 08; 09; 10 |
| | … of reuse dealers. | 01; 03; 04; 05; 07; 08; 09; 10 |
| Own database … | … of reclaimed building materials. | 01; 03; 07; 08; 09 |
| | … of reuse dealers. | 01; 02; 03; 04; 06; 07; 08; 09 |

*Table 4: Four main categories of matchmaking between the offer and demand of reclaimed construction products*

 shows that contacting reuse dealers through online databases or their own private databases is more popular than searching directly for reclaimed materials. Reclaimed building materials are more searched for in online databases than in their own private databases.

Online databases and our own databases are both digital tools. The difference between an online database and a personal database lies in the following two features: ownership and access. The difference is better explained below in Table 5.

| Features | Online database | Own database |
|---|---|---|
| Ownership | Third-party | Own |
| Access | Internet | Local network or remote |

*Table 5: Difference between an online database and own database.*

 makes a second distinction between searching for reclaimed building materials and searching for reuse dealers. Searching for reclaimed building materials is a broader approach. The construction actor is essentially looking for the materials themselves, regardless of the source. Searching for reuse dealers of reclaimed building materials is a more focused approach. In this case, the construction actors are looking for established businesses that specialize in collecting, processing, and selling reclaimed building materials. When searching in our own database for reuse dealers, this would not just be a database of reuse dealers but also of other interested construction actors such as contractors, clients, or architects.

A graphic display of these four different possibilities for matchmaking between the offer and demand of reclaimed construction products is shown in . The next sub-chapters will explain one by one how each of these four possibilities for matchmaking works.

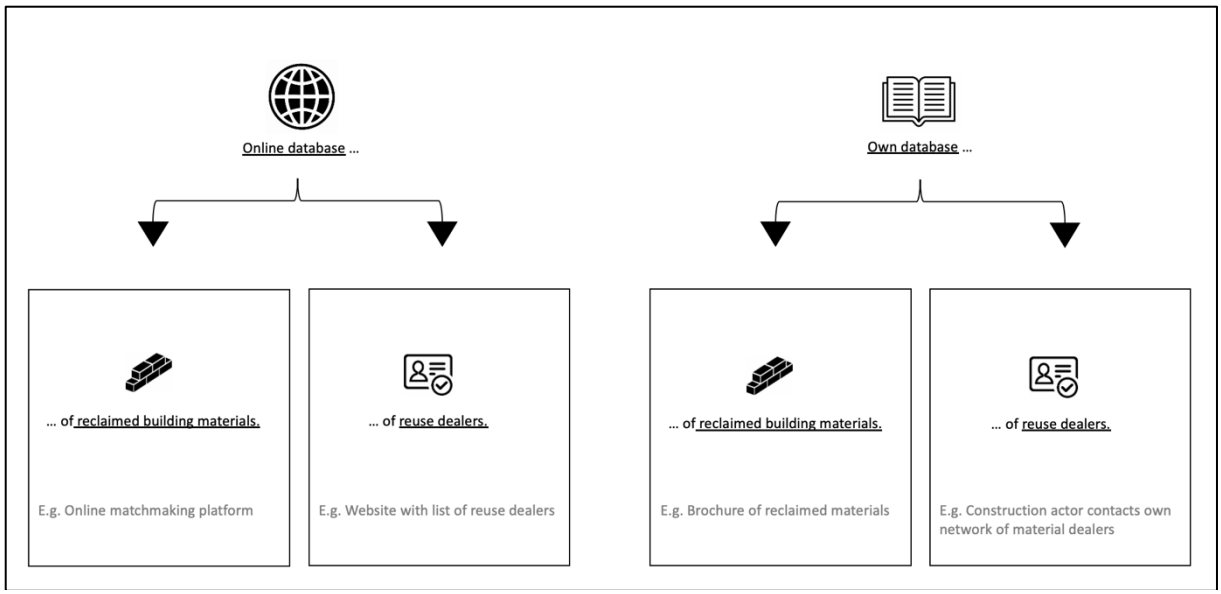


*Fig. 4: Four main categories of matchmaking between the offer and demand for reclaimed construction products.*

### 2.1.1. Online database of reclaimed building materials

Online databases of building materials are a digitally and publicly available collection of reclaimed construction products with specific information about the construction products, such as their physical properties. It can act as a digital and publicly available marketplace that construction actors can access. A difference can be made between materials that have already been effectively disassembled and possibly refurbished and materials that will be available soon. Materials that will be available soon are materials from a building that is planned to be demolished or disassembled in the future. The owner of this building is, in this case, the supplier of materials, looking for buyers before even the materials are dismantled.

### 2.1.2. Online database of reuse dealers

Online databases of reuse dealers are a contact list providing an overview of the material categories that can be found at each dealer, supplemented with information such as possible treatment processes they offer. Some reuse dealers may have their own online database of building materials, which can act as an online marketplace for construction actors to access. Some other reuse dealers only have a private digital database of their available building materials. Opalis is an example of an online database of reuse dealers in Belgium. Opalis is a website specifically for the Benelux and France. The reuse dealers available on Opalis are often small-scale businesses specializing in a few material categories.

### 2.1.3. Own database of reclaimed building materials

Own databases of reclaimed building materials are databases that are not online, such as brochures, of reclaimed construction products with specific information about the construction products, such as physical properties. The databases provide a certain e-mail address or another possible way to contact the material owner. These databases are not online but can still have a digital format. A possible example is the private digital database of

a reuse dealer of reclaimed construction materials, which has its own private digital database of available building materials. Databases shared within a company or team network are, for example, possible on C-ID. C-ID is an online database of construction materials that allows users to share material overviews with specific people.

### 2.1.4. Own database of reuse dealers

Own databases for reuse dealers are databases that are not online, such as a phone book or a private digital database. In such databases, different reuse dealers of reclaimed construction products are available with specific information about the category of reclaimed materials with which they are dealing.

## 2.2. Motivation to reuse construction products

Each of the interviewed construction actors was asked the following question: What is the motivation to reuse construction products? The results of this question are listed in .

| N° | Motivation to reuse construction products | Construction actors agreeing (N°) |
|---|---|---|
| 01 | The client's commitment to sustainability | 01; 02; 04; 05; 06; 08; 09; 10 |
| 02 | The price to reuse materials is lucrative | 09 |
| 03 | The aesthetic aspect of reclaimed materials | 05 |

*Table 6: Motivation to reuse construction products*

### 2.2.1. The client's commitment to sustainability

The client's commitment to sustainability means that the client has decided to reuse construction materials as a result of a sustainable ambition. This sustainable ambition can come from different places. Sustainable ambition can be a personal sustainability belief, a CO2 reduction business objective, or an anticipation of external obligations in legislation. The result of this question clearly shows that the client has a big influence on the choice of whether to reuse or not reuse construction products in a project. Contemporary economic systems are characterized by a significant influence on clients and investors. This is an economic system that is capitalist rather than circular.

It is done so that the client is the one who makes the decision. But the motivation for the decision may lie elsewhere, for example, with the architect, reuse advisor, or contractor that motivates the client.

### 2.2.2. The price of reusing materials is lucrative

The cost of reusing construction materials is often not the primary motivation to do so. One of the possible explanations is that the process is not yet business as usual, so the construction actors often need to spend more time thinking compared to the business-as-usual practice of the linear economy. In a capitalistic model, as Belgium is living in today, it is important to show that the reuse of reclaimed materials can be lucrative. Those examples of lucrative reuse

already exist, but they are not yet known to everyone. The price of reusing materials can be lucrative for different construction actors.

It can be lucrative for the general contractor. The contractor can bid at the same price as new materials but may have a lower purchase cost because of the lower cost of reclaimed construction products. It can be lucrative for the demolition contractor, who sees a small profit in reusing certain materials compared to the cost of waste disposal. An example given by the interviewed construction actors is roof panels. Some roof panels are more profitable to dismantle and sell than to pay for waste disposal. It can be lucrative for the client who can reuse construction materials that are already in his building, which are going to be demolished, or reuse ex-situ construction materials, which are cheaper than new materials.

Another example of the lucrative reuse of construction materials is given in the book Reuse in Construction: A Compendium of Circular Architecture by Eva Stricker et al. (2022). In this book, the renovation of an existing building is described using as many reclaimed materials as possible. The Swiss project is called K.118 and was finished in 2022. The researchers retrospectively documented the process from the beginning untill the end and analyzed several aspects such as the scouting process, environmental impact, costs, etc. One of the outcomes was a comparison between the construction cost of the K.118 with a new project. The results show that this project was only 2-3% more expensive than it would have been using new materials. It is important to mention this 2-3% is only regarding the price of the construction materials. For this project, there was also an additional 2% study cost. According to the authors, these extra costs are mainly related to the lack of established processes and markets. [21]

### 2.2.3. The aesthetic aspect of reclaimed materials

One of the interviewed construction actors claims that the aesthetic aspect of reclaimed materials is exactly what he is searching for and says that the aesthetic aspect of an artificially aged construction product is not as good for him as the aesthetics of a reclaimed construction product. An example was given of a brick. Producers of new bricks are now also producing bricks that seem to be old but are artificially aged. The producers of those artificially aged bricks aim for an aesthetic as close to the reclaimed bricks as possible. The construction actor claims that this artificially aged brick hasn't the same aesthetics as a reclaimed brick.

## 2.3. Hurdles to reuse construction products

Each of the interviewed construction actors was asked the following question: What are the hurdles to finding a new destination for existing construction products or to scout them for implementation in a project? The results of this question are listed in .

| N° | Hurdles to reuse construction products | Construction actors agreeing (N°) |
|---|---|---|
| 01 | Timing of matchmaking and storage | 01; 02; 06; 07; 09; 10 |
| 02 | Strict norms for non-structural reclaimed components | 01; 10 |

[21] E. Stricker et al., *Reuse in Construction: A Compendium of Circular Architecture* (Park Books, 2022), https://books.google.be/books?id=i8j5zgEACAAJ.

| | | |
|---|---|---|
| 03 | Lack of established material scouting processes | 02; 06 |
| 04 | Testing and treatment of reclaimed products are expensive | 02; 05; 09 |
| 05 | Not enough incentive to adopt reuse | 02; 06; 07; 09 |
| 06 | Updating online platforms is time-intensive | 04; |
| 07 | Mentality change is needed for all construction actors | 04; 06 |
| 08 | New imported construction products are too cheap | 05 |
| 09 | Excessive number of contractors in large-scale projects | 05 |
| 10 | Limited technical information on reclaimed materials | 05; 10 |
| 11 | Supply of reclaimed materials is bigger than the demand | 06; 09 |
| 12 | Extra charges for the construction actors | 06 |
| 13 | Highlighting the warranty's limitations | 06; 09 |
| 14 | Widespread online and physical offers | 07; 08; 10 |
| 15 | Architects prefer to reach for new products | 08 |
| 17 | Design of construction projects is in constant change | 10 |
| 18 | Absence of overview of reclaimed material stock | 10 |

*Table 7: Hurdles to reuse construction products.*

### 2.3.1. Timing of matchmaking and storage

Based on the interviews with construction actors, the timing of matchmaking and storage is the hardest hurdle nowadays. The timing of matchmaking means that the offer of reclaimed materials often doesn't synchronize with the demand for those materials. Two different types of matchmaking exist. Direct matchmaking from project to project and indirect matchmaking from project to storage space, or reuse dealer, to project. For both matchmaking possibilities, the demand for materials needs to know early in the process (before the building application) what materials are available. This is because the demand needs to reserve those materials so that they remain available until the construction project is executed.

The first possibility, which doesn't happen so often yet, is direct matchmaking from project to project. In this case, the offer of the reclaimed materials will only become available at the time of construction project execution. This means the demolition timing execution of the offering project matches perfectly with the construction timing execution of the demanding project. In this case, the reclaimed construction materials for the offering project can be reserved beforehand so that the demand for the reclaimed materials is sure and he will receive the materials in the future. This matchmaking process is shown in Fig. 5. The reclaimed materials go from point R1 to point R5, with a very short storage time. In this case, the intermediary who stores the materials knows that they will certainly be used in the future.

The second possibility, which happens more often, is the indirect matchmaking from project to storage space to project. This means the demolition timing execution of the offering project doesn't match the construction timing execution of the demanding project. In this case, the reclaimed construction materials need to be stored somewhere to overlap the time between the demolition timing execution of the offering project and the construction timing execution of the demanding project. This is a long period in which the materials need to be stored somewhere. This can be either on the demand side or the offer side. In any case, that storage can often cost some money, and this is a big hurdle. Demolition companies and contractors

see an opportunity in storing reclaimed products and start hiring storage spaces. This matchmaking process is shown in Fig. 5. The reclaimed materials go from point R1 to point R5, with a possibly longer use of a storage place. In this case, the intermediary takes on the risk of storing materials without having a buyer yet. Most of the time, based on past experiences, the intermediary will only store materials that he knows have reuse potential.

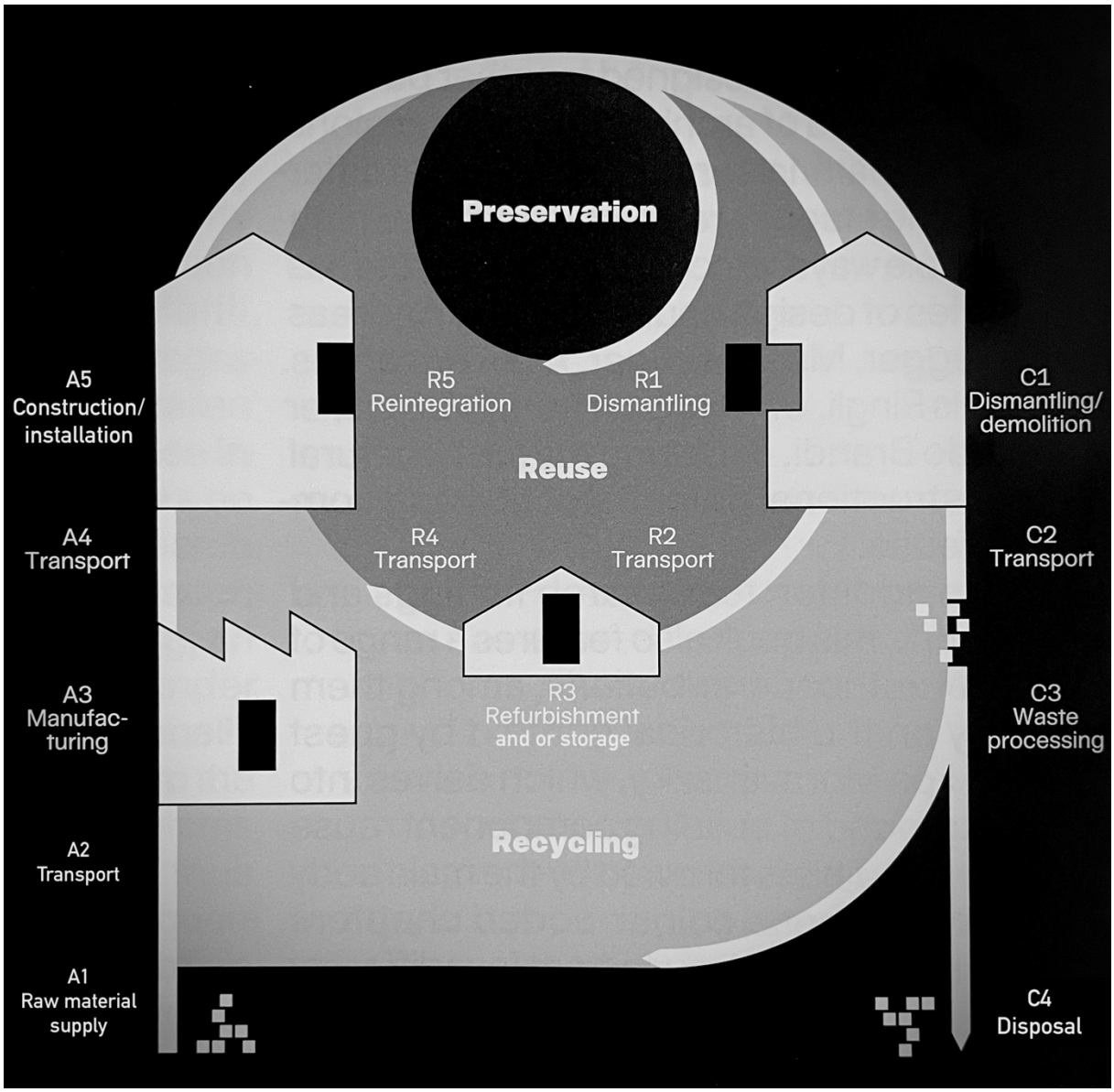


*Fig. 5: Material flow of the circular economic model of the construction sector.*[22]

The timing for matchmaking of reclaimed construction materials will further be discussed in Chapter 3.3. Using online matchmaking platforms at the right phase of the construction project.

### 2.3.2. Strict norms for non-structural components

[22] Stricker et al.

This hurdle emerged from the interviewee's example of a possible solution. The interviewed reuse advisors and architects claim that exceptions to norms for non-structural reclaimed components would help to reuse more construction materials. To give an example, the norms oblige the use of cobblestones with a specific coefficient of friction. In the case of reclaimed stones, the information is often not available anymore, so a reuse advisor or architect cannot reuse this stone because of the strict norms. A solution for this would be to make exceptions for reclaimed materials under the existing norms of today.

### 2.3.3. Lack of established material scouting processes

The reuse advisors say the reuse costs are too high because of a lack of established material scouting processes. This confirms what was said in the previous chapter: State-of-the-art. It is necessary to increase knowledge and competence in the field of reuse of reclaimed construction products, unlock data and information for the authorities, and inform the public/demand/client about the circular economy method. Research shows that if a construction actor sees that the quest to search for reclaimed materials is not worth the time, the user will often quit very early in the quest.

### 2.3.4. Testing and treatment of reclaimed products are expensive

The testing and treatment of reclaimed products are expensive, and it is therefore more lucrative for the construction actors to use new products that are already tested and don't need extra treatment. The testing of materials could be solved if exceptions in norms for non-structural reclaimed components are made, just as explained in Chapter 2.3.2. Another solution that the interviewed construction actors suggest is a prolonged producer's responsibility for their products. This means the producer of new construction materials is responsible for their products even at the end of their lives and is ready to provide all technical properties of these products and even give the possibility to test the materials again. The treatment of reclaimed products is expensive because this work is often done manually and because the costs of manual labor in Belgium are high.

### 2.3.5. Not enough incentive to adopt reuse

Interviewed construction actors say that the authorities have the power to make circularity possible in the construction sector by giving financial advantage to circular buildings. However, other solutions besides financial incentives from the government are conceivable, such as mandatory measures. A good example, therefore, is when looking at the regulations applied in the Netherlands.

In the Netherlands, construction is given an MPG score. MPG stands for Milieu Prestatie Gebouw, which translates to Environmental Performance of Buildings. The MPG score is a score in €/$m^2$ assigned to new buildings, indicating their environmental impact throughout their life cycle. The environmental impact of a building, calculated using the MPG methodology, cannot exceed a cost threshold set by the authorities.

The MPG is calculated by various factors throughout a building's life cycle. The calculation takes into consideration the energy consumption for heating, cooling, and ventilation, the use

of materials and their environmental impact (manufacturing, transportation), the potential waste generation during construction and demolition, and the water use of the construction

A good MPG score results in reduced operational costs, eligibility for subsidies and grants, and the avoidance of potential penalties or delays in obtaining building permits. Construction actors in the Netherlands, therefore, want an MPG score as low as possible. A low MPG score requires careful consideration of material selection. Reused construction materials result in a lower MPG score than new materials. This is how the authorities in the Netherlands are making the reuse of materials attractive for construction actors.

In Belgium, the only regulations applied for new buildings take into consideration only the energy consumption and the water use of the building, not the use of materials and their environmental impact (manufacturing, transportation) nor the potential waste generation during construction and demolition.

#### 2.3.6. Updating online platforms is time-intensive

One of the reuse advisors who has its online marketplace for reclaimed construction materials argues that significant time resources are necessary to continuously update the platform's content and functionalities. For a starting business or any small company (like a large proportion of existing reuse dealers), it is very expensive to pay 2/3 people a full-time job to keep the platform up to date.

Updating the platform consists of knowing exactly how many materials go out and come in every day. The platforms' updaters have a lot of tasks. The reclaimed products available on the platform need to have as many physical properties as possible. Tests on the reclaimed product are potentially required. Pictures need to be taken of the new incoming materials in such a way that the construction actors searching on the online marketplace know exactly what the product looks like, how big the product is, and what the defaults of the product are. Further research on what exactly the updaters of the platform need to provide on such an online marketplace will be discussed in Chapter 3.4. Nice-to-have and must-have parameters of online matchmaking platforms.

#### 2.3.7. Mentality change is needed for all construction actors

The interviewed construction actors perceive a lack of interest and demand from clients. This problem was already described in the State-of-the-art: that there is a lack of interest and demand from clients and that the attitudes toward reuse practices of all the construction actors can evolve for the better. An evolution towards more use of reclaimed construction products can be started on the side of building clients when using mandatory legislation. This shows the authorities have a big role in this story, just as explained in Chapter **Error! Reference source not found.**

#### 2.3.8. Owner of online platform

The existing online matchmaking platforms for reclaimed construction materials available in **Table 8** were analyzed to see who the owner of the platform is. This information about the platforms is purely informative and can be found in Annex to Table 22.

### 2.3.9. Information offered about circularity

The existing online matchmaking platforms for reclaimed construction materials available in **Table 8** were analyzed to see if the platforms contained extra information about how to implement reuse actions in construction projects. This extra information can be in the form of lists with links to matchmaking platforms for reclaimed materials or reuse dealers, workshops, formations, books, tools, research articles, or pilot projects to inspire construction actors to implement reuse actions in construction projects. A list of the platforms showing the different additional information provided about circularity can be found in Annex 23 of Table 23.

### 2.3.10. Limited technical information on reclaimed materials

Interviewees claim that often physical parameters of reclaimed materials are not available anymore. An example of this is the reuse of insulation materials. The U-value of reclaimed insulation materials is not directly available and to reuse it, tests need to be done. The interviewees argue this could be solved by implementing an extended responsibility for the manufacturers of new materials. This should be done in a structured way and anticipated from the beginning of the project. This means that the technical datasheet of the new construction product needs to be stored and made accessible at the end of the life of that construction product. Some manufacturers of new materials, such as roof tiles, are even making testing available for some of their construction materials at the end of their life. In the case of roof tiles, some tests are showing that roof tiles at the end of life are even stronger than roof tiles at the beginning of their life.

In smaller projects such as the Zwijnaarde pavilion, see Fig. 6, it is possible to make exceptions and test the materials with other methods than the ones described in the norms. In this case, the tests are improvised by the construction actors and the test can be done without the help of manufacturers of new materials. For bigger projects, such as the Multi - De Brouckère Tower, see Fig. 7, it is mandatory to test the materials with the methods described by the norms.

*Fig. 6: Zwijnaarde pavilion*

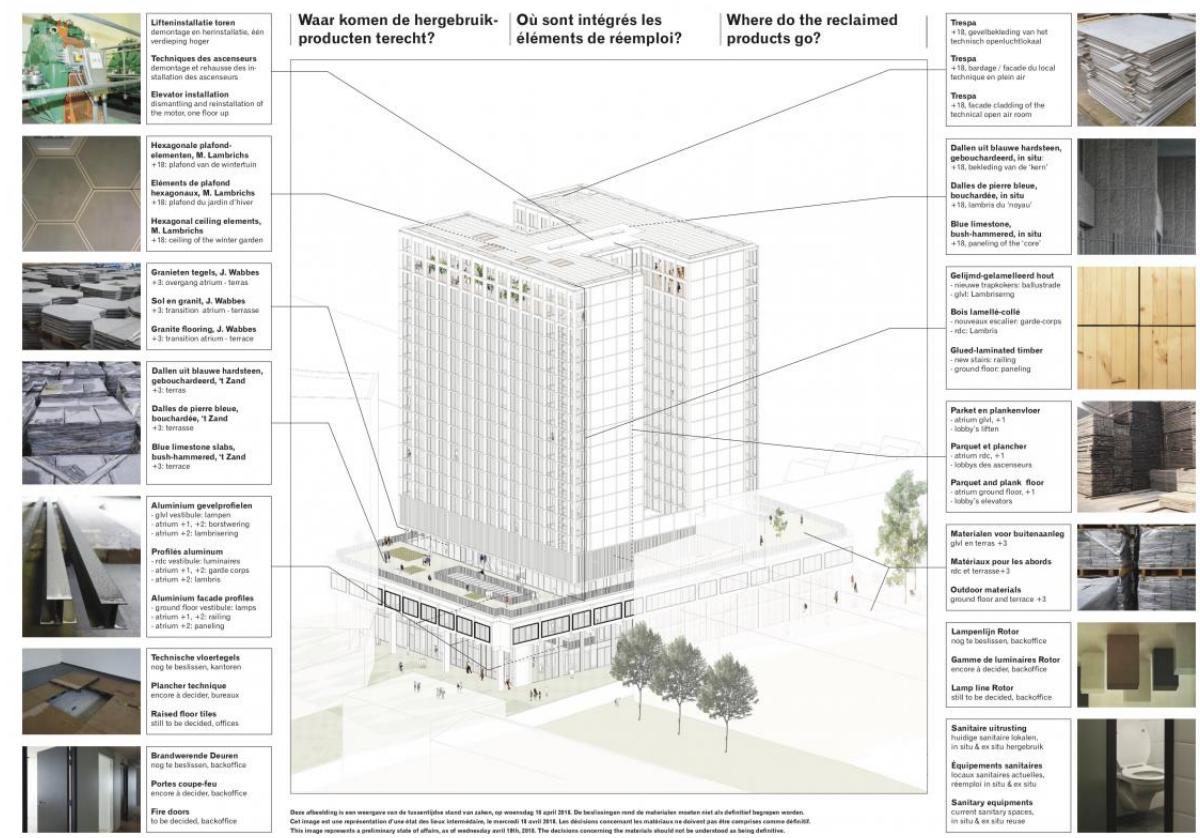


*Fig. 7: Reuse in the Multi - De Brouckère Tower*

### 2.3.11. The supply of reclaimed materials is bigger than the demand

Interviewed construction actors argue that the way construction materials are reused nowadays is mostly driven by the supply side. They have the impression the initiative comes less from the demand side and more from the supply side. Often there is a building that needs to be demolished in some time, and the reuse advisor is then, some months before the demolition, making a reuse inventory of the materials that could be reused. In the inventory made by the reuse advisor, all the known information about the materials is available. The inventory is made accessible to many other construction actors who would possibly need reclaimed construction products. Inventories are being made and shared in various ways. What the possible ways are to match reclaimed materials between offer and demand is explained in Chapter 2.1. Existing matchmaking methods.

A more concrete example from the Belgian construction sector is the one of a client acting as the offer of reclaimed construction materials. About six months before the demolition of one of the client's buildings, several of its partners such as reuse advisors and general contractors came into the client's building to look for reuse opportunities. This example shows how in Belgium the supply side needs to make the first step to reuse construction materials. There is also a demand side, such as reuse advisors and general contractors in the example mentioned before, available to come and look for reuse opportunities.

### 2.3.12. Extra charges for the construction actors

Extra charges for the construction actors are the scouting for reclaimed materials. The scouting for reclaimed materials is a new job that needs to be taken under the workload of one of the already existing construction actors or by a new category of construction actors. Possible construction actors that would add the work of scouting materials into their workload would be the general contractor (as happens in the linear construction sector), the architects, or the reuse advisors.

A change of roles of the construction actors must happen if the construction sector wants to make the move from a linear construction sector to a circular construction sector. A demolition contractor no longer only must have the know-how to demolish buildings but also needs the know-how to disassemble one. These are new skills that the demolition contractor will have to learn.

A new construction actor taking the workload of scouting materials could appear with the shift to a circular construction sector. This new construction actor could be formed by the people under the screens of online marketplaces for reclaimed materials. Nowadays, some online marketplaces for reclaimed materials, such as the Coliseum in Belgium, are already doing the work of scouting the materials needed for the construction actors. The construction actor- is giving the online marketplace, in this case, Coliseum, a list of materials he needs, and the people behind the screens of the online marketplace for reclaimed materials, Coliseum, will scout the materials for the construction actor.

Scouting reclaimed materials for construction actors falls under the category of services provided by an online marketplace of reclaimed materials. Online marketplaces of reclaimed

materials can provide different services, such as scouting or transporting. Different existing online matchmaking platforms together with their offered services will further be discussed in Chapter 3.1. Existing online matchmaking platforms.

### 2.3.13. Highlighting the warranty's limitations

The effectiveness of warranties for new materials can vary. Additionally, testing has shown that older materials can sometimes outperform newer ones in terms of performance. This is the case with the already mentioned case of roof tiles, where tests are showing that roof tiles at the end of life are even stronger than roof tiles at the beginning of their life. Warranty on products is a mental security because often reclaimed products are products that are still fulfilling their function in their original application.

An example to illustrate better what is trying to be explained can be a beam that is disassembled from a steel frame skeleton of a warehouse and which is now reused in another warehouse that carries the same load as the original one. The beam surely will be able to carry the load of the newly constructed warehouse. But in this case, the beam will not be able to be used unless some tests on the beam are made first and a warranty is given so that someone takes responsibility for that beam. Nowadays the problem is in case the reclaimed beam is not tested and used in the new warehouse and the beam falls on someone and causes several injuries, who is taking responsibility for that beam? Will it be the client who decides to reuse the beam even if the beam was not tested? Or will it be the producer of new materials who originally produced that beam? This could be solved by implementing an extended responsibility for the manufacturers of new materials. This means that the technical datasheet of the new construction product needs to be stored and made accessible at the end of the life of that construction product. The manufacturers of new materials are responsible for the material for a longer period and could even provide testing for reclaimed construction materials. It is important to mention that an additional assessment is still needed. This is in case the beam may have corroded, experienced a fire, steel fatigue, etc.

### 2.3.14. Widespread online and physical offers

Reuse advisors who are scouting reclaimed materials claim the need for a centralized online platform for reclaimed construction products. This centralized online meta-platform for reclaimed construction products would contain all the reclaimed construction products available on different existing online platforms. Searching for reclaimed materials nowadays happens on different online marketplaces. Those existing online marketplaces for reclaimed materials are not synchronized on one centralized meta-platform. This makes it for the construction actors very labor-intensive to scout reclaimed construction materials because it takes so much time to analyze all these different sub-platforms. In Fig. 8 is visible the meta platform in green is right in the middle between the supply and demand of reclaimed construction materials. The different existing online marketplaces of reclaimed construction products are represented as four light grey circles connected to the one centralized meta platform.

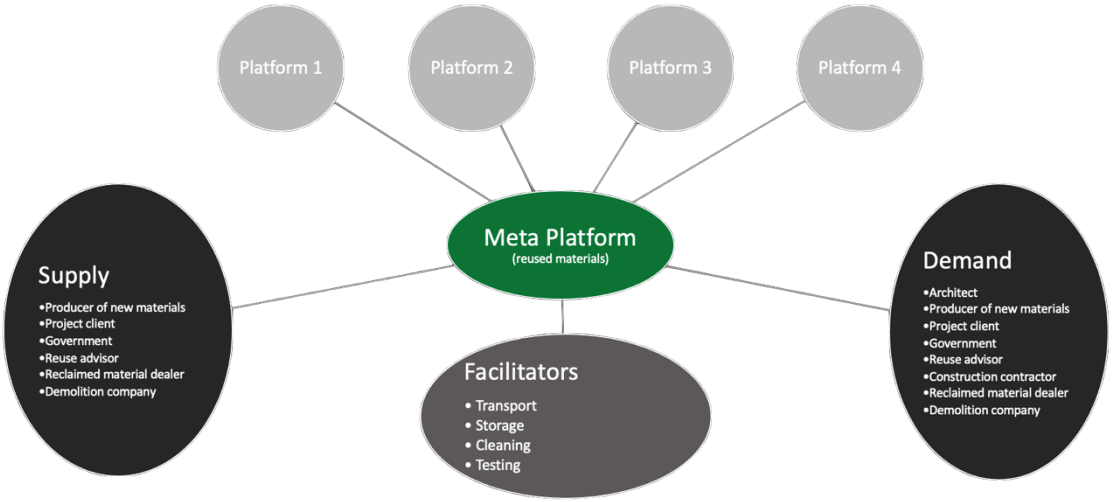


*Fig. 8: Matchmaking of reclaimed construction materials on online marketplaces.*

In Fig. 8 the facilitators available on the online matchmaking platforms are also shown. These are the services that can be provided by an online matchmaking platform. Different existing online matchmaking platforms together with their offered services will further be discussed in Chapter 3.1. Existing online matchmaking platforms.

Architecture students who contributed to the creation of the reclaimed pavilion in Zwijnaarden argue that it is very difficult to find all the reclaimed construction products in the same spot. It is needed to puzzle all the reclaimed materials together from different places and make the shortest trajectory to go and pick them up so that the CO2 emission of the transport of the materials remains limited.

### 2.3.15. Architects prefer to reach for new products

Architects need to come out of their comfort zone and start designing with more limited already existing construction materials. A change in the design process of architects needs to take place because architects need to design buildings following the existing construction materials and not anymore design a building and afterward look for the materials applied in the design.

### 2.3.16. Design of construction projects is in constant change

The design of projects reusing materials is constantly changing because of the changing availability of the reclaimed materials. Often it is not possible to directly have reserved the materials on the moment of the design of the project. Architects need to make the projects flexible for the use of many kinds of reclaimed materials of slightly different sizes.

Authorities in Belgium are giving construction permits. Construction permits allow clients to build. In Sint-Niklaas, the local authority is developing a project where it is trying to reuse construction materials. This means the authorities now take the place of the client. During the project, the authorities discovered the limitations for the architects when asking for a construction permit. For the architect to ask for a construction permit, information should be

given about the materials that will be used on the façade of the future project. The public client now discovered that this was a difficulty for the architect using reused materials and couldn't know exactly which materials would become available at the execution phase of the construction phase. In this case, the authorities made some exceptions and the architect only had to say that the façade would be in wooden slats. Wooden slats are a more general description of the façade than what was asked before by the authorities. This shows circular projects are also new for authorities and they also need to adapt.

### 2.3.17. Absence of overview of reclaimed material stock

During the scouting of materials, it was noticed by the architecture students, who contributed to the creation of the reclaimed pavilion in Zwijnaarden, that reuse dealers do not have online platforms showing the availability of their materials. Lists of existing reuse dealers can be found on online platforms such as Opalis. Suppose the reuse dealer doesn't have an online platform. In that case, it is more difficult for an architect who is scouting reclaimed materials to know what materials are available, in what quantities, what sizes, and other extra information that would be available on an online platform (see Chapter 3.4). Reuse dealers often deal in specific kinds of materials. To know exactly if the materials are available at the reuse dealers it is often needed to call or mail the reuse dealer. It would have been more convenient for the architecture students if they had all this information available on an online platform. When asked to the interviewed construction actors why reuse dealers do not make an online platform for showing their materials, the answer is because of lack of time and the high flow of materials. The reason why it is difficult to hold a platform up to date is explained in Chapter 2.3.6 by the reuse advisor having its online platform.

# 3. REUSE THROUGH ONLINE MATCHMAKING PLATFORMS

This chapter will give insights into the following sub-questions:

- What are the existing online matchmaking platforms used by construction actors to facilitate matchmaking between the offer and demand of reclaimed construction products?

- At what stages of a construction project are these digital matchmaking platforms used by the different actors?

- What are the needs and expectations of the construction actors concerning these platforms? More specifically, what aspects or features do the actors consider as nice-to-have and which as must-have?

## 3.1. Existing online matchmaking platforms

Online matchmaking platforms are a tool for the offer and demand of reclaimed construction materials to interact with each other. The different construction actors that can act as the offer or demand of reclaimed construction materials are listed above in Fig. 8. The figure shows already that online matchmaking platforms are often not only the point for the offer and demand of reclaimed construction materials to interact but they often also offer other services such as transport, storage, treatments, testing, etc.

Different online matchmaking platforms already exist today. In this chapter, existing matchmaking platforms of different countries will be listed, categorized, and analyzed on different parameters. The scope of this chapter is to understand which different types of online platforms for the matchmaking of reclaimed materials already exist and what extra services, on behalf of the matchmaking between offer and demand of reclaimed construction materials those platforms can offer. The analyzed existing online matchmaking platforms for reclaimed construction materials can be found in Table 8. The scope is not to provide a complete overview of the existing platforms but to understand which types of different platforms exist. In this table, the different aspects that were analysed can be found. These were iteratively listed according to the observations of differences between the existing platforms.

| N° | Country | Platform name |
|---|---|---|
| 01 | Belgium | **Floow2** |
| 02 | | **Harvest Bay** |
| 03 | | **Circonflexe** |
| 04 | | **Platforme Reemploi Construction** |
| 05 | | **Atelier Circuler** |
| 06 | | **Relive Furniture** |
| 07 | | **Coliseum** |
| 08 | | **Batiterre** |
| 09 | | **Buurman Antwerpen** |
| 10 | | **Cornermat** |
| 11 | | **ROTOR DC** |
| 12 | | **Vlaanderen Circulair tools en platformen** |
| 13 | | **Opalis** |
| 14 | **Denmark** | **Genbyg** |
| 15 | France | **Articonnex** |
| 16 | | **Gepetto** |
| 17 | | **Cyneo** |
| 18 | | **Skop** |
| 19 | | **Tricycle Environnement** |
| 20 | | **Baticycle** |
| 21 | | **R-place** |
| 22 | | **Backacia** |
| 23 | | **Tricycle Office** |
| 24 | | **Cycle-up** |
| 25 | Germany | **Concular** |
| 26 | | **Restado** |
| 27 | Netherlands | **Madopt** |
| 28 | | **Nationale bruggenbank** |
| 29 | | **Duspot** |

| | | |
|---|---|---|
| 30 | | **Oogstkaart** |
| 31 | | **Marktplaats Insert** |
| 32 | | **GEBRUIKTEBOUWMATERIALEN** |
| 33 | **Norway** | **Rehub** |
| 34 | | **Loopfront** |
| 35 | **Sweden** | **Ccbuild** |
| 36 | **U.K.** | **Globechain** |
| 37 | | **Salvo** |
| 38 | **U.S.** | **Rheaply** |
| 39 | **Zwitserland** | **Salza** |
| 40 | | **Cirkla** |
| 41 | | **Materiuum** |
| 42 | | **Use again** |

*Table 8: The analyzed existing online matchmaking platforms for reclaimed construction materials.*

The URL links of all the analyzed existing online matchmaking platforms for reclaimed construction materials can be found in Annex in Table 13.

### 3.1.1. Material bank or a list of suppliers of reclaimed construction materials

The existing online matchmaking platforms for reclaimed construction materials were analyzed to see if a material bank or a list of suppliers of reclaimed construction materials is available. A material bank mostly is a list of all the available reclaimed materials of that online platform. Each element of the list can be further clicked on if the element of the list seems interesting enough to know more about it. The list of suppliers of reclaimed construction materials is the same principle as the material bank but instead of reclaimed construction materials it consists of suppliers of reclaimed construction materials. The existing online matchmaking platforms for reclaimed construction materials consisting of a material bank or a list of suppliers of reclaimed construction materials are available in Annex in Table 14.

### 3.1.2. Demand for reclaimed construction materials possibility on the platform

The existing online matchmaking platforms for reclaimed construction materials were analyzed to see which platforms give the possibility for platform users to ask for reclaimed construction materials. This means somewhere on the platform; the platform user can input a quest for reclaimed construction materials. A list of the platforms that give the possibility for platform users to ask for reclaimed construction materials can be found in Annex in Table 15.

It is visible that the platforms that don't have a material bank or a list of suppliers of reclaimed construction materials, such as platforms number 3, 7, and 27, have the possibility to demand reclaimed construction materials. This means point 3.1.1 Material bank or a list of suppliers of reclaimed construction materials is complementary to point 3.1.2 Demand for reclaimed construction materials possibility on the platform.

### 3.1.3. Material category

The existing online matchmaking platforms for reclaimed construction materials were analyzed to see what kind of reclaimed materials are available on each platform. Two different types of platforms exist. Platforms with one specific material category and platforms with a wide range of materials categories available. A platform with one specific material category is for example platform 09 Buurman Antwerpen which specializes in reclaimed wood materials. A platform with a wide range of materials categories is for example platform 08 Batiterre on which can be found different types of material categories and in this case, filters will help the platform user to find faster the needed reclaimed material. A list of the platforms categorized by material category can be found in Annex in Table 16.

### 3.1.4. Material owner

The existing online matchmaking platforms for reclaimed construction materials were analyzed to see who the owner of the reclaimed materials is. The owner of the reclaimed materials available on the platform can be the property of the matchmaking platform itself or the property of a third party. Reclaimed materials being the property of the matchmaking platform itself can often directly be ordered from the platform itself. Platform number 11 ROTOR DC is an example of a platform with its own materials. Reclaimed materials being the property of a third party means that the material is located at an external construction actor called the third party which is mentioned in the platform's description of the reclaimed material. Platform number 22 Backacia is an example of a platform dealing with third-party reclaimed materials. A list of the platforms categorized by material owner can be found in Annex in Table 17.

### 3.1.5. Business model

The existing online matchmaking platforms for reclaimed construction materials were analyzed to see their business model. The three different business models that exist are B2B (business-to-business), B2C (business-to-consumer), and C2C (consumer-to-consumer). Some platforms can also be a mix of those business models. A concrete example is a platform that sells materials on the platform to the platform users (B2C) and at the same time also allows the possibility for other businesses to contact the platform with a specific request (B2B). A list of the platforms categorized by business models can be found in Annex in Table 18.

Platforms having a B2B business model will only show some examples of the possible matchmaking of reclaimed materials. Those platforms are only used as an interface for other businesses to be informed and further make contact with the owner of the matchmaking platform. Platform number 07 Coliseum is an example of a platform having a B2B business model.

Platforms having a B2C business model are platforms that make transactions of reclaimed construction materials possible through the platform. The platform offers or demands reclaimed construction products to the platform user. Platform number 26 Restado is an example of a platform having a B2C business model.

Platforms having a C2C business model are platforms that serve as tools for two platform users, offer and demand, to connect and make transactions of reclaimed construction

materials possible. Those platforms are a virtual place for offer and demand of reclaimed construction materials to meet. Platform number 42 Use again is an example of a platform having a C2C business model.

### 3.1.6. Possibility for material passport database after purchase

The existing online matchmaking platforms for reclaimed construction materials were analyzed to see if the platforms give the possibility for the platform users to obtain a material passport database on the online platform after purchasing a reclaimed construction material. Those platforms usually let the platform users make their material database on the platform. At the end of the life of the construction materials, the platform user can choose to move the construction material into a specific region of the platform where the offer and demand of reclaimed construction materials can find each other. Platform number 18 Skop is an example of a platform giving the possibility to the platform users to obtain a material passport database after purchasing a reclaimed construction material. A list of the platforms giving the possibility for the platform users to obtain a material passport database on the online platform after purchasing a reclaimed construction material can be found in Annex in Table 19.

### 3.1.7. Possibility for design/scouting/support (& execution)

The existing online matchmaking platforms for reclaimed construction materials were analyzed to see if the platforms offer services such as the design of a project, the scouting for reclaimed materials products, the supporting of clients in a sustainable project, or even the execution of the construction project itself. Platform number 07 Coliseum is an example of a platform that offers the service of scouting reclaimed materials. More in detail, this means that the general contractor is coming to Coliseum and is giving a list of materials needed for the project. Coliseum will scout those reclaimed materials from different places so that the general contractor doesn't have to do anything more. The process for the general contractor is similar to the process in a linear construction sector. In a linear construction sector, often the general contractor is going to a producer of new construction materials with the list of construction materials needed and the producer of new construction materials provides him with those materials. In the case of a circular construction sector, a new actor comes in the place of the producer of new construction materials. Coliseum is becoming in this case the new actor of the construction project. A new construction actor responsible for the scouting of reclaimed construction materials. A list of the platforms giving the possibility for the platform users to obtain design/ scouting/ support or even execution from the online platform can be found in Annex in Table 20.

### 3.1.8. Possible logistical support (transport, storage, treatments, testing)

The existing online matchmaking platforms for reclaimed construction materials were analyzed to see if the platforms offer logistic support such as transportation, storage, treatments, or testing of the reclaimed construction materials. Logistic support can be an extra offered by online platforms. Platform number 07 Coliseum is an example of a platform that offers logistic support for transportation. Coliseum will scout the reclaimed materials needed for its client (see point 3.1.7) and afterward, Coliseum can deliver the reclaimed materials to the construction site. A list of the platforms giving the possibility for the platform

users to obtain logistic support such as transportation, storage, treatments, or testing of the reclaimed construction materials from the online platform can be found in Annex in Table 21.

### 3.1.9. Owner of online platform

The existing online matchmaking platforms for reclaimed construction materials available in Table 8 were analyzed to see what the owner of the platform is. This information about the platforms is purely informative and can be found in Annex in Table 22.

### 3.1.10. Information offered about circularity

The existing online matchmaking platforms for reclaimed construction materials available in Table 8 were analyzed to see if the platforms contain extra information about how to implement reuse actions in construction projects. This extra information can be in the form of lists with links to matchmaking platforms for reclaimed materials or reuse dealers, workshops, formations, books, tools, research articles, or pilot projects to inspire construction actors to implement reuse actions in construction projects. A list of the platforms showing the different extra provided information about circularity can be found in Annex in Table 23.

### 3.1.11. Organic search traffic

The existing online matchmaking platforms for reclaimed construction materials available in **Table 8** were analyzed to see how many people accessed the platform in April 2024. More specifically, the organic search traffic of the subdomains of the existing matchmaking platforms was analyzed in April 2024. This analysis was made using the next link: AHREF.com. The organic search traffic of an online platform is a subset of the total search engine traffic, focusing specifically on unpaid visits. The total search engine traffic of an online platform is the total traffic a website receives from all search engines.

AHREF provides an estimate of the total organic traffic a website receives. This is a free tool to check the estimated traffic for any website. These estimates should be considered approximations, not exact numbers. AHREF's estimated traffic refers to the total number of times the platform might appear in search results and get clicked on by users, not individual user visits. This means AHREF doesn't track individual user sessions nor deduplicates searches by the same person. A list of the platforms showing the organic search traffic of the subdomains of the existing matchmaking platforms during April 2024 can be found in Annex to Table 24. In  a ranking was made of all these existing matchmaking platforms for reclaimed construction materials. It is visible that platform number 14 (Genbyg) is the top 1 with more than 16k organic search traffic in April 2024. The top 5 are fulfilled by the 4 platforms with numbers 24 Cycle-Up, 37 Salvo, 26 Restado, and 13 Opalis with organic search traffic in April 2024 between 2000 and 6000. The rest of the platforms all had organic search traffic in April 2024 of less than 2000.

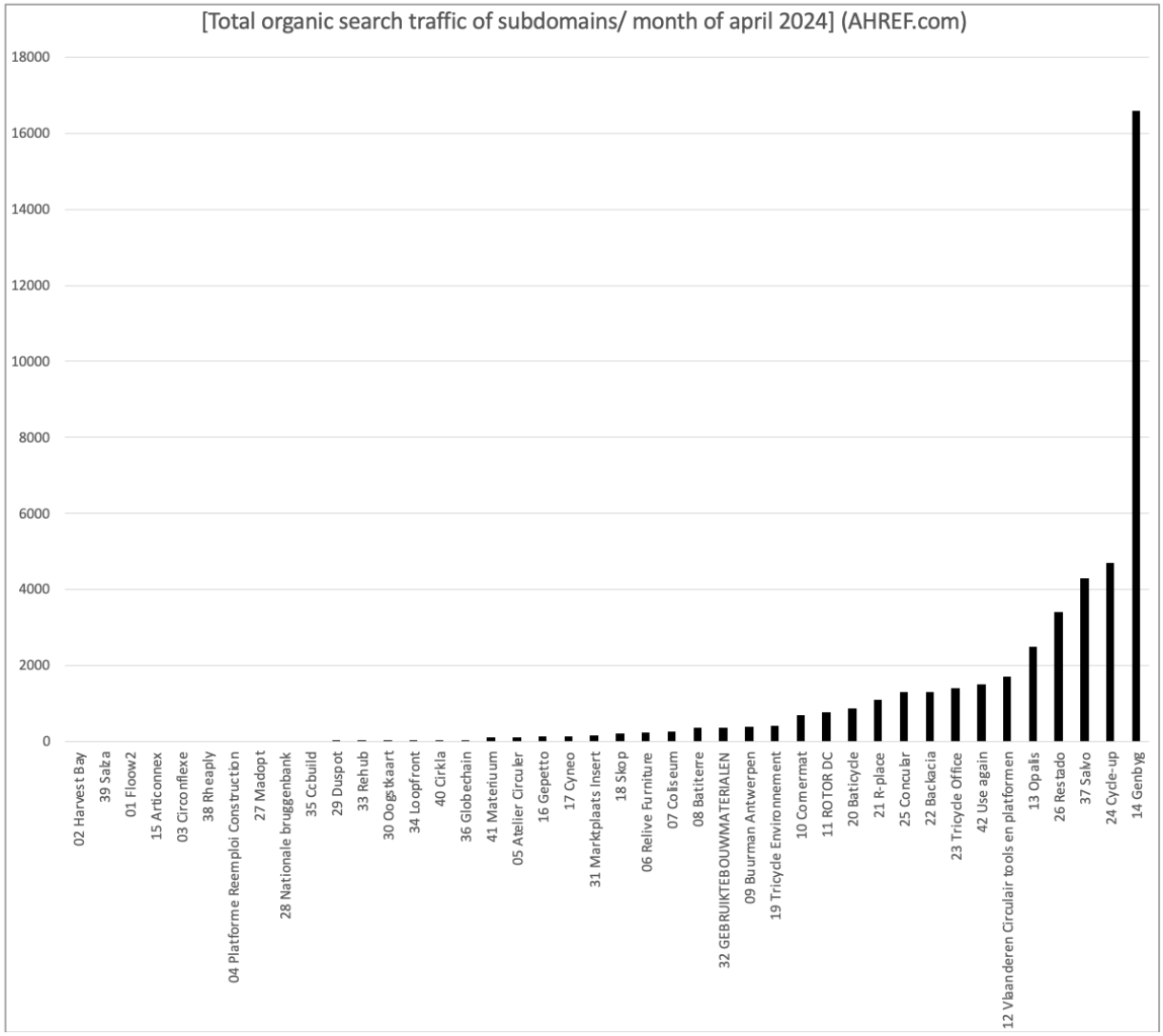


*Table 9: Ranking of online platforms for reclaimed construction materials based on organic search traffic.*

## 3.2. Categories of online matchmaking platforms

It was possible to divide the existing matchmaking platforms into four main categories based on the collected data. The four categories are listed below. A list of the platforms showing their attributed categories can be found in Table 10.

A. **LINK** based
B. **DEMAND** based
C. **OFFER** based
D. **MATCH** based

**Link**-based platforms work like a portal between the effective material-searching website and the material-searcher. On this platform, you can find links to matchmaking platforms for reclaimed materials or reuse dealers. All of the platforms in this category have a link to a material bank or a list of suppliers of reclaimed construction materials.

**Demand**-based platforms are platforms on which reclaimed construction materials can only be scouted by providing the platform with a quest. These platforms have neither a material bank nor a list of suppliers of reclaimed construction materials. These platforms only have a demand for reclaimed construction materials.

**Offer**-based platforms are effective material-searching websites. Those platforms all have a (digital) material bank of reclaimed construction materials and deal with their own platform's reclaimed materials.

**Match**-based platforms are effective material-searching websites. Those platforms all have a material bank of reclaimed construction materials and deal with third-party reclaimed materials.

A mix of the above-listed four categories is also possible, e.g., a combination of an offer-based and demand-based platform. This example might raise the following question: why are those platforms not just match-based platforms? The answer is that the category of match-based platforms is defined as having only third-party reclaimed materials. Platforms, which are a mix of offer-based and demand-based platforms, have their own platform materials.

In Table 10, there is only one unique platform. The platform with number 24 Cycle-Up. This is a mix of offer-based, demand-based, and match-based platforms. This is because this platform makes a difference between its own platform's materials and third-party materials by using different trust levels for the offered materials. Materials with a higher trust level are the platform's own materials or come from third parties that are trusted by the platform. The remaining third-party materials are marked with a low trust level. It is important to notice that Cycle-Up is the second platform in the ranking of organic search traffic.

| N° | Category |
|---|---|
| 1 | D. **MATCH** based |
| 2 | D. **MATCH** based |
| 3 | B. **DEMAND** based |
| 4 | A. **LINK** based |
| 5 | C. **OFFER** based |
| 6 | D. **MATCH** based |
| 7 | B. **DEMAND** based |
| 8 | BC. **OFFER** and **DEMAND** based |
| 9 | C. **OFFER** based |
| 10 | BC. **OFFER** and **DEMAND** based |
| 11 | C. **OFFER** based |
| 12 | A. **LINK** based |
| 13 | A. **LINK** based |
| 14 | C. **OFFER** based |
| 15 | C. **OFFER** based |
| 16 | C. **OFFER** based |
| 17 | C. **OFFER** based |
| 18 | D. **MATCH** based |
| 19 | A. **LINK** based |
| 20 | C. **OFFER** based |
| 21 | D. **MATCH** based |
| 22 | D. **MATCH** based |

| | |
|---|---|
| 23 | C. **OFFER** based |
| 24 | BCD. **OFFER** and **DEMAND** and **MATCH** platform |
| 25 | D. **MATCH** based |
| 26 | C. **OFFER** based |
| 27 | B. **DEMAND** based |
| 28 | D. **MATCH** based |
| 29 | D. **MATCH** based |
| 30 | D. **MATCH** based |
| 31 | D. **MATCH** based |
| 32 | C. **OFFER** based |
| 33 | D. **MATCH** based |
| 34 | D. **MATCH** based |
| 35 | D. **MATCH** based |
| 36 | D. **MATCH** based |
| 37 | D. **MATCH** based |
| 38 | D. **MATCH** based |
| 39 | D. **MATCH** based |
| 40 | A. **LINK** based |
| 41 | D. **MATCH** based |
| 42 | D. **MATCH** based |

*Table 10: Categories of online matchmaking platforms.*

## 3.3. Using online matchmaking platforms at the right phase of the construction project

As the previous chapter shows, timing of matchmaking is one of the main perceived hurdles by the interviewed stakeholders. Additional analyses were made on this subject. The timing of matchmaking means that the offer of reclaimed materials often doesn't synchronize with the demand for those materials. A direct match from construction site to construction site seems to be very rare, and this is why a storage place acts as a buffer where the reclaimed materials can wait until they are needed by the demand side.

For the first two sub-chapters, interviews were organized with the 18 construction actors listed in Table 3. The purpose of the interviews is to better understand when exactly during the construction project the construction actors would search for or offer reclaimed materials. Each of the interviewed parties was asked the same questions. Nonetheless, not all of the interviewed construction actors could fully respond to them because of a lack of experience.

First, the interviewees were asked: What is the moment a matchmaking platform for reclaimed construction products is used in a construction project, and why? The interviewed construction actors were free to choose one or different moments on the timeline of a construction project when they used or would use a matchmaking platform for reclaimed construction products. Two different timelines were given to the interviewed construction actors. The first timeline represents the construction project timeline for the offer of reclaimed construction products and can be seen in Fig. 9. The second timeline represents the construction project timeline for the demand for reclaimed construction products and can be seen in Fig. 10.

The last part of this sub-chapter discusses the results of the second question to the 18 interviewed construction actors, which concerned intermediate storage. More specifically, the question was asked: which of the next three models for the storage of an online matchmaking platform would be needed?

- **Physical temporary storage**
  - This is a physical location where reclaimed construction materials reserved or purchased from the platform can be temporarily stocked until they are reapplied.

- **Physical marketplace**
  - This is the physical location where the platform's reclaimed construction materials are displayed. This means the construction actors can come and see the reclaimed construction materials.

- **No physical storage space**
  - This means that the online matchmaking platforms for reclaimed construction materials do not need a physical storage space.

### 3.3.1. Construction project timeline of the offer of reclaimed construction products

| Person | Construction actor |
|---|---|
| 01 | Architect |
| 02 | Architect |
| 03 | Architect |
| 04 | Architect |
| 05 | Architect |
| 06 | Architect |
| 07 | Producer of new materials |
| 08 | Producer of new materials |
| 09 | Producer of new materials |
| 10 | Project client |
| 11 | Project client |
| 12 | Project client |
| 13 | Government |
| 14 | Government |
| 15 | Government |
| 16 | Reuse advisor |
| 17 | Reuse advisor |
| 18 | Construction contractor |

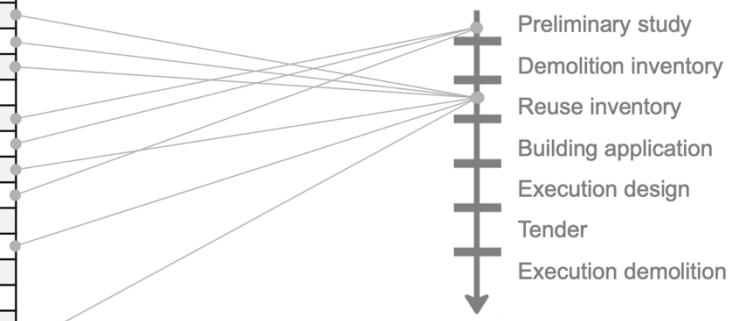


*Fig. 9: Timeline of the offer of reclaimed construction products checked by the interviewed construction actors.*

From Fig. 9 it is visible that for the execution of a demolition, most of the interviewed construction actors use or would use a matchmaking platform for reclaimed construction products as early as possible in the process. The scope of using a platform as early as possible is so that construction materials with reuse potential will be identified and shared on the platform in the hope that the offer of materials will match the demand. The longer the offer can stay on the platform, the more time there is to match demand. Most of the construction actors would still wait until the reuse inventory was made. The reuse inventory shows what construction materials have reuse potential and also gives a clear description of the construction materials that can be used on the platform. Demolition inventory and reuse inventory are not project phases; they are tasks that can be performed at any time during the project. In reality, these tasks often take place at the beginning of a project, during the design phase.

### 3.3.2. Construction project timeline of the demand for reclaimed construction products

| Person | Construction actor |
|---|---|
| 01 | Architect |
| 02 | Architect |
| 03 | Architect |
| 04 | Architect |
| 05 | Architect |
| 06 | Architect |
| 07 | Producer of new materials |
| 08 | Producer of new materials |
| 09 | Producer of new materials |
| 10 | Project client |
| 11 | Project client |
| 12 | Project client |
| 13 | Government |
| 14 | Government |
| 15 | Government |
| 16 | Reuse advisor |
| 17 | Reuse advisor |
| 18 | Construction contractor |

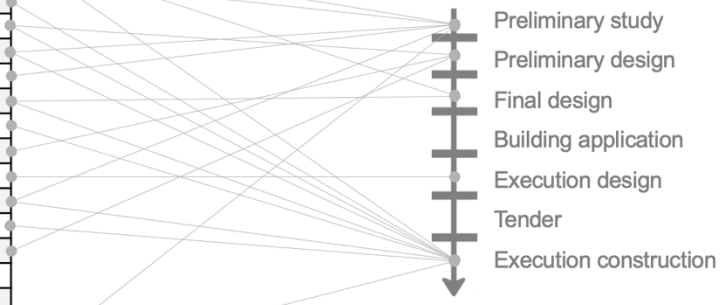


*Fig. 10: Timeline of the demand for reclaimed construction products checked by the interviewed construction actors.*

From Fig. 10 it is visible that to find reclaimed products from outside the construction site, most of the interviewed construction actors use or would use a matchmaking platform in different phases of the project. Based on the objective of using the platform, it is possible to split these into two main phases.

Before the building application, the first phase takes place. The construction actors want to know what reclaimed construction materials are available on the market, so they have already taken a look at online matchmaking platforms. In some cases, depending on the availability of storage by the online matchmaking platform or the client, the material can already be reserved in that phase.

The earlier in the design process it is taught about reusing materials, the higher the chances that reuse ambitions will be effectively realized. The longer you wait, the slimmer the chance of finding a batch of materials whose properties and availability match those of the demanding project. The longer you wait, the more decisions are already made that do not consider reuse.

The construction's execution is the second phase. In this phase, the construction actors that didn't already buy or reserve their reclaimed construction materials use the platform to search for available reclaimed materials. The search is more specific as the building permit has been granted, allowing only minor changes on certain levels, such as interior finishing. The more flexible the project was designed during the building application, the easier it is to find reclaimed materials that fit into that project. An example of a flexible design given during the interviews is allowing the finishing boards of the façade to have different sizes or colors and still fit in the project.

In Fig. 10 it is visible that one specific construction actor, number 10 chooses to use the matchmaking platform only during the execution design. This specific construction actor is a client that has many buildings throughout Belgium. All of his buildings are built with approximately the same construction products. The construction actor only needs to look at

matchmaking platforms just before the building application. This is later than the rest of the construction actors and can be explained because the building's design by construction actor number 10 is very similar. In this case, material scouting takes place during the execution design phase. During this phase, all the reclaimed materials can be bought and stored at their premises.

### 3.3.3. Physical place for the storage of reclaimed construction products

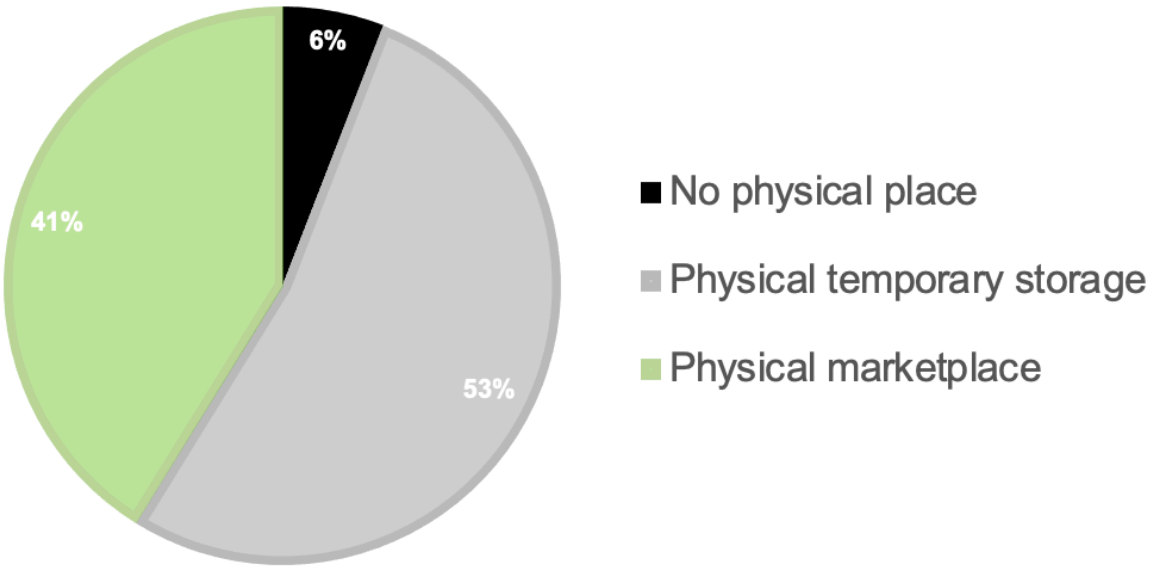


*Fig. 11: Type of physical place needed for an online matchmaking platform of reclaimed construction products.*

From Fig. 11 it is evident that most of the interviewed construction actors indicate the need for a physical space for the storage of the reclaimed construction materials offered by an online platform. A slight preference is present for physical temporary storage. This means a bit more than half of the construction actors that claim to need a physical storage space do not also need a physical marketplace where they can physically see the reclaimed materials before purchasing them. An example of a physical marketplace is shown below in Fig. 12. This is a picture of reclaimed sanitary showcased at the physical marketplace of ROTOR DC.

*Fig. 12: Physical marketplace of reclaimed sanitary showcased at ROTOR DC*

## 3.4. Nice-to-have and must-have parameters of online matchmaking platforms

Because previous Chapter 2.3.6 shows that the fact that updating online platforms is time-intensive is one of the biggest hurdles nowadays, new analyses were made on this subject. Analyses were made to help the owners of an online matchmaking platform with what they needed to provide on that platform. The analysis of this chapter is based on the needs of the professional construction actors listed in Table 3. Each of the interviewed construction actors was asked the same question: What parameters of a matchmaking platform for reclaimed construction products are nice-to-haves, must-haves, or not needed? The interviewed construction actors were helped by showing them screenshots of the features provided by the already existing online matchmaking platforms for reclaimed construction materials. In this chapter, the different features will be described. Figures for the described features can be found in the Annex. The figures are shown in the same way they were shown to the interviewed construction actors. The answers provided by the interviewed construction actors are available in Annex 25. A ranking of the features provided by existing online matchmaking platforms for reclaimed construction materials can be found in Table 11.

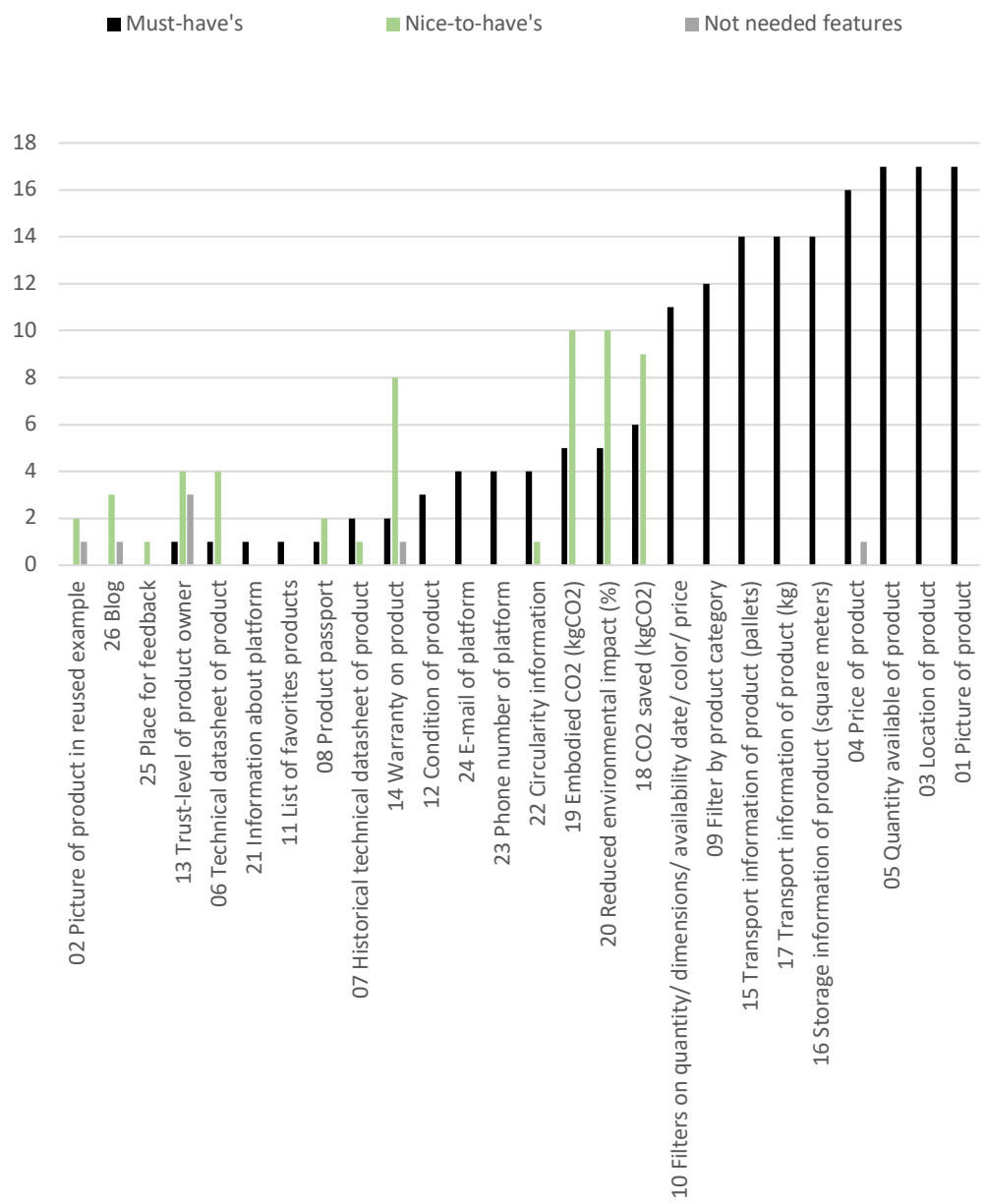


*Table 11: Ranking of the features provided by existing online matchmaking platforms of reclaimed construction materials.*

In Table 11 all the features shown to the interviewed construction actors can be found, numbered from 01 to 26. All these numbers correspond with the numbers from the screenshots shown to the interviewed construction actors to make clear what is meant by each of the features. The annotated screenshots can be found in the Annex from Fig. 13 to Fig. 17. All the features will be discussed shortly, as well as the comments of the construction actors on those features.

### 3.4.1. Picture of product

This feature is a must-have. For taking better pictures of reclaimed materials the instruction of the FCRBE[23] project could be followed. The construction actors would like to see exactly where the reclaimed materials are damaged.

### 3.4.2. Picture of product in reused

Pictures of the reclaimed product in a reclaimed situation are not mandatory. This feature is a nice-to-have.

### 3.4.3. Location of product

The product's location is a must-have. The location is important for the construction actors because if the materials are located too far, they are not sustainable anymore. The origin of the reclaimed construction product can have extra value.

### 3.4.4. Price of product

The reclaimed construction product's price is a must-have. The construction actors would like to know the costs of the repair of the products if a repair is needed. The price of the reclaimed construction product remains the most important parameter for most of the construction actors. The construction actors' meaning is that the authorities should influence the price of those materials. One of the construction actors says: “If we don’t pay the price today, we will pay it tomorrow”. Some other construction actors say that the prize is better not shown because this can scare the reclaimed material seeker.

### 3.4.5. Quantity available of product

The quantity of reclaimed construction products is a must-have. For the construction actors, it would be nice to have a similar product presented in case the quantity is not enough.

### 3.4.6. Technical datasheet of product

The technical datasheet for the reclaimed construction product is a nice-to-have feature. The basic dimensions of the reclaimed construction product should be shown directly so you don't have to open a PDF with the technical specifications to find out. If the technical datasheet for the reused material is not available, the technical datasheet for the new product would be appreciated. This technical datasheet could be found at the producer of new construction materials.

### 3.4.7. Historical technical datasheet of product

Two of the construction actors interviewed believe that the product's historical technical datasheet is a must-have. The historical technical datasheet of the product is a technical

[23] Smeyers Tijl, Deweerdt Morgane, and Mertens Marilyn, “REUSE TOOLKIT THE RECLAMATION AUDIT A GUIDE TO CREATING AN INVENTORY BEFORE DEMOLITION OF POTENTIALLY REUSABLE CONSTRUCTION PRODUCTS” (Interreg NWE, 2022).

datasheet based on archives of other technical datasheets made in the past of the same reclaimed construction material. An example of this could be an insulation board produced in a specific range of years that has already been tested several times for its thermal resistance. A historical technical datasheet of the already several times tested insulation boards of the past could be proposed.

#### 3.4.8. Product passport

A material passport after purchasing the reclaimed material is a nice-to-have feature for two of the interviewed construction actors.

#### 3.4.9. Filter by product category

Filtering by product category is a must-have for the interviewed construction actors. One of the interviewed construction actors proposed to categorize the reclaimed construction products according to the charge book articles.

#### 3.4.10. Filters on quantity/ dimensions/ availability date/color/ price

Filters on quantity/ dimensions/ availability date/color/ price are a must-have for the interviewed construction actors. Interviewed construction actors claim that, especially in the first phase of the reuse of materials, a different color of reclaimed materials shouldn’t be seen as a problem. One other construction actor who was interviewed claims that when working with professionals, the exact color code must be known. A last comment on the colors of the reclaimed construction materials is that a authorities can more easily accept doors of different colors but for a private client it's more difficult because that mind shift is still far away.

#### 3.4.11. List of favorites products

The list of favorite reclaimed materials gives the possibility of having a private list of interesting reclaimed materials. This feature is a must-have for one of the interviewed construction actors.

#### 3.4.12. Condition of product

Information about the reclaimed construction product's condition is a must-have for three of the interviewed construction actors. One of the construction actors claims that reclaimed construction products should be ready for reuse right away because nobody wants a material that still needs to be repaired. One other construction actor says that European standards on the condition of a material may work for professional construction actors.

#### 3.4.13. Trust-level of product owner

The trust level of a product owner is a nice-to-have feature for 4 interviewed construction actors and a not-needed feature for the other 3 interviewed construction actors. The 3

interviewed construction actors did not want this feature on platforms because they claim everything on a professional website should be trusted.

#### 3.4.14. Warranty on product

Warranty on a reclaimed construction product is a nice-to-have feature for the interviewed construction actors. One of the construction actors who thinks this is a must-have feature argues by saying that there is already a warranty on reused cars.

#### 3.4.15. Transport information for product (pallets)

Information about the transportation of reclaimed construction materials in terms of the quantity of pallets is a must-have for the interviewed construction actors.

#### 3.4.16. Storage information for product (square meters)

Information about the storage of reclaimed construction materials in terms of the square meters of space that the materials occupy is a must-have for the interviewed construction actors.

#### 3.4.17. Transport information for product (kg)

Information about the weight of the reclaimed construction materials is a must-have for the interviewed construction actors.

#### 3.4.18. CO2 saved (kgCO2)

Information about the CO2 saved (kgCO2) of the reclaimed construction materials is a nice-to-have feature for the interviewed construction actors. Some of the construction actors want to have a clear specification about the CO2 saved (kgCO2) compared to what? In this case, it is compared to the new material.

#### 3.4.19. Embodied CO2 (kgCO2)

Information about the embodied CO2 (kgCO2) of the reclaimed construction materials is a nice-to-have feature for the interviewed construction actors. For the environmental impact, it would be nice for the construction actors to take into account the location to calculate the environmental impact based on that, even if it were only an approximation.

#### 3.4.20. Reduced environmental impact (%)

Information about the reduced environmental impact of the reclaimed construction materials is a nice-to-have feature for the interviewed construction actors. When communicating with clients, the environmental impact is extremely helpful. But again, construction actors want to know exactly what this means in terms of reduced environmental impact. In this case, it is compared to the new material.

### 3.4.21. Information about platform

Information about the platform itself means that the platform provides correct information about who is the owner of the platform and what economic model the platform follows. The platform could be controlled by the authorities. The platform could be a nonprofit platform, or it could be a market-driven platform. Combinations of those or other options are also possible. One of the interviewed construction actors finds it a must-have feature.

### 3.4.22. Circularity information

Different ways to implement circularity information on the platform are described above in Chapter 2.3.9. . It is a must-have feature, according to the construction actors interviewed.

### 3.4.23. Phone number of platform

The phone number of the platform for reclaimed construction materials is a must-have feature for the interviewed construction actors.

### 3.4.24. E-mail of platform

Just like the phone number, the e-mail of the platform for reclaimed construction materials is a must-have feature for the interviewed construction actors.

### 3.4.25. Place for feedback

A feedback area for the online platform users is a nice-to-have feature for the interviewed construction actors.

### 3.4.26. Blog

A blog in which users of the online platform can ask open questions is seen as a place to learn from the interviewed construction actors. This is a nice-to-have feature for them. One of the interviewed construction actors claims that this blog is a not-needed feature because dumb questions would stick there too.

# 4. PROPOSING A MULTI-BENEFIT MATERIAL SCOUTING PROCESS

This chapter will give insights into the following research questions:

- What are the added values for different professional actors of the building sector in using an online platform that facilitates the matchmaking between the offer and demand of reclaimed construction products in Belgium?

In this chapter, the functioning of a matchmaking platform in an architectural project is tried to be illustrated by a paradigmatic example story. Paradigmatic example stories play a significant role in shaping our understanding. Researchers can gain deeper insights by studying these prototypical examples. This process of analysis can directly contribute to addressing the central research question of this master's thesis.

All the construction actors that can be present in a construction project from Table 1 are present in the next story. The story is created based on knowledge from existing construction pilot projects and the hurdles the construction actors encounter during those projects. In the story, the matchmaking platform of reclaimed construction materials isn't longer just an online marketplace but becomes a new construction actor. All the construction actors used in the story are visible below in . The story strives to explain the added value of each different construction actor. From all the interviewed construction actors in this research, important points are that for each construction actor individually to benefit from this example reuse system, each of the construction actors involved in the construction project must look at this process systematically, trust the collaboration between construction actors, and not work against the reuse process. For the paradigmatic example story, the renovation of a building is chosen from the demolition of the existing building until the construction of the new building so that all the possible construction phases can be tackled.

| |
|---|
| Client |
| Architect |
| General contractor |
| Demolition contractor |
| Reuse advisor |
| Dealer of reclaimed materials |
| Authorities |
| Producer of new materials |
| Matchmaking platform of reclaimed construction materials |

*Table 12: All the construction actors used in the paradigmatic example story.*

## 4.1. Preliminary study

- The client asks an architect and a reuse advisor for the demolition and renovation of a construction project.

- Already in this phase, the client has to be informed about the reuse of construction materials in his construction project. The architect, together with the reuse advisor, is informing the client of the positive and negative aspects of applying reuse to his construction project. In an ideal scenario, the client itself already has clear circular ambitions. Examples of negative aspects are the negative financial costs at the beginning of the project for the scouting of the reclaimed construction materials. Examples of positive aspects are the reduced environmental impact and the positive financial income of offering existing construction materials.

- The client plays an important role in this process because it is the construction actor who pays. Living in a capital system, the investor (client) has the power to make the final decision.

- The goal of the architect and the reuse advisor is to try to reduce the global warming potential and contribute to a more sustainable construction sector.

- The architect, together with the reuse advisor, uses the matchmaking platform of reclaimed construction materials to inform the client of already existing pilot projects and to give him a first glimpse of the possible offer and demand for reclaimed construction products.

- The client, architect, and reuse advisor are satisfied because they are contributing to a more sustainable construction sector. This is the motivation that the interviewed construction actors in Chapter 2.1 claim to be the most important driver.

## 4.2. Demolition inventory and reuse inventory

- The architect together with the reuse advisor make up the demolition and reuse inventory. These two documents will enable the architect and reuse advisor to decide together with the client which construction materials of the existing building are being maintained, reused in situ, reused ex-situ, or demolished. To make the reuse inventory, the architect together with the reuse advisor can use the reuse toolkit made by the Interreg NEW project[24].

- The matchmaking platform for reclaimed construction materials can help by already giving a glimpse of the demand for reclaimed construction materials. This way, it is easier for the architect and reuse advisor to inform the client what to do with which construction materials.

- In Chapter 3.3.1 it is visible that the interviewed construction actors would use the matchmaking platform of reclaimed construction materials starting from the preliminary study till the reuse inventory phase of the construction project. In this phase, the existing and documented materials listed in the reuse inventory can be already offered on a matchmaking platform of reclaimed construction materials. The earlier the materials are put online, the more amount of time the materials stay on the platform, and the bigger the possibility for a match.[25]

- Ideally, the demolition contractor is already present in this phase and tries to advise the client, architect, and reuse advisor.

## 4.3. Preliminary design and final design

[24] Tijl, Morgane, and Marilyn.
[25] Seys Sophie and Billiet Lionel, "De Recuperatie van Bouwmaterialen Uit Publieke Gebouwen Haalbaar Maken," *Vademecum Voor Hergebruik Buiten de Bouwsite*, 2016.

- The architect, together with the reuse advisor, completes the architectural project from preliminary design to final design. The matchmaking platform for reclaimed construction materials can help by already giving a glimpse of the offer of reclaimed construction materials. This way, it is easier for the architect and reuse advisor to make decisions while designing the new construction.

- In Chapter 3.3.2 it is evident that the interviewed construction actors would use the matchmaking platform of reclaimed construction materials, starting from the preliminary study and design phase until the final design phase of the construction project.

- Ideally, the general contractor is already present in the preliminary design and final design phases and tries to advise the client, architect, and reuse advisor.

### 4.4. Demolition and building applications

- In this phase of the construction project, the authorities emphasize the reuse of construction materials by giving financial advantage to the exemplary construction actors. A good example, therefore, is the regulation applied in the Netherlands. Those regulations can be found in Chapter 2.3.5.

- The authorities are satisfied because they are contributing to a more sustainable construction sector and because there's a strong possibility that every kilogram of CO2 saved avoids a future positive financial cost due to climate change.

### 4.5. Execution design

- For the execution design, the architect and reuse advisor should think about the future end-of-life of the used materials. The architect and reuse advisor should design for deconstruction. This means that the design prioritizes the reuse of materials at the end of their lifespan.[26]

### 4.6. Tendering

- In this phase, the requirements document is already made by the architect and reuse advisor. In this document, the requirements for the execution of the demolition and construction of the project are written down. All the circular actions that need to be undergone by the demolition contractor and the general contractor are written down so that every construction actor is on the same line. With this document, both the demolition contractor and the general contractor know exactly which materials need to be maintained, reused in situ, reused ex-situ, or demolished. From recent pilot

[26] Rodrigues Balbio de Lima Patricia, e Souza Rodrigues Conrado, and M. Post Jouke, "Integration of BIM and Design for Deconstruction to Improve Circular Economy of Buildings," *Journal of Building Engineering*, 2023.

projects, it is visible that the percentage amount of materials possible to be reused from ex-situ is 2%[27].

- Ideally, the demolition contractor is already present in the demolition inventory and reuse inventory phases, and the general contractor is already present in the preliminary design and final design phases, and both try to advise the client, architect, and reuse advisor from the beginning of the project.

### 4.7. Execution of demolition and construction

- The demolition contractor demolishes and detaches from the building by following the indications of the requirements document received during the tendering.

- Based on the matchmaking platform for reclaimed construction materials that gives a glimpse of the offer and the demand for reclaimed construction materials, the client and the demolition contractor decide what to do with the detached materials. The detached materials that aren't needed anymore on-site can be in charge of the client or the demolition contractor. Those two construction actors can further use those materials themselves or trade them with a dealer of reclaimed materials. Matchmaking platforms provide information about existing reclaimed materials dealers.

- Dealers of reclaimed construction materials are happy to be on a matchmaking platform because other construction actors can find them more easily.

- The general contractor scouts reclaimed construction products. The client, architect, or reuse advisor could help the general contractor with his quest. The general contractor could search by himself for the needed reclaimed materials on matchmaking platforms for reclaimed construction materials. Another option is to rely on the services offered by matchmaking platforms for scouting reclaimed materials. In this case, the matchmaking platform is going to scout the materials and search on different other matchmaking platforms until all the materials needed for the construction project are available.

- The general contractor is satisfied because the matchmaking platform is doing his task more efficiently, so he has a positive financial income. The construction actor scouting the materials can use the different methods explained in Chapter 2.1.

- The matchmaking platforms provide several services that can be found in Chapter 3.1, including testing of reclaimed construction materials. In this case, it is possible that the producer of new materials can help with the testing or provide a technical datasheet for the reclaimed or new material.

[27] ande Capelle Arne and Billiet Lionel, . . *Working with . MULTI - Open Debate, Public Interior and Circularity* (CONIX RDBM Architects, 2022), http://rotordb.org/en/projects/reuse-multi-project.

- The producer of new materials is satisfied because the reuse of materials opens a whole new business in which they can dive in and become pioneers. Reusing construction materials can be lucrative because the new material is sold or tested a second time.

# 5. CONCLUSION

This thesis identifies the added value for different professional actors in the Belgian building sector by using an online platform that facilitates the matchmaking between the offer and demand of reclaimed construction products. The scope of the research also aligns with the broader objective of advancing towards a circular economy. The results of this research are gained from an analysis of existing works, an analysis of existing platforms, and interviews with key industry stakeholders in reuse processes.

In the first phase of the research, four main categories of matchmaking methods were identified, and the focus was further put on matchmaking through online databases for reclaimed building materials. Interviews with various construction actors revealed three motivations for reusing construction products. The primary motivation seems to be because of the client's commitment to sustainability, followed by the lucrative price of reusing materials and the aesthetic aspect of reclaimed materials. During the interviews, seventeen obstacles were identified. The main hurdles mentioned are the timing of matchmaking and storage, the expensive testing and treatment of reclaimed products, the lack of incentives to adopt reuse, and the widespread online and physical offers of reclaimed construction materials.

In the second phase of the research, different existing matchmaking platforms from different countries were analyzed on different parameters and will be classified based on the collected data into four main categories: link-based, demand-based, offer-based, and match-based platforms. Further on, the interviewees were investigated in terms of the timing of using online matchmaking platforms for reclaimed construction materials and the need for physical temporary storage or marketplaces associated with these platforms. Construction actors further identified essential, desirable, and undesirable features available on an online matchmaking platform for reclaimed construction materials. These findings can provide valuable insights for developers of online platforms that facilitate reuse of reclaimed building materials.

Eventually, a multi-benefit material scouting process is created based on knowledge from existing construction pilot projects and the hurdles the construction actors encounter during those projects. This multi-benefit material scouting process has the form of a paradigmatic example story and tries to give a systematic view of the added values of different actors in the Belgian building sector by using an online platform that facilitates the matchmaking between the offer and demand of reclaimed construction products.

## 5.1. Added values of a platform

The added value of using an online matchmaking platform for a client is the contribution of the platform to finding reclaimed materials so that the client can fulfill existing circularity goals and may benefit from future incentives favoring reuse. The matchmaking platform can help the client sell unused materials. A user-friendly platform that also ensures transparency in certification processes can help the client build confidence in the quality and reliability of reclaimed materials.

The added value of using an online matchmaking platform for an architect or reuse advisor is having a platform that provides insights into available reclaimed materials and aids in design

choices and reuse potential assessment. The platform is also providing support for the organization and management of large-scale projects. Architects and reuse advisors are helped by the platform to transmit sustainable intentions in a structured and anticipated way to the contractor, who are not always aware of the sustainable intentions that were put in place from the beginning of the construction project. The platform could help prepare the reuse inventory by providing historical technical information on reclaimed construction products. The platform in this way helps the architect or reuse advisor to meet the client's sustainability goals and potentially also reduce project costs through material reuse. The architect and reuse advisor will have less time to search for suitable reclaimed materials. This could be entirely done by the matchmaking platform.

The added value of using an online matchmaking platform for authorities is that the platform can encourage reuse in the construction sector, aligning it with future policy objectives. Construction's reduced environmental impact may lead to lower future costs associated with climate change.

The added value of using an online matchmaking platform for a demolition contractor is that the platform can facilitate finding buyers for construction materials that need to be dismantled, potentially generating additional revenue. The platform could provide a clearer understanding of materials designated for reuse, which can optimize demolition procedures.

The added value of using an online matchmaking platform for a general contractor is that the platform aids in sourcing reclaimed materials, potentially at lower costs compared to new materials. Platform services like material scouting can save time and increase efficiency. The platform could provide extensive support throughout the project, including logistics and storage, ensuring that the contractor can focus on its core construction activities without the added burden of material management.

The added value of using an online matchmaking platform for dealers of reclaimed material is that the platform increases the dealer’s visibility and attracts potential buyers. The platform could digitize material sales and facilitate communication with other construction actors.

The added value of using an online matchmaking platform for producers of new materials is that the platform can help open new business opportunities in testing and selling reclaimed materials. Participation in the circular economy can enhance the company's image.

## 5.2. Timing to use a platform

The interviewees claim the design phase is the optimal timing for an initial scan of the offer. This initial scanning is critical for integrating reclaimed materials into the project plan. At that time, the materials are not yet purchased because there is no permit yet. The first possibility is to work with a reservation that spans the permit period. A second possibility is to go back to the platform at the moment of construction execution and purchase the available reclaimed construction materials.

## 5.3. Form of a platform

The platform will take form based on the needs of the construction actors. The research demonstrates that future online platforms need to significantly enhance the synchronization of supply and demand for reclaimed materials by addressing a major barrier to their widespread use.

Interview data reveal a strong preference among construction professionals for platforms providing extensive support throughout the project lifecycle. This includes early-stage design assistance, continuous scouting of materials, and robust logistic solutions.

Platform features such as user-friendly interfaces, detailed material databases, and transparent certification processes are highlighted as critical to fostering trust and adoption among users.

Just as mentioned in the state of the art, the interviewees also think it's crucial to enhance knowledge and competence in the reuse of materials among all stakeholders, including authorities and clients. This can be enhanced on the platform through proposed targeted education, showcased demonstration projects of successful applications of reclaimed materials, or other offered information about circularity. This can build confidence and encourage wider adoption of reclaimed construction materials.

## 5.4. Termination

Having such a platform is a win-win situation for various actors in the Belgian construction sector. Moreover, the platform contributes to environmental benefits and potentially reduces construction or demolition costs. In a linear construction economy, material scouting is traditionally the responsibility of general contractors, who often resist taking on these additional tasks due to time constraints and a lack of expertise. The platform would operate similarly to a distributor of new construction materials in a linear economy, but with the role of matching supply with demand for reclaimed materials and continuously scouting for reclaimed materials. A newly imagined construction actor could be charged with all this work. In this case, the matchmaking platform is serving as a new construction actor. This means new business opportunities are created. This business opportunity could be fulfilled by a new business on its own or by an extension of an already existing business by an existing construction actor. An example, therefore, is a manufacturer of new materials, a reuse advisor, a dealer of reclaimed materials, or another construction actor that can offer the services of an online matchmaking platform. Whatever construction actor takes on this workload, they can become pioneers in the reuse of construction materials.

This research presented a multi-faceted material scouting process that underscores the added value of online matchmaking platforms for various construction actors. This thesis aims to contribute to the ongoing efforts to promote sustainable construction practices and support the shift towards a circular economy in the construction sector. The proposed strategies and insights try to enhance the practical application of reclaimed materials, ultimately leading to more sustainable and resource-efficient construction practices.

# 6. RESEARCH LIMITATIONS

Not all aspects relevant to digital matchmaking platforms for reclaimed building products could be handled within the context of this master thesis. Underneath, the research limitations are listed as opportunities for further research.

## 6.1. Demand-based perspective

The demolition contractor and the reclaimed materials dealer were the two actors who were not interviewed during this research. This is important to know because the two parties together represent a significant portion of the supply of reclaimed construction products. This means that the research's conclusions are primarily based on the demand side. Reflecting on this, this seems to have been an appropriate starting point for this new research domain, as the construction actors interviewed (from the demand side) in Belgium claim that the offer side of reclaimed construction products is more active for the moment than the demand side. This means that, from the perceptions of the interviews, the offer of reclaimed construction materials is more searching for demand than vice versa.

## 6.2. Data accuracy on the existing matchmaking platforms

Matchmaking platforms were analyzed and categorized. It is important to mention that the data concerning the matchmaking platforms used for this research was not received from the matchmaking platforms but was collected by looking visually at them. But, sometimes, the matchmaking platform’s interface does not align completely with the ideas or business model behind that interface. Therefore, it is important to know that the matchmaking platforms themselves did not check the data gathered in this research.

## 6.3. Final validation of the multi-benefit material scouting process

By the end of the research, the scope was to show the proposals of a multi-beneficial material scouting process to the involved construction actors and let them comment on the way this imaginary case scenario develops to make the last adjustments to the process. This exploratory research in a new research domain ends with several hypotheses on the value-added creation of a digital matchmaking platform for different actors. These are synthesized in a prototype reuse process for a batch of materials. As mentioned before, future research can build on these hypotheses by validating them, supplementing them with additional hypotheses, or building a prototype platform and testing it in pilot projects.

# 7. RESEARCH OPPORTUNITIES

Above, in Chapter 6, the research limitations were listed as opportunities for further research.

### 7.1. Financial feasibility of a platform/meta-platform

Construction actors claim that it is financially intensive to run an online platform. Such an online platform can take a lot of time and money. How much money exactly is needed to run an online matchmaking platform for reclaimed construction materials? Further research could include building a prototype platform and testing it in pilot projects.

The idea of having a meta-platform for all the online platforms for reclaimed construction products will certainly make the work of scouting reclaimed construction materials more efficient, but at what cost? What does it take financially to run such a meta-platform? Further research could include building a prototype meta-platform and testing it in pilot projects.

### 7.2. Cost of construction in Belgium

The scouting of reclaimed construction materials takes a lot of time for the architect or the general contractor, and a new construction actor, the matchmaking platform, could help them in this job. Does this mean that Belgian construction in general will become more expensive? This is something that can be analyzed in the future. This could be researched by looking at a pilot project using reclaimed construction materials and comparing it financially to a project constructed with new materials. Maybe the construction will not become more expensive because of the costs associated with selling and buying reclaimed materials at a lower price than new materials, or because of incentives provided by the authorities.

### 7.3. In-depth analysis of existing online matchmaking platforms

The data analyzed for the existing matchmaking platforms in this research is data from the visual consultation of existing online matchmaking platforms for reclaimed construction products. This data is available and can be further arranged and categorized in many other ways to be able to draw new conclusions and analyze the existing matchmaking platforms more in detail. An example of further research could be to compare the organic search traffic of a platform that is only able to offer reclaimed construction products with that of a platform that is only able to demand reclaimed construction products. By comparing the two organic search traffics, the statement of the interviewed construction actors, arguing that in Belgium, the offer side of reclaimed construction products is more active for the moment than the demand side, can be verified. Another possible way to further research the data collected from the already existing online matchmaking platforms is to look more in-depth at their financial business model. Possible questions then could arise, such as how those platforms are surviving economically and how many hours a week of work are needed to keep such a platform working.

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## Declaration of Generative AI and AI-assisted technologies in the writing process

In this paper, ChatGPT (https://chat.openai.com/) was used to refine the academic language and accuracy. On 17 May 2024, the author submitted a text for the **ABSTRACT** and the Conclusion of this paper with instructions to "Reformulate and improve the text in academic style". The output was then further modified to better reflect the author's tone and writing style.

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# 9. ANNEX

## 9.1. Interviews

All the transcriptions and recordings of the interviews of this research are made available to the supervisors and advisors of this master thesis. As the discussions were project-specific the identity of the interviewees might be deducted from the transcriptions. Therefore, these are not included in the thesis.

## 9.2. Existing online matchmaking platforms

### 9.2.1. Website link

| N° | Website link | Status |
|---|---|---|
| 1 | https://www.floow2.community | Works |
| 2 | https://oogstkaart.harvestbay.be | Works |
| 3 | https://www.circonflexe.be | Works |
| 4 | http://www.hergebruik-bouw.brussels | Works |
| 5 | https://www.ateliercirculer.be | Works |
| 6 | https://www.relievefurniture.com | Works |
| 7 | https://coliseum.build | Works |
| 8 | https://batiterre.be | Works |
| 9 | https://www.buurmanantwerpen.be | Works |
| 10 | https://www.cornermat.be | Works |
| 11 | https://rotordc.com | Works |
| 12 | https://vlaanderen-circulair.be | Works |
| 13 | https://opalis.eu | Works |
| 14 | https://genbyg.dk | Works |
| 15 | https://www.articonnex.com | Works |
| 16 | https://gepetto-mobilier.fr | Works |
| 17 | https://cyneo-reemploi.fr | Works |
| 18 | https://www.skop.app | Works |
| 19 | https://tricycle-environnement.fr | Works |
| 20 | https://baticycle.fr | Works |
| 21 | https://r-place.fr | Works |
| 22 | https://www.backacia.com | Works |
| 23 | https://tricycle-office.fr | Works |
| 24 | https://www.cycle-up.fr | Works |
| 25 | https://concular.de | Works |
| 26 | https://restado.de | Works |
| 27 | https://materiaalscout.nl | Works |
| 28 | https://www.nationalebruggenbank.nl | Works |
| 29 | https://www.duspot.nl | Works |
| 30 | https://www.oogstkaart.nl | Works |
| 31 | https://marktplaats.insert.nl | Works |
| 32 | https://zakelijk.gebruiktebouwmaterialen.com | Works |
| 33 | https://www.rehub.no | Works |
| 34 | https://www.loopfront.com | Works |
| 35 | https://www.ccbuild.se | Works |
| 36 | https://globechain.com | Works |
| 37 | https://www.salvoweb.com | Works |
| 38 | https://app.rheaply.com | Works |
| 39 | https://www.salza.ch | Works |
| 40 | https://cirkla.ch | Works |
| 41 | https://materiuum.ch | Works |
| 42 | https://www.useagain.ch | Works |

*Table 13: URL links of all the analyzed existing online matchmaking platforms for reclaimed construction materials*

### 9.2.2. Material bank or list of suppliers of reclaimed construction materials

| N° | Material bank or list of suppliers of reclaimed construction materials |
|---|---|
| 1 | YES |
| 2 | YES |
| 3 | NO |
| 4 | YES |
| 5 | YES |
| 6 | YES |
| 7 | NO |
| 8 | YES |
| 9 | YES |
| 10 | YES |
| 11 | YES |
| 12 | YES |
| 13 | YES |
| 14 | YES |
| 15 | YES |
| 16 | YES |
| 17 | YES |
| 18 | YES |
| 19 | YES |
| 20 | YES |
| 21 | YES |
| 22 | YES |
| 23 | YES |
| 24 | YES |
| 25 | YES |
| 26 | YES |
| 27 | NO |
| 28 | YES |
| 29 | YES |
| 30 | YES |
| 31 | YES |
| 32 | YES |
| 33 | YES |
| 34 | YES |
| 35 | YES |
| 36 | YES |
| 37 | YES |
| 38 | YES |
| 39 | YES |
| 40 | YES |
| 41 | YES |
| 42 | YES |

*Table 14: Platforms consisting of a material bank or a list of suppliers of reclaimed construction materials.*

### 9.2.3. Demand for reclaimed construction materials possibility on the platform

| N° | Demand for reclaimed construction materials possibility on the platform |
|---|---|
| 1 | NO |
| 2 | NO |
| 3 | YES |
| 4 | NO |
| 5 | NO |
| 6 | NO |
| 7 | YES |
| 8 | YES |
| 9 | NO |
| 10 | YES |
| 11 | NO |
| 12 | NO |
| 13 | NO |
| 14 | NO |
| 15 | NO |
| 16 | NO |
| 17 | NO |
| 18 | NO |
| 19 | NO |
| 20 | NO |
| 21 | YES |
| 22 | NO |
| 23 | NO |
| 24 | YES |
| 25 | NO |
| 26 | NO |
| 27 | YES |
| 28 | YES |
| 29 | NO |
| 30 | NO |
| 31 | NO |
| 32 | NO |
| 33 | NO |
| 34 | NO |
| 35 | YES |
| 36 | NO |
| 37 | NO |
| 38 | NO |
| 39 | YES |
| 40 | NO |
| 41 | NO |
| 42 | YES |

*Table 15: Platforms that give the possibility for platform users to ask for reclaimed construction materials.*

### 9.2.4. Material category

| N° | Material category |
|---|---|
| 1 | Wide range |
| 2 | One specific material category |
| 3 | Wide range |
| 4 | Wide range |
| 5 | Wide range |
| 6 | One specific material category |
| 7 | Wide range |
| 8 | Wide range |
| 9 | One specific material category |
| 10 | Wide range |
| 11 | Wide range |
| 12 | Wide range |
| 13 | Wide range |
| 14 | Wide range |
| 15 | Wide range |
| 16 | One specific material category |
| 17 | Wide range |
| 18 | Wide range |
| 19 | Wide range |
| 20 | Wide range |
| 21 | Wide range |
| 22 | Wide range |
| 23 | One specific material category |
| 24 | Wide range |
| 25 | Wide range |
| 26 | Wide range |
| 27 | Wide range |
| 28 | One specific material category |
| 29 | Wide range |
| 30 | Wide range |
| 31 | Wide range |
| 32 | Wide range |
| 33 | Wide range |
| 34 | Wide range |
| 35 | Wide range |
| 36 | Wide range |
| 37 | Wide range |
| 38 | Wide range |
| 39 | Wide range |
| 40 | Wide range |
| 41 | Wide range |
| 42 | Wide range |

*Table 16: Material category of online matchmaking platforms for reclaimed construction materials.*

### 9.2.5. Material owner

| N° | Material owner |
|---|---|
| 1 | Third party materials |
| 2 | Third party materials |
| 3 | Third party materials |
| 4 | Third party materials |
| 5 | Platfrom's materials |
| 6 | Third party materials |
| 7 | Platfrom's materials |
| 8 | Platfrom's materials |
| 9 | Platfrom's materials |
| 10 | Platfrom's materials |
| 11 | Platfrom's materials |
| 12 | Third party materials |
| 13 | Third party materials |
| 14 | Platfrom's materials |
| 15 | Platfrom's materials |
| 16 | Platfrom's materials |
| 17 | Platfrom's materials |
| 18 | Third party materials |
| 19 | Third party materials |
| 20 | Platfrom's materials |
| 21 | Third party materials |
| 22 | Third party materials |
| 23 | Platfrom's materials |
| 24 | Platfrom's materials & Third party materials |
| 25 | Third party materials |
| 26 | Platfrom's materials |
| 27 | Third party materials |
| 28 | Third party materials |
| 29 | Third party materials |
| 30 | Third party materials |
| 31 | Third party materials |
| 32 | Platfrom's materials |
| 33 | Third party materials |
| 34 | Third party materials |
| 35 | Third party materials |
| 36 | Third party materials |
| 37 | Third party materials |
| 38 | Third party materials |
| 39 | Third party materials |
| 40 | Third party materials |
| 41 | Third party materials |
| 42 | Third party materials |

*Table 17: Material owner of online matchmaking platforms for reclaimed construction materials.*

### 9.2.6. Business model

| N° | Business model |
|---|---|
| 1 | C2C |
| 2 | C2C |
| 3 | B2B |
| 4 | B2C |
| 5 | B2C |
| 6 | C2C |
| 7 | B2B |
| 8 | B2B & B2C |
| 9 | B2C |
| 10 | B2B & B2C |
| 11 | B2C |
| 12 | B2C |
| 13 | B2C |
| 14 | B2B & B2C |
| 15 | B2C |
| 16 | B2C |
| 17 | B2B |
| 18 | C2C |
| 19 | B2C |
| 20 | B2C |
| 21 | C2C |
| 22 | C2C |
| 23 | B2C |
| 24 | B2B & B2C & C2C |
| 25 | C2C |
| 26 | B2C |
| 27 | B2B |
| 28 | C2C |
| 29 | C2C |
| 30 | C2C |
| 31 | C2C |
| 32 | B2C |
| 33 | C2C |
| 34 | C2C |
| 35 | B2C & C2C |
| 36 | C2C |
| 37 | C2C |
| 38 | C2C |
| 39 | C2C |
| 40 | B2C |
| 41 | C2C |
| 42 | C2C |

*Table 18: Business model of online matchmaking platforms for reclaimed construction materials.*

### 9.2.7. Possibility for material passport database after purchase

| N° | Possibility for material passport database after purchase |
|---|---|
| 1 | NO |
| 2 | YES |
| 3 | NO |
| 4 | NO |
| 5 | NO |
| 6 | YES |
| 7 | NO |
| 8 | NO |
| 9 | NO |
| 10 | NO |
| 11 | NO |
| 12 | NO |
| 13 | NO |
| 14 | NO |
| 15 | NO |
| 16 | NO |
| 17 | NO |
| 18 | YES |
| 19 | NO |
| 20 | NO |
| 21 | NO |
| 22 | YES |
| 23 | NO |
| 24 | YES |
| 25 | YES |
| 26 | NO |
| 27 | NO |
| 28 | NO |
| 29 | NO |
| 30 | YES |
| 31 | YES |
| 32 | YES |
| 33 | NO |
| 34 | YES |
| 35 | YES |
| 36 | NO |
| 37 | NO |
| 38 | NO |
| 39 | NO |
| 40 | NO |
| 41 | NO |
| 42 | NO |

*Table 19: Platforms possibility for material passport database after purchase.*

### 9.2.8. Possibility for design/ scouting/ support (& execution)

| N° | Possibility for design/ scouting/ support (& execution) |
|---|---|
| 1 | NO |
| 2 | NO |
| 3 | YES |
| 4 | NO |
| 5 | YES |
| 6 | NO |
| 7 | YES |
| 8 | YES |
| 9 | NO |
| 10 | YES |
| 11 | NO |
| 12 | NO |
| 13 | NO |
| 14 | YES |
| 15 | NO |
| 16 | YES |
| 17 | YES |
| 18 | NO |
| 19 | YES |
| 20 | NO |
| 21 | YES |
| 22 | YES |
| 23 | NO |
| 24 | YES |
| 25 | YES |
| 26 | NO |
| 27 | NO |
| 28 | NO |
| 29 | NO |
| 30 | YES |
| 31 | YES |
| 32 | NO |
| 33 | YES |
| 34 | NO |
| 35 | YES |
| 36 | NO |
| 37 | NO |
| 38 | NO |
| 39 | NO |
| 40 | NO |
| 41 | YES |
| 42 | NO |

*Table 20: Possibility for design/ scouting/ support (& execution) of reclaimed construction materials.*

### 9.2.9. Possible logistical support (transport, storage, treatments, testing)

| N° | Possible logistical support (transport, storage, treatments, testing) |
|---|---|
| 1 | NO |
| 2 | NO |
| 3 | YES |
| 4 | NO |
| 5 | NO |
| 6 | YES (transport, treatments) |
| 7 | YES (transport, storage, treatments, testing) |
| 8 | YES (storage) |
| 9 | NO |
| 10 | YES (transport) |
| 11 | YES (treatments) |
| 12 | NO |
| 13 | NO |
| 14 | YES (storage) |
| 15 | YES (storage) |
| 16 | YES (transport, treatments) |
| 17 | YES (storage, treatments) |
| 18 | NO |
| 19 | YES (treatments) |
| 20 | YES (transport) |
| 21 | NO |
| 22 | NO |
| 23 | YES (transport) |
| 24 | YES (treatments) |
| 25 | NO |
| 26 | NO |
| 27 | NO |
| 28 | NO |
| 29 | NO |
| 30 | NO |
| 31 | YES (transport) |
| 32 | YES (transport) |
| 33 | YES (transport, storage, treatments, testing) |
| 34 | NO |
| 35 | YES (transport, storage, treatments, testing) |
| 36 | YES (storage) |
| 37 | NO |
| 38 | NO |
| 39 | NO |
| 40 | NO |
| 41 | NO |
| 42 | NO |

*Table 21: Possible logistic support (transport, storage, treatments, testing of reclaimed construction materials.*

### 9.2.10. Owner of online platform

| N° | Owner |
|---|---|
| 1 | Floow2 |
| 2 | Jansen |
| 3 | Circonflexe |
| 4 | Embuild |
| 5 | Atelier Circuler |
| 6 | Relive Furniture |
| 7 | Coliseum |
| 8 | BATIGROUPE |
| 9 | BUURMAN |
| 10 | RETRIVAL SCRL FS |
| 11 | ROTOR vzw |
| 12 | Vlaanderen circulair |
| 13 | ROTOR, Atelier 4/5, Bellastock |
| 14 | Genbyg |
| 15 | Articonnex |
| 16 | Tricycle environment |
| 17 | Cyneo |
| 18 | Cyneo |
| 19 | Tricycle environment |
| 20 | Tricycle environment |
| 21 | Caprionis |
| 22 | Backacia |
| 23 | Tricycle environment |
| 24 | Cycle-ip |
| 25 | Concular |
| 26 | Restado |
| 27 | Repurpose |
| 28 | AMROR |
| 29 | Duspot |
| 30 | SUPERUSE |
| 31 | Insert |
| 32 | A VAN LIEMPD SLOOPBEDRIJVEN |
| 33 | Rehub |
| 34 | Loopfront |
| 35 | Ccbuild |
| 36 | Globechain |
| 37 | Salvo |
| 38 | Rheaply |
| 39 | Salza |
| 40 | Cirkla |
| 41 | Materiuum |
| 42 | Use again |

*Table 22: Owner of online platform of reclaimed construction materials.*

### 9.2.11. Information offered about circularity

| N° | Information about circularity to implement reuse actions in construction projects |
|---|---|
| 1 | NO |
| 2 | NO |
| 3 | NO |
| 4 | YES (matchmaking platforms/ transfered to EMBUILD vzw for books) |
| 5 | YES (workshops) |
| 6 | NO |
| 7 | NO |
| 8 | YES (transfered to BATIGROUPE for formations) |
| 9 | YES (workshops) |
| 10 | NO |
| 11 | YES (transfer to ROTOR vzw for books) |
| 12 | YES (circularity tools such as circularity calculator) |
| 13 | YES (matchmaking platforms/ reuse dealers/ researchs such as Interreg project) |
| 14 | NO |
| 15 | NO |
| 16 | NO |
| 17 | YES (workshops) |
| 18 | YES (transfer to Cyneo for workshops) |
| 19 | YES (workshops) |
| 20 | NO |
| 21 | NO |
| 22 | NO |
| 23 | NO |
| 24 | YES (formations) |
| 25 | NO |
| 26 | NO |
| 27 | YES (transfer to Repurpose for formations or pilot projects) |
| 28 | NO |
| 29 | NO |
| 30 | NO |
| 31 | YES (articles) |
| 32 | NO |
| 33 | YES (articles about for example the risk distribution of the construction actors) |
| 34 | YES (articles) |
| 35 | YES (pilot projects) |
| 36 | NO |
| 37 | NO |
| 38 | NO |
| 39 | NO |
| 40 | YES (matchmaking platforms/ reuse dealers/ links to publications) |
| 41 | YES (articles/ workshops) |
| 42 | NO |

*Table 23: Information offered by online platforms about the circularity of reclaimed construction materials.*

### 9.2.12. Organic search traffic

| N° | Organic search traffic of subdomains/ month of april 2024 (AHREF.com) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 4 |
| 4 | 10 |
| 5 | 106 |
| 6 | 239 |
| 7 | 258 |
| 8 | 355 |
| 9 | 390 |
| 10 | 704 |
| 11 | 780 |
| 12 | 1700 |
| 13 | 2500 |
| 14 | 16600 |
| 15 | 0 |
| 16 | 137 |
| 17 | 138 |
| 18 | 205 |
| 19 | 427 |
| 20 | 869 |
| 21 | 1100 |
| 22 | 1300 |
| 23 | 1400 |
| 24 | 4700 |
| 25 | 1300 |
| 26 | 3400 |
| 27 | 16 |
| 28 | 25 |
| 29 | 29 |
| 30 | 32 |
| 31 | 170 |
| 32 | 363 |
| 33 | 30 |
| 34 | 32 |
| 35 | 25 |
| 36 | 39 |
| 37 | 4300 |
| 38 | 5 |
| 39 | 0 |
| 40 | 37 |
| 41 | 104 |
| 42 | 1500 |

*Table 24: Organic search traffic of online platforms of reclaimed construction materials.*

## 9.3. Nice-to-have and must-have parameters of online matchmaking platforms

### 9.3.1. Features of existing online matchmaking platforms

| N° | Features | Must-have | Nice-to-have | Not needed |
|---|---|---|---|---|
| 1 | Picture of product | 17 | 0 | 0 |
| 2 | Picture of product in reused example | 0 | 2 | 1 |
| 3 | Location of product | 17 | 0 | 0 |
| 4 | Price of product | 16 | 0 | 1 |
| 5 | Quantity available of product | 17 | 0 | 0 |
| 6 | Technical datasheet of product | 1 | 4 | 0 |
| 7 | Historical technical datasheet of product | 2 | 1 | 0 |
| 8 | Product passport | 1 | 2 | 0 |
| 9 | Filter by product category | 12 | 0 | 0 |
| 10 | Filters on quantity/ dimensions/ availability date/ colour/ price | 11 | 0 | 0 |
| 11 | List of favourites products | 1 | 0 | 0 |
| 12 | Condition of product | 3 | 0 | 0 |
| 13 | Trust-level of product owner | 1 | 4 | 3 |
| 14 | Warranty on product | 2 | 8 | 1 |
| 15 | Transport information of product (pallets) | 14 | 0 | 0 |
| 16 | Storage information of product (square meters) | 14 | 0 | 0 |
| 17 | Transport information of product (kg) | 14 | 0 | 0 |
| 18 | CO2 saved (kgCO2) | 6 | 9 | 0 |
| 19 | Embodied CO2 (kgCO2) | 5 | 10 | 0 |
| 20 | Reduced environmental impact (%) | 5 | 10 | 0 |
| 21 | Information about platform | 1 | 0 | 0 |
| 22 | Circularity information | 4 | 1 | 0 |
| 23 | Phone number of platform | 4 | 0 | 0 |
| 24 | E-mail of platform | 4 | 0 | 0 |
| 25 | Place for feedback | 0 | 1 | 0 |
| 26 | Blog | 0 | 3 | 1 |

*Table 25: Features provided by existing online matchmaking platforms of reclaimed construction materials.*

### 9.3.2. Annotated screenshots of existing features of platforms

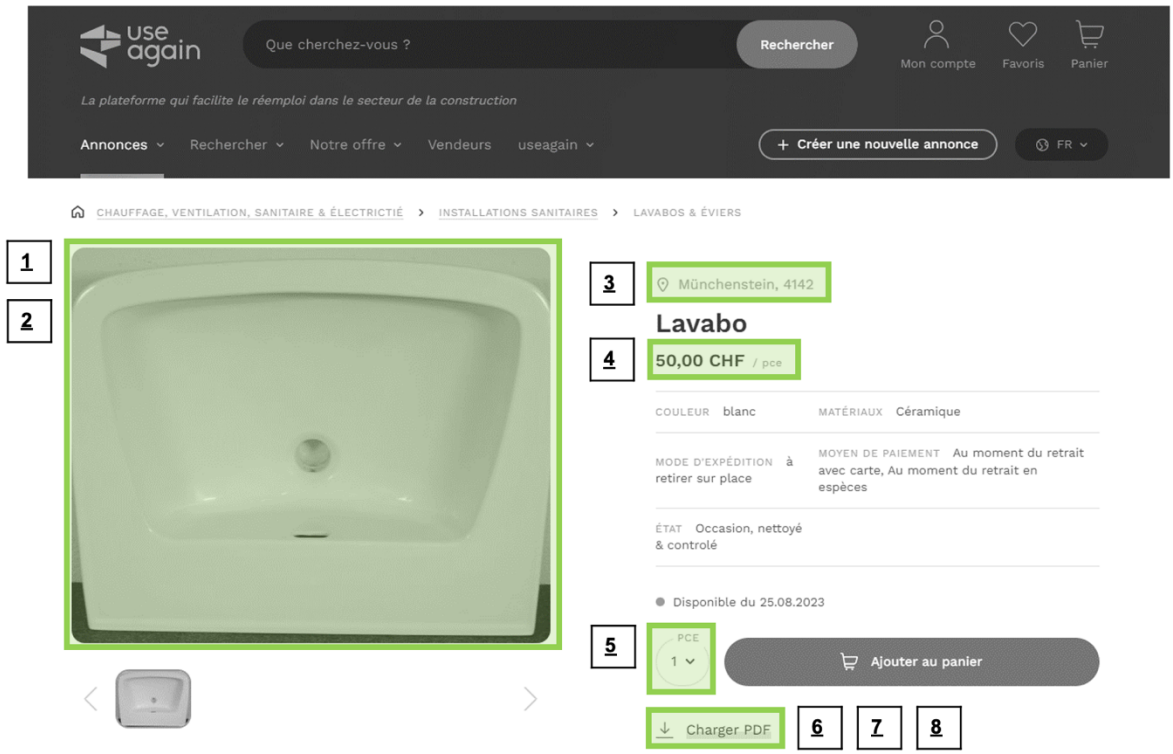


*Fig. 13: Screenshot of existing features of online matchmaking platform Use again.*

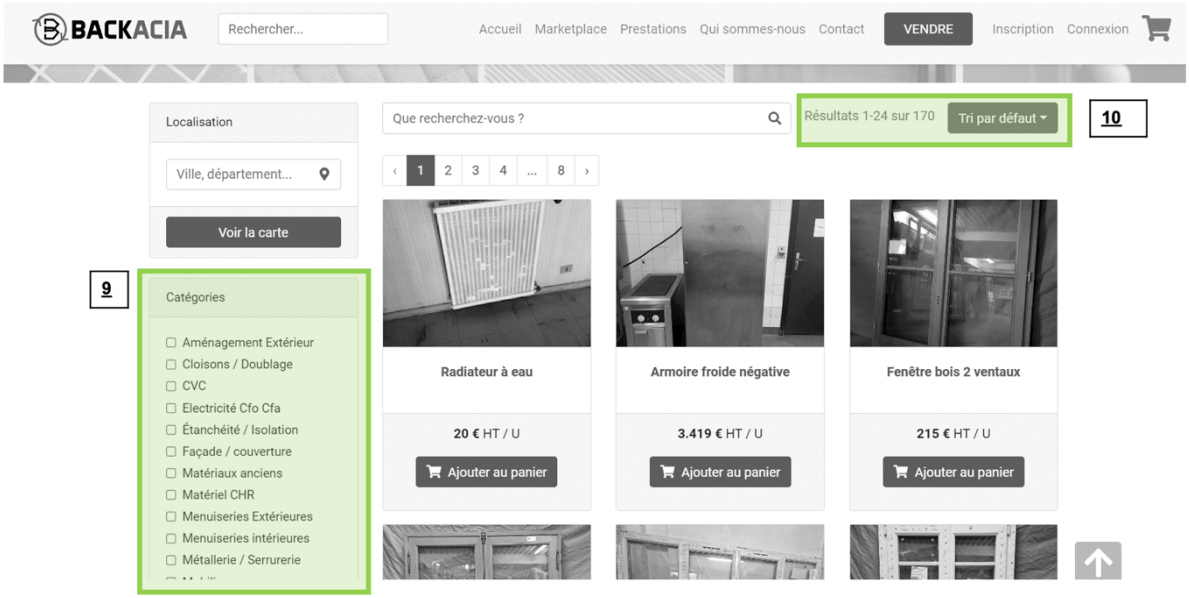


*Fig. 14: Screenshot of existing features of online matchmaking platform Backacia.*

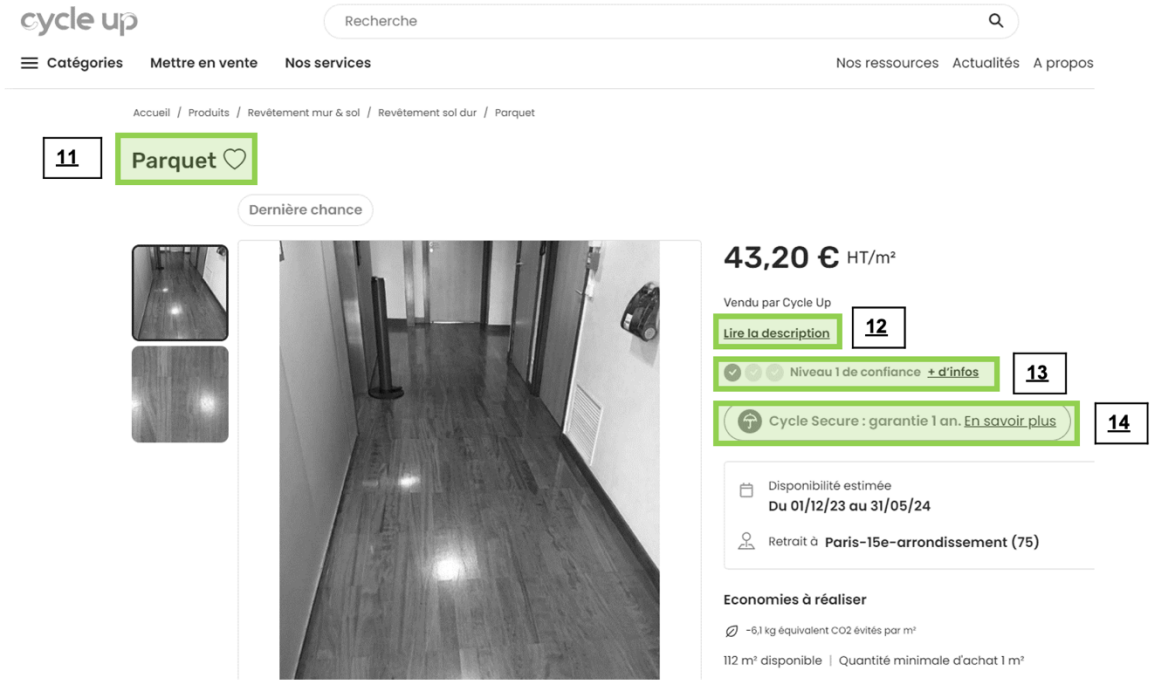


*Fig. 15: Screenshot of existing features of online matchmaking platform Cycle-up.*

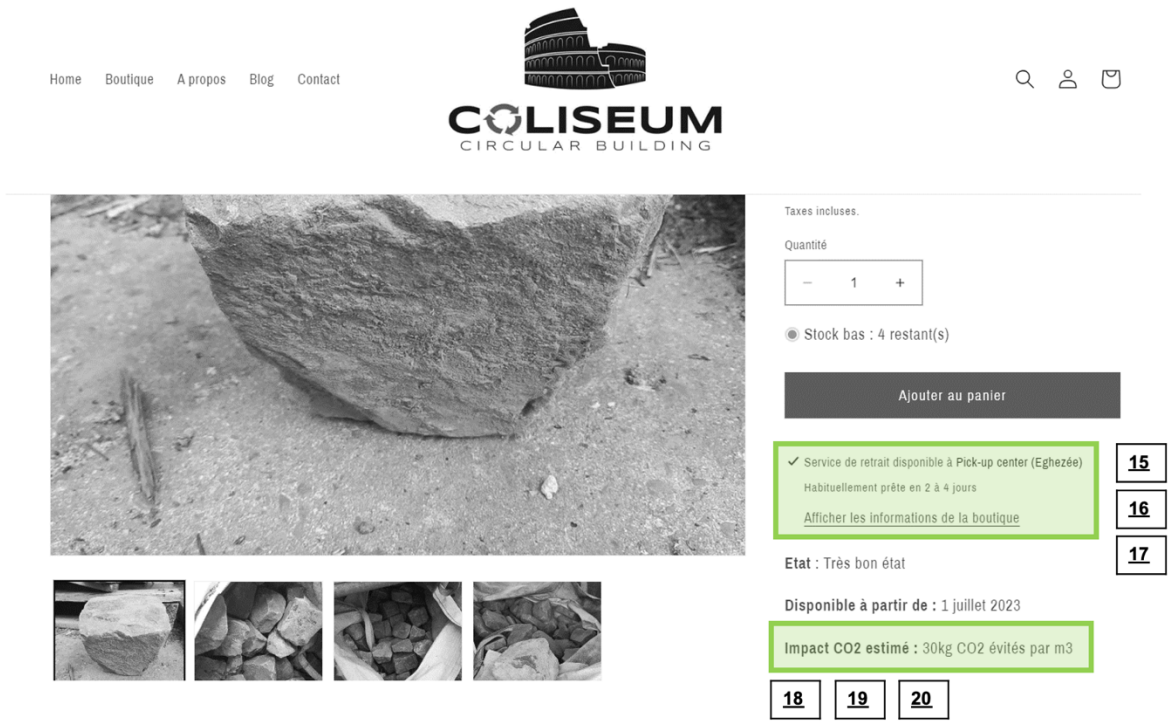


*Fig. 16: Screenshot of existing features of online matchmaking platform Coliseum.*


*Fig. 17: Screenshot of existing features of online matchmaking platform Restado.*

## 9.4. Consent form for publicisng Master's thesis

VRIJE UNIVERSITEIT BRUSSEL

**Consent form for publicising Master's thesis**

Student: Gabriel David Singeorzan
Enrolment number : 0567669
Study programme : Architectural Engineering
Academic year: 2023 - 2024

Master's thesis
Title: Matchmaking between supply and demand of reclaimed construction products using online platforms
Supervisor: Prof. Dr. Ir. Arch. Waldo Galle

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Drawn up at Kerkhofstraat 93, 1651 Beersel ..... on 29/04/2024.....

Signature of student