LAMARTRA

Bridging decarbonization and labour market in sustainability transitions

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Research report on transitions governance case analyses

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1. Introduction

This research report gathers the results of three case studies analysing transition governance processes and tools in three sectors identified in the case selection note (deliverable 2.1.1).

The objective is to investigate acceleration and backlash drivers of "dual transitions", understood as transitions combining decarbonization and employment challenges. In order to do so, we selected different case studies whose focus is at the intersections of decarbonization (given their fit into a circular model that privileges the reuse of materials and products), employment (because of the challenges they raise in terms of training and skills required for the deployment and implementation of such alternative economic models) and digitalization (which is often framed as an impetus or accelerator of circular economy, decarbonization and labor changes).

In this case study, we consider the development of material passports as an exemplary circular economy tool (Munaro & Tavares, 2021) based on digitalization (Çetin & al., 2022) and potentially requiring specific skills. Like any kind of transition tool, it relies not only on technological innovations, but also on innovations in knowledge, skills and expertise (Pel & Achten, 2022). Consequently, the development of material passports is primarily understood as an issue at the intersections of circular economy, digitalization, and employment, even though complementary studies adopting other perspectives could be useful. With this interdisciplinary perspective in mind, we want to investigate the reasons why the development of material passports is slow in the Brussels capital region despite its role as a driver or facilitator of circular economy. More precisely, we seek to unpack the enablers and challenges to this development, from the point of view of relevant stakeholders.

Because of their potential in terms of recovery and reuse, these tools are currently being explored extensively at the EU and Belgian research and policy levels. The EU Horizon-2020 research program funded for example from 2015 to 2019 a project called BAMB - Buildings as Material Banks (Atta & al., 2021), which explored solutions to increase the value of building materials, by reducing waste production and virgin resource use. Similar projects are expected to be funded through the follow-up Horizon Europe research program, through its tender called "Technological solutions for tracking raw material flows in complex supply chains" (European Commission, 2022a). At the EU policy level, digital passports are also mentioned in the Circular Economy Action Plan (European Commission, 2020), and in the "Ecodesign for Sustainable Products" regulation package, which should include a revision of the current Construction Products Regulation (European Commission, 2022b). At the Belgian federal level, the development of a "building passport" was also identified in the framework of the federal Energy & Climate Plan 2021-2030 as one of the key tools to assess the composition of existing buildings (Plan National Energie Climat, 2019).

2. Theoretical framework

The theoretical approach for the case study builds on transition studies, policy instruments, and circular economy bodies of literature.

2.1. Governing transitions

The governance of transitions is aimed to support long-term processes of structural change (Smith et al. 2005; Voß et al. 2009). The idea is to reach beyond incremental tinkering and bring about structural changes in socio-technical 'regimes' (Grin et al. 2010). Encompassing change is sought in technologies, consumer cultures, infrastructures, expertise, business models and administrative routines (Loorbach 2007). Transition governance is not oriented towards specific innovations, but towards system innovation i.e. innovation on the level of the relations between markets, states, civil society and knowledge production (Rotmans 2005). This implies a radically networked kind of governance, in which state actors are not necessarily leading (Johnstone & Newell 2018).

Moreover, transitions are complex processes of societal evolution that as such cannot be implemented, managed', or controlled (Rip 2006; Walker & Shove 2007; Stirling 2016). Transitions can be imagined and pursued, but even purposive transitions are largely emergent, i.e. resulting from the largely autonomous interactions between institutions, technologies, cultures and infrastructures (Smith et al. 2005). This is why transition governance has been aptly described as 'goal-oriented modulation' (Kemp et al. 2007): it is a matter of seeking to influence and synchronize (Pel et al. 2020) the transformation processes through a multitude of relatively 'light' interventions.

These ideas about broad, systemic governance have become snowed under a bit by the wide obsession with innovation. Transition governance has often been reduced to the cultivation of emergent sustainable technologies and practices - frameworks like transition management (Loorbach 2007), strategic niche management (Kemp et al. 1998) and technological innovation systems (Bergek et al. 2008) have led the way.

Yet in recent years it has become clear that the experimentation with innovative 'niches' is not enough (this awareness is also present in FEB/VBO (2021) and in the follow-up of the Brussels regional plan circular economy). These cultivation policies do not guarantee that the old, unsustainable development paths will be abandoned; the 'regime' structures supporting coal-fired energy production, internal combustion engine cars in place are too resilient (David 2017). What is more, significant governance challenges of 'after-care' (Stegmaier et al. 2014) arise when old structures are in fact discontinued, especially as it leaves sectors, regions, and individuals vulnerable. These issues of downfall and vulnerability are recently gaining attention through the work on destabilization, decline, phasing--out and 'exnovation' (Rosenbloom & Rinscheid 2020; Brauers et al. 2020). Especially this attention to the flipside of creative destruction has led to a rethinking of transitions governance.

More comprehensive 'policy mixes' are needed (Kivimaa & Kern 2016; Rogge & Reichardt 2016): Beyond the existing approaches geared towards the cultivation of sustainable 'niche'

innovations (and the associated 'green jobs'), broader governance repertoires should also contain measures to soften, redirect, slow down, democratize, or mediate, processes of decline and phasing--out.

2.2. Policy Instruments

As Fransolet (2019) points out, a framework using the different intertwined aspects of governance, like politics, policy and polity framework, would better account for the hybridity or 'messiness' of governance. However, this holistic approach is beyond our scope and capacities. We have therefore chosen to focus our analysis on the policy aspect and more specifically policy instruments.

As Lascoumes and Le Galès (2005) point out, approaching public action through policy instruments can reveal many elements that together make for the complexity of governance. It can reveal values, interpretations of social interactions and behaviours, the power relationship between governed and governing, representations. By studying the reasons, choices and effects (whether desired and planned or the unexpected once) behind policy instruments, the complexity of governance can surpass a purely functionalist reading.

Kaufmann-Hayoz et al. (2001) define policy instruments as "the basic way in which an actor chooses to influence the behaviour of another actor" (p. 35) and for their typology focus specifically on "intervention instruments" defined as such: "the goal-directed influence of an actor upon the conditions that determine a target group's action" (p. 35).

They distinguish 5 types of policy intervention instruments: Command and control instruments; economic instruments; service and infrastructure instruments; collaborative agreements; communication and diffusion instruments.

We will now give a review of these instruments as laid out by Kaufmann-Hayoz et al. (2001), which is also laid out in Table 1.

The first type they discern is the instruments of command and control. They are intended to constrain the options and consequently the actions of the targetted actors through legal prescriptions. Enforcement and sanctions, which are often economic, are indispensable for these instruments to have an impact. The use and implementation of this type of instrument is in the hands of public authorities, though the execution might be delegated to private societies. It does require a lot of technical, human and financial resources.

Secondly, they discuss the economic instruments that aim at holding polluters responsible [making those that are responsible for environmental damage pay, instead of the general public]. Kaufmann-Hayoz et al. (2001) distinguish three types (p. 37) all intended to encourage environmentally sound behaviour, through positive actions (facilitating sound behaviour) or negative actions (discouraging or sanctioning unsound behaviour):

1. "raising the cost of polluting behaviour"
2. "reducing the cost of environmentally sound behaviour":
3. "establishing markets for pollution rights" centred on permits restricting the access to environmental resources

These instruments are usually implemented by public authorities and can apply to both companies, by increasing the competitiveness of environmentally sound behaviour, or households, which is more related to consumption behaviour. Kaufmann-Hayoz et al. (2001) stressed the importance of simple and flexible regulations, as well as thorough monitoring and enforcement.

Third, there are the service and infrastructure instruments intended to promote or discourage certain behaviours of the public or specific subgroups. By services and infrastructure Kaufmann-Hayoz et al. (2001) respectively mean "actions of individuals or organisations that enable or support other actors to achieve their goals" and "the man-made, mobile or immobile physical objects that shape the actor's scope of opportunities of action" (p. 39). Like for the economic instruments, the aim of the instrument can be positive (attracting and enabling environmentally sound behaviour) and negative (repulsing undesirable behaviour). As opposed to the other instruments mentioned so far, these can be applied by a wide range of actors, from individuals to public authorities to private societies.

Next, collaborative agreements. These are (legally binding or non-binding) commitments made by (parts) of the private sector towards the government on environmental targets. These voluntary agreements hold elements of self-regulation that usually motivate the participants; as well as the fear of more restrictive regulations that might be implemented to compensate for the lack of agreements. These agreements can also be made solely between private actors, leaving out government actors.

Lastly, the communication and diffusion instruments which aim at changing the goals, knowledge and behaviour programs of the target group, which is usually the general population (or subgroups). One of the consequences of this is that their social relations and communication are influenced as well. Since large sections of the population are targeted, the diffusion of communication is crucial, and generally proceeds in two phases: an initial diffusion reached by the instruments and the self-diffusion where this communication snowballs. Both the actors as the targets can be pretty much any segment of society.

Tableau 1: Policy Instruments (Retrieved from Kaufmann-Hayoz et al. (2001) p. 90-91)

	COMMAND AND CONTROL INSTRUMENTS	ECONOMIC INSTRUMENTS
Why is the instrument effective?	***...because people want to avoid the penalties for non-compliance.***	***...because people want to achieve maximal benefit at minimal cost.***
Who can apply it in the main?	• Public authorities	• Public authorities[1]
What are the most important target groups?	• Individuals • Companies • Public and private organisations	• Companies • Individuals
What can be said about its effectiveness?	• Effectiveness highly foreseeable • Effective if compliance easily controlled • Relatively inflexible – not very adaptable to specific situations • Can adapt to changes only slowly	• Reaches goals at minimal cost • In practice often limited effectiveness due to low taxes, undifferentiated charges, and approval of exemptions • Provides incentives for improvements beyond the prescriptions
What innovations does it promote?	• Spread of best available technologies	• Development and spread of new technologies, processes, and products • Innovations in company organisation
How well is it accepted?	• Accepted as the main element of current environmental policy • Resistance to increasing regulation	• Resistance to new costs • Disagreement over the utilisation of new revenue • Increasing political acceptance
What efforts and costs does it involve?	• Creating and instituting laws is time-consuming • Administrative costs	• Creation of legal bases is time-consuming • Administrative costs covered by revenues from taxes and charges • Costs for subsidies

[1] Incentives can also be implemented by private organisations in the framework of campaigns and deposit-refund systems.

SERVICE AND INFRASTRUCTURE INSTRUMENTS	COLLABORATIVE AGREEMENTS	COMMUNICATION AND DIFFUSION INSTRUMENTS
...because people can carry out an action only if there is the possibility to do so, and because they prefer to make use of attractive as opposed to unattractive offers.	***...because people uphold contracts.***	***...because people pursue goals in accordance with their perceptions, categorisations, appraisals, and knowledge.***
1. Public authorities 2. Companies 3. Public and private organisations 4. Individuals	• Public authorities together with companies[2]	1. Public authorities 2. Public and private organisations 3. Individuals
1. Individuals 2. Companies 3. Public and private organisations	• Companies	1. Individuals 2. Public and private organisations
• Effective if demand can be created • Once created, infrastructures are as a rule not reversible	• Effective if legally binding and if there are sanctions for non-compliance • Reaches only those companies/branches involved • Relatively flexible – quite adaptable to specific situations	• Effectiveness difficult to measure • Effective quickly, but with limited reach if applied in the framework of action campaigns • Effective in the long term if there is a corresponding trend in society • Suited to supporting the acceptance and effectiveness of other instruments
• New companies • New institutions	• Optimisation of processes • Innovations in company organisation • New institutional arrangements	• New forms of social organisation • New institutional arrangements • Development and spread of new technologies, processes, and products
• Acceptance of attraction-based forms • Resistance to repulsion-based forms	• High acceptance by companies, as long as less expensive than other measures	• High acceptance of traditional forms • Hesitant acceptance of unfamiliar forms • Resistance to new forms of participation possible
• Investment and operating costs	• Negotiations can be tedious and lengthy	• Costs for planning and executing projects and action campaigns • Costs for education and research

[2] Or, for labels, public and private organisations together with companies.

2.3. Circular Economy

The development of a circular economy is one of the axes of the European Green Deal. This axis is developed in greater depth in the new Circular Economy Action Plan adopted by the European Commission in March 2020, which "provides a future-oriented agenda for achieving a cleaner and more competitive Europe". At the Belgian level, both the federal and regional public authorities are developing their programs and strategies for fostering the circular economy transition. The Federal Action Plan for the Circular Economy 2021-2024, which is currently under development, should soon succeed the set of measures in favor of the circular economy adopted in 2016 by the federal government.

As Kircherr et al. (2017)[1] point out, the circular economy concept has gained a lot of attention over the last years, both in academic circles and among practitioners. This has led to the proliferation of understandings and definitions of this concept, making it sometimes hard to grasp. The concept has evolved over time, from narrow to broader and more ambitious interpretations (Pel & Achten, 2022; Reike & al., 2018). The definition of circular economy provided by the Ellen MacArthur Foundation (2013) remains the most employed and cited one. According to this definition, circular economy should be understood as:

> "An industrial system that is restorative or regenerative by intention and design […]. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models, etc."
>
> (Ellen MacArthur Foundation, 2013, p.7)

This definition holds many elements. The core relies on the transition to a *system* that instead of generating waste, restores materials and products endlessly. This requires fundamental changes, in the way we conceive, produce and use materials, products, systems, business models and energy.

According to their review of existing definitions, Geissdoerfer et al. (2017) point out that this notion of 'endlessness' is the common factor: as the name reveals, circular economy is about closing material and energy loops (Figure 1). They distil the following definition:

> We define the Circular Economy as a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling. (Geissdoerfer et al., 2017, p. 3)

[1] Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy : An analysis of 114 definitions. *Resources, Conservation and Recycling*, *127*, 221-232. https://doi.org/10.1016/j.resconrec.2017.09.005

Compared to Ellen MacArthur's definition, Geissdoerfer et al.'s (2016) seems more compact and complete. As previously mentioned, the loop is much more central in the latter. Both start with the same principle of a regenerative system and the centrality of reducing (or eliminating) waste. Geissdoerfer et al.'s (2016) definition also integrates resource input and emission output, and a larger understanding of energy use. And where Ellen MacArthur Foundation's focuses more on design, restoration and reuse, Geissdoerfer et al.'s (2017) tread into more detail when summing the ways to achieve this system.

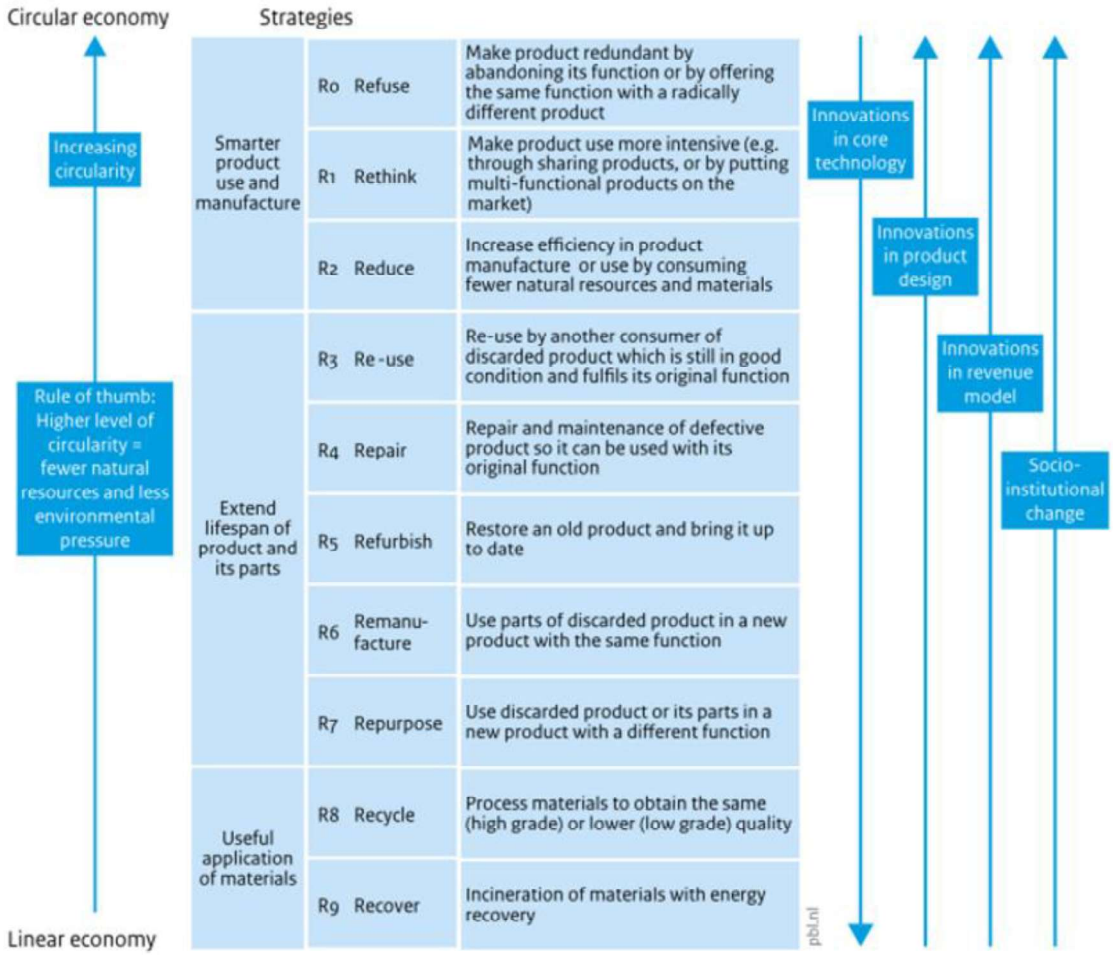
From their analysis of 114 definitions of CE, Kircherr et al. (2017), have composed a definition that is the following:

> "An economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes. It operates at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations. It is enabled by novel business models and responsible consumers" (p. 229)

This definition holds similar elements but adds three new ones: the role of consumers, the notion of levels and the three-dimensional notion of sustainability. Regarding the latter, some authors point out that though CE is commonly associated with sustainability, the link between the two is surprisingly absent in most definitions (Kirchherr et al., 2017; Geissdoerfer et al., 2016).

All definitions agree that CE is a new system that opposes the current take-make-waste linear system. Kirchherr et al. (2017) distinguish two visions on how to achieve this system which can be summarised as the debate between a fundamental or radical system change or a progressive evolution of the current system, respectively the systemic perspective and the R-frameworks. These R-frameworks, ranging from three (reduce, reuse, recycle) to nine R's (Figure 2) are seen as a pragmatic approach to implementing CE.

Figure 1: Circular Economy strategies: The 9R Framework as developed in Kirchherr et al., 2017.



Generally, circular economy is often understood as a basis, a precondition, or a necessity for sustainable development, even though some authors argue that circular economy models might worsen greenhouse gas emissions or tend to disregard the social dimensions of sustainability, the latter being often reduced to job creation (Geissdoerfer & al., 2017).

2.4. Circular Economy and Labour

Sustainable employment can be broadly defined as "*paid, formalized work that meets the needs of present or future generations, without compromising the capacities of future or foreign people in other countries to meet their needs*" (Bohnenberger, 2022, p.1).

Bohnenberger (2022) & Bottazzi (2019) distinguish different perspectives on the links between jobs and the environment, and work and social-ecological transitions respectively. The first – and most common one – is the green job perspective. Although there is no consensus on how to define a green job, it is often understood as an employment that contributes substantially to preserving or restoring environmental quality. This includes *"jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption through high efficiency strategies; de-carbonize the economy; and minimize or*

altogether avoid generation of all forms of waste and pollution". (UNEP, 2008, p.3). In general, the green job approach is often criticized for being a "marketing tool" for green growth (Bohnenberger, 2022) based on innovation and eco-efficiency (Bottazzi, 2019) and for ignoring central sustainable work issues such as well-being and sustainable employability (Fleuren & al., 2020). Despite these critics, a vast body of literature tries to try to assess the "greenness" of jobs by assessing their environmental impact (Bohnenberger, 2022), mostly quantitatively, to distinguish green jobs from non-green jobs. This approach is often criticized for ignoring the ambivalent features of most jobs, which often contain green and non-green tasks on a continuous scale. Another approach regarding green jobs is about defining, usually qualitatively, the main characteristics of those jobs, in terms of job tasks, formal education requirements and the pathways through which employees acquire and carry know-how (Consoli & al., 2016).

Other studies have tried to assess quantitatively the impact of a low carbon transition on job creation. The evolution of the labour market remains one of the crucial issues of this systemic transition, impacting all sectors of the economy. Such transition is expected to produce a positive net employment gain for Belgium, estimated between 1% (Eurofound, 2019) and 1,7% (Climact & al., 2016), and impacting low, middle, and high-skilled jobs. If high-skilled labour might be the most positively impacted in the short term, much of job creation is expected at the low and medium-skilled levels in the medium term (Climact & al., 2023). Moreover, the construction sector is expected to be one of the two sectors with the most job gains by 2050, with a growth of 12% (Climact & al., 2016), and the most impacted by the low carbon transition in general (Climact & al., 2023). Job creation in the context of such transition is divided into 3 categories: emerging jobs specifically created for the transition, existing jobs whose skillsets need to evolve to include "green" skills and existing jobs whose skillsets do not need to change (Climact & al., 2023). Indeed, beyond the creation of creation or destruction of jobs, a low carbon transition will require additional skills on top of mobilizing existing skills.

Despite the growing body of literature on the size, growth, and potential of sustainable employment, little is known about the type of skills and education it requires (Burger & al., 2019). By comparing circular and non-circular oriented occupations in terms of skills and education, Burger & al. (2019) have attempted to question the possible specificity of circular economy employment in the US. They found that CE employment requires more complex solving skills, resource management skills, system skills and technical skills compared to the rest of the economy. However, they found no difference in basic and social skill requirements.

Regarding educational requirements, they compared the levels of formal and informal education (understood as training on the job and work experience) required in the CE sector with those required in the rest of the economy. Overall, they found that CE jobs do not require more formal education but require significantly more training and work experience. However, these results should be received with caution, because they did not systematically take the potential change brought by on-going digitalization into account, which could create not-yet existing skills and could drive a quantum leap in terms of educational requirements in the coming years (Burger & al., 2019). Indeed, their analysis suggests that incorporating digital technologies into daily CE practice usually requires more work experience.

In Europe, the European Commission (2018) contracted out a prospective study to evaluate the impact of a transition to a more circular economy on jobs and skills demand in five key sectors (Food products & beverages, Motor vehicles, Construction, Electronics and Electrical equipment, and Waste collection and treatment). Overall, they found that a circular economy transition had little impact on skills needs across the various sectors and occupations, in comparison with other drivers of change, such as the impact of technological change on jobs and the shift to high-skilled jobs in some sectors. In other words, this finding suggests that transitioning to circular economy activities does not have a transformative effect on labor markets with regards to skills needs. However, they noticed a general trend towards increased demand for cross-cutting competences and transversal skills, such as problem solving and communications, in all sectors of the economy.

In summary, and based on the little knowledge we have, we can conclude that it is unlikely that transitioning to a CE model requires specific skills and higher formal education levels. Both studies (in the US and in Europe) point out other key drivers (digitalization in particular) when it comes down to education and skills demands evolution. That is why we turn to the potential impact of digitalization on these two in the next section.

2.5. Circular Economy and Digitalisation

Digitalization remains a contested concept, most of the time ill or not defined. For Nikmehr & al. (2021, p. 2), it refers to the use of digital technologies to change business models and may be seen as a powerful intervention in the core business of companies. For others, it is better described as "*a remarkably fast process of generalisation, amplification and intensification of the use of many digital technologies*" (SEAD, 2021, p. 5). Digitalization is a process that could drive a digital transition, understood as a "*transition from analog to digital processes that allows digital tools to model processes and activities, thus improving performance and productivity"* (Rosário & Dias, 2022, p. 2). This definition reflects a techno-optimistic view on digitalization, despite existing technological, economic, social, or institutional barriers to a digital transition, amongst others (Chaun & al., 2022; Rosário & Dias, 2022). Despite these barriers, digitalization is often presented in the scientific literature as an enabler of circular economy (Antikainen & al., 2018), even though the integration between digitalization and circular economy faces numerous challenges (Chauhan & al., 2022), to which we will return below. It is also associated with industrial sustainability improvement, through intelligent management systems which can improve energy and resource efficiency, pollution control and reduce waste and carbon emissions (Rosário & Dias, 2022). Such transition might lead to more sustainable production and manufacturing systems (Rosário & Dias, 2022).

Several studies have described digitalization as an impetus of the transition to circular economy, as it allows to transform CE principles into feasible and practical activities and facilitates disruptions from traditional linear business models (Chauhan & al., 2022). Consequently, a vast body of literature focuses on better understanding the ways in which the adoption of various digital technologies can enable the implementation of the CE (Chauhan & al., 2022) by enhancing the development of CE capabilities (Bag & al., 2021). More precisely, this broad research stream may be divided into 4 categories (Chauhan & al. 2022)

which put an emphasis on: 1) the role that each category of digital technologies (eg. AI, big data and analytics, cloud computing, ICT, IoT, robots, augmented reality, sensors etc.) can play in circular economy; 2) enablers and barriers for the development of digital-led CE; 3) digital-led business model innovations; 4) sector-specific studies (eg. health, agri-food, fashion, construction etc.). Each and every focus points might help to better understand the links between digitalization and CE despite fragmentation amongst disciplines and perspectives. Because of our emphasis on enablers and challenges in the construction industry, the last two categories seem particularly relevant to mention.

Chauhan & al. (2022) have identified in their literature review the main enablers and challenges for the development of digital-led CE. On the one hand, the most important enablers for the development of digital led-CE are social awareness, technology approval, and government incentives. However, operational efficiency, supply chain integration and top management commitment also seem important. On the other hand, the most important barriers for the development of digital-led CE are the absence of structured data management processes, the costs associated with the adoption of technologies, the absence of appropriate policy regulations and governmental push, the scarcity of environmental education and culture and the low pressure from market demand. Closer geographically to our case study, Çetin & al. (2022) have studied the main challenges faced by large social housing organizations in the Netherlands when applying digital-led CE strategies. They also identified different kinds of barriers, including strategic and technological ones, like expressed uncertainties on data requirements for circular strategies and the perceived lack of digital data management mechanism. On top of that, they also pointed out key cultural challenges (including the reluctance of employees to use advanced technologies in daily practice and the necessity for managers to convince them to do so) and market incentives (digital-led CE tools remaining a niche). Concerning MPs specifically, they found that these large social housing organizations considered difficult to find technology companies implementing this tool. MPs were also perceived as incomplete (with insufficient volume of listed material) and requiring considerable financial and human resources to keep them relevant. Indeed, MPs must be updated manually each time a change is made in buildings in order to stay relevant.

Digitalization is also expected to have a major impact on labour markets. Beyond the vivid discussion generated by some prospective studies on the negative impact of digital transformations on jobs, it is increasingly accepted that digitalization will lead to job transformation rather than job losses or job creation (Climact & al., 2023). Indeed, digital and data-related skills is expected to play an increasingly important role in a whole range of jobs. No profession will escape the impact of digitalization altogether. By 2030, 63% of job profiles will require at least one level of professional application of digital skills, with a continuous need for digital training to stay up to date (Climact & al., 2023), involving reskilling (updating existing skills to accompany job changes) and reskilling (learning new skills to take a different job).

2.6. Digital Policy Tools for Circular Economy: Traceability and Digital Passports

In this case study, we consider the development of material passports as an exemplary circular economy tool (Munaro & Tavares, 2021) based on digitalization (Çetin & al., 2022) and potentially requiring specific skills. Like any kind of transition tool, it relies not only on technological innovations, but also on innovations in knowledge, skills and expertise (Pel & Achten, 2022). Consequently, the development of material passports is primarily understood as an issue at the intersections of circular economy, digitalization, and employment, even though complementary studies adopting other perspectives could be useful. With this interdisciplinary perspective in mind, we want to investigate the development of material passports in several sectors and its role as a driver or facilitator of circular economy. More precisely, we seek to unpack the enablers and challenges to this development, from the point of view of relevant stakeholders.

A material passport can be defined as a "material stock document that contains information about building materials composition" (Atta & al., 2021, p. 2). Although they may be analog or digital, the large amount of involved data at the different levels that make up a building (materials, components, products and systems[1]) usually require digital solutions to collect, process, store, utilize and/or share information (Heinrich & Lang, 2019). Moreover, material passports are first and foremost designed to improve resources and material efficiency in terms of reuse and recycling (Honic & al., 2021). Indeed, material passports can also be described as "(digital) sets of data describing defined characteristics of materials and components in products and systems that give them value for present use, recovery and reuse" (Mulhall & al., 2017, p. 17). They are an information tool that complement other documents or certifications related to building products. Their content may vary according to the methodology used, including the definition attributed to each level (materials, components, products, and/or systems). Indeed, the lack of harmonization and standardization has been highlighted as one of the many barriers to the development of material passports (Honic & al., 2019).

In this case studyies, we consider the development of material passports as an exemplary circular economy tool (Munaro & Tavares, 2021) based on digitalization (Çetin & al., 2022) and potentially requiring specific skills. Like any kind of transition tool, it relies not only on technological innovations, but also on innovations in knowledge, skills and expertise (Pel & Achten, 2022).

3. Methodology

Now that this literature review has set the stage, we will lay out the specifics of this report, starting with the formulation of the research questions and how we will try to address them in this report.

3.1. Research questions

As previously mentioned, LAMARTRA studies the interplay between decarbonization and labour transitions. The general research question is the following: How to understand the ongoing and future developments of the low-carbon and labour transitions, and which governance strategies are available in Belgium to ensure the joint pursuit of climate targets and 'just' work and employment?

First, we have chosen to narrow down the 'low-carbon and labour transition' to the circular economy transition, because this has become a prominent political strategy for the sectors under investigation in their regional context, and it integrates both an ecological element and a labour element, as has been laid out in the literature review.

The approach for this report was to inductively address the different topics that are at the core of this work package. We have therefore dissected the general research question into different questions, organised in two parts.

1) For each case study, we reviewed the role of the different actors, the problems and potential solutions, as well as the labour implications of the circular transition in the sector. This allowed us to gain insights on: which governance strategies are at play, the different visions expressed by diverse actors, and how this transition is expected to impact labour.
2) We then analysed the percpetions of the role that digitalisation can or should play in this dual transition. In that sense, digitalization and digital policy tools such as material passports might be a process that can enable, challenge or accompany this dual transition, depending on the visions and perspectives of the actors involved.

3.2. Case studies and research settings

Sectors have been selected following criteria laid out in the research proposal:

- **Relevance for transition 'policy mixes'.** Case studies need to be relevant for study of transition 'policy mixes' (Kivimaa & Kern 2016). The 'salient sectors' selected should somehow be displaying interesting **multi-actor transition governance processes** (cutting across private/public/civil society), **interplay** between social, technological, institutional and infrastructural **innovations** (the focus in transitions research), and dynamics of innovation and **exnovation** (that theme of creative destruction that is central in transitions research).

Transitions research is in principle sector-transcending, but it can be focused on a series of 'salient sectors'.

- **Connected, intersecting cases:** Key units of analysis in transitions research are functional societal subsystems like mobility, energy, food, systems. It focuses on socio-technical 'regimes', dominant sets of rules that guided the development of these socio-technical systems. Transitions theory does not work along a distinction of economic or policy sectors. Cases of 'salient sectors' can for this empirical stream be demarcated more in terms of the socio-technical systems/'regimes' that the sectors form part of, and in terms of the decision-making/innovation arenas that form around concrete transition issues. Transitions theory highlights that social, technical etc. innovations occur across sectors and socio-technical systems, and that there is co-evolution (Köhler et al. 2019) between developments in different sectors. It would make sense in this WP to mind the intersections (Pel 2014) between our four 'salient sectors'. Relevant interactions between cases are: Jobs/workers migrating from one sector to another, good/bad practices being transferred and imported. **The 'salient sectors' do not evolve in isolation.**

- **Temporal demarcation:** Transitions are long-term processes of structural change. The cases need to be demarcated such in this WP that they allow for some process understanding, i.e. development over time, innovation, and anticipation of future changes. The purely historical cases (e.g. the studies of the rise of 'industrial modernity', mass manufacturing or the introduction of grain elevator technology, Cf. van Driel & Schot 2005; Schot & Kanger 2018) are not suitable. These bird's eye view analyses are too remote from our interest in policy mixes. Cases need to involve *ongoing/recent past/anticipated futures* transitions (Garud & Gehman 2012). Cases also better not focus on transitions mainly *projected* to unfold, and without somehow visible 'labour' implications - (for example the 'autonomous cars', which have remained future visions for decades). Empirical analysis should be close to day-to-day decision-making.

- **Access to data:** This empirical stream will work with a combination of document analysis, semi-structured interviews with transition governance actors (state and non-state actors), and focus groups/workshops[2]. The precise balance between those can be chosen according to availability of documents/respondents in chosen 'salient sectors'. The sectors with all too high secrecy/political sensitivity may be problematic - we do need to get a reasonable sense of actor dynamics, and reliable/detailed accounts of governance challenges.

The sectors that consequently have been chosen for this report are e-commerce, metallurgy and construction. More information on the salience of these sectors will be provided in the context description of each of them (cf. infra).

Sectors

The first sector under investigation is the e-commerce sector. Eurostat defines e-commerce as follows: "E-commerce can be defined generally as the sale or purchase of goods or services, whether between businesses, households, individuals or private organisations, through electronic transactions conducted via the internet or other computer-mediated (online communication) networks." [3] Given the wide range of this definition, we have chosen to narrow it down to the consumer textile since "clothes, shoes and accessories" were by far the

[2] The workshops form the linkage with WP7 Valorisation, Dissemination, Exploitation of results

[3] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:E-commerce

most online purchased goods in 2022 in Europe (Eurostat, 2023). This choice also ensures that we stay within the criteria laid out above. So, our first case study is consumer textile in the Flanders.
For the metallurgy, we have chosen the Walloon context. And finally, for the construction sector, the region under investigation is the Brussels Capital Region.
With these three case studies we have a representative image of the three Belgian regions, though the sectors and their maturity regarding circularity and digitalization vary widely.

3.3. Data collection and analysis

For the data collection, the main method used was semi-directive interviews, as well as document analysis. Because circularity remains our key focal point, we decided to focus this empirical work on circular actors exclusively. In doing so, we wanted to gather the perception of actors that could potentially be aware of practical issues related to circularity. These actors were selected according to their expertise in relevant themes. Then, other interviewees were contacted via the snowball technique (in the sense that they were mentioned by previous interviewees).

They can be put into two categories: the public actors, that represent public institutions in charge of developing and carrying out regional Circular Economy strategies. And the private actors working on or interested by circular concepts and practices. This way allowed us to have insights into the policy side, as well as the practical implications of transitioning to circular business models. The sample size for each case study ranged between 7 and 13 participants and the interviews lasted between 35 and 90 minutes.

The interview guides slightly differed according to the main area of expertise of the interviewee (eg. job training, reuse of materials/products, digital tools etc.) and according to the ideas mentioned by previous interviewees. However, the 4 main themes (1. sector description, 2. digitalization/digital tools, 3. employment/training/skills and 4. circular economy/reuse of materials and products) remained the same.

Because of our focus on the intersections between different issues and different insights coming from various academic disciplines, we used content analysis. Indeed, the aim of a content analysis is precisely to attain a condensed and broad description of a given phenomenon, and the outcome of the analysis is concepts or categories describing the phenomenon to produce a conceptual map or model (Elo & Kyngas, 2008). To organize the qualitative data, we used primarily an inductive approach and open coding. Once the coding phase was achieved, we started the analysis part of the reporting phase.

4. Results

As detailed in the previous section, we start out by sketching the general context of the circular transition for each sector, starting with the rôle of the different types of actors. Then we display the constraints and possible solutions, whether policy related or not, in a table format. Based on these constraints and solutions we created a framework, inspired on Kaufmann-Hayoz et al. 's (2001) typology of policy instruments that is specific to environmental politics. We have analyzed what policy instruments were mentioned in the interviews and how they fit in this typology. We have done so for both the existing policy instruments as well as the instruments that are lacking or needed according to the actors. Given our focus on digital instruments that could enable or facilitate circular economy, we have added this to Kaufmann-Hayoz et al.'s (2001) typology, when the data allowed it. This gave us an overview of the current state of play, drivers and constraints of these instruments. Lastly, we have completed the framework with the labour implications mentioned by the actors.

4.1. E-commerce

Introduction and context

The textile industry poses a heavy burden on the environment, requiring a lot of agricultural ground, water, energy and chemicals and resulting in important GHG emissions and textile waste, which makes it the "the fourth highest-pressure category for the use of primary raw materials and water, after food, housing and transport, and fifth for GHG emissions" (Manshoven et al., 2019, p. 45). The mass consumption that is a characteristic of the European clothing market, translates to an average 26kg of textile consummate per year per person, and a waste of 11kg per person per year. This amounts to 5.8 million tonnes of textile waste per year (EEA, 2019).
This waste generation is currently being dealt with in three ways: either reuse/recycling, incineration and landfills. As we have covered in the literature review, circular economy can have a big impact on the way consumer textiles are fabricated, used and discarded.

For the textile industry, those actions commonly look like this:

- (ecoresponsible) material use: either organic, better quality or second hand; use homogenous materials
- limit waste and energy consumption in production process
- change businessmodel (back system and second-hand retail, repair services)
- recycling textile

Circular economy strategies in Belgium sometimes target the textile industry. Vlaanderen Circulaire (hereafter abbreviated as 'VC') is a partnership that has been developed by the flemish government in 2021 to carry out the 'Vision 2050' plan. The Flemish institute for waste management 'Openbare Vlaamse Afvalstoffenmaatschappij' (OVAM) is the coordinator of this program. The specific value chain 'textile', which is a part of the strategic agenda 'manufacturing' of this program, is being pulled by Creamoda, the fashion federation, and

Circletex, a partnership created to develop a circular textile industry in Flanders. The strategy intends to respond to the fact that, in Flanders, for consumer textile, "there are few signals that textiles are transitioning towards a more circular system" Vermeyen et al. (2021)

For this case study DPP's seem to be an interesting object of study because of the new European Textile Strategy, that introduces the concept of DPP's. The passports should contain "mandatory information requirements on circularity and other key environmental aspects" (European Commission, 2022, p. 5) and will apply to "all entities (economic operators) placing products on the EU market – including non-EU companies (GS1, 2023, p. 1). The specific requirements will be detailed between 2023 and 2027. Our exploratory research has shown that some actors in the alternative textile have already adopted DPP's.

Data collection

As previously mentioned, the actors that we interviewed were partly from the public sector and partly from the private sector. For the case of textile in Flanders our exploratory research indicated that currently the main driver for change is the private sector, as will be detailed further on. This is also translated in our sample, where the ratio of public actors - private actors is more in favour of the private sector. And within this last category the actors can be divided in two groups: the organizations that were *created* with the intention of contributing to the circular transitions and therefore had circular businessmodels to begin with. We expected them to have extensive insights on what a circular textile sector would entail and its implications on labour. And lastly, we included an organisation that has a linear business model but is undertaking steps to evolve towards a more circular model to fill us in on the practicalities of making such a transition on a company scale.

Results

Part 1: Circular economy in the Flemish consumer textile industry

The first part of the results displays the general context of circular economy as it is today for the consumer textile in Flanders and its implications for labour. The research questions are the following:

General research question 1

What is the state of sustainable textile and circular economy in the consumer textile sector?

Sub-research questions

- What are the mutual roles of the consumers, the private and the public sector? What are the drivers and constraints on the development of circular economy? How is this transition perceived?
- What are the main challenges and opportunities regarding employment? How do they relate to circular economy development and digitalization?

General dynamic/ state of play

→ RQ: What is the state of circularity? What is the role of public authorities? What are the drivers and constraints?

In this section we address the first research question: What is the current state of circularity in the flemish textile industry? We were able to give a general (though not exhaustive) overview of what circularity looks like today in this sector based on interviews and document analysis. This overview is structured according to the three types of actors mentioned: the general public/consumers, the private sector/businesses and the public sector. This contextualisation is important to understand the second part of this analysis, that of the policy instruments and labour implications.

The circular textile ecosystem generally holds three types of actors that are all linked. Businesses that try to put circularity to practice, either by adopting circular principles and practices, or by starting out with circular businessmodels respond to different types of pressure and support: from the public authorities, with existing and upcoming legislation (i.e. European and regional CE strategies and plans) and from the consumers because of the generalized awareness about the harm of the (fast) fashion industry.

The private sector

Awareness

The central actors of circularity today are the businesses that are engaging in circular practices. There is a consensus among our participants that the environmental and social problems of the industry are well-known and acknowledged by the sector. Circular economy is therefore presented as an effective solution to these problems and has gained a lot of attention over the last years. The main motivations for making circular transitions within a business can be summarized as such:

- ethical consideration: those that want to contribute to a more sustainable industry
- legal considerations: those that want to comply with or anticipate (upcoming) legislation
- economic consideration: those that either want to attract customers through sustainable branding/marketing and those that anticipates rising cost of raw materials due to depleting resources (though the latter expectation has not materialized sufficiently yet to become a real economic incentive for businesses to develop circular practices and sourcing).

Circular practices

Depending on the type of business, their size (and consequently financial and human ressources), the actions deriving from these motivations vary widely.

Dependent on these motivations and actions, some sort of typology can be drawn of the current ecosystem and its dynamics:

- the businesses that hold circularity as a main objective and consequently have a circular business model

  eg: rental services, but also well-established actors in the second hand sector

- the actors that started out with the linear 'take-make-waste' business model, but are trying to integrate circular principles

  The effort and the outcome depend on the features of the company and the type of action taken.

  The first step is to start with an analysis of the business and the development of a circular action plan. This can either be done with an external service (like close the loop, cf. infra), or the companies with enough ressources hire a specific profile (sustainability manager) to do this. Usually, the 'easy' way into circularity are the 'eco responsible quick-wins'

  eg: developing a take back system or a repair service
- the actors that are aware of the problem, but are reluctant to act
- the actors that invest in research on circularity (mostly on recycling)
- the actors that are aware of the problem, and communicate on it, but in reality, continue business as usual (e.g. greenwashing)

Since there is no 'one way to circularity', it is up to the business to assess what the best suited direction is, considering their specific features (like the size, current business model and the specifics of the production process) and (economic) possibilities.
For many companies it is not clear how to make this transition, or where to start, which translates to three options: refer to an external service for advice/consultancy (whether public or private), or hire a sustainability manager (though this is not an option for many SME's), or make changes without additional human resources. The financial cost and further economic insecurity of these innovations are the biggest barriers mentioned by all actors. Subsidy and other types of funding provided by Vlaanderen Circulair, VLAIO or European Funds and project calls are therefore crucial to cover development costs (cf. infra). This brings us to another characteristic of this sector: the polarization between very big, international fashion brands, and smaller brands. Each has specific struggles in their transition to circularity. The former encounters problems with gaining control and transparency over their (globalized) production chain. But these companies have a person, or even a team, in charge of following up sustainable regulations, capturing funds, developing sales strategies and marketing/branding and possibly developing circular practices.
The latter are more likely to struggle financially, and therefore often don't have the (financial or human) ressources to make sustainable adaptations like hiring a sustainability manager, using more qualitative or organic materials (that are more expensive), applying for public funging/certification/labels/audits
Additionally, there are lots of research and pilot projects, often involving private actors. This can have multiple forms: either private companies invest in research (especially textile recycling has gained a lot of interest), they can test circular practices (like a takeback system) within their company or participate in a research project with other partners. Most research projects are (partly) funded by public authorities.

The businesses with a circular business are considered the front runners in this field, the ones that create 'real change'. They usually are small and have emerged quite recently. Many point out that circularity today depends on 'bold and motivated individuals', the 'first movers' or 'early adopters': ideological individuals, that act and try out new things to enable the transition. Overall, many participants noted the importance of collaboration for upscaling.

Among front runners, openness and willingness to exchange experiences and knowledge is there, since they are all in the same boat: they want to introduce an alternative for the dominant system, but there are a lot of questions on how to do this effectively. This works especially well when there is a specific framework (like a research project or living lab), because it creates a safe space for sharing.
A special case in the ecosystem of circular textiles is the Kringwinkel, which has been the secondhand pioneer in Flanders since the 1990's. For them this shifting ecosystem brings a lot of uncertainty about their role in the future. They try their best to find ways to remain relevant and innovate.

So, the general conclusion of the private sector's role in this ecosystem is that there are a lot of different speeds and levels of engagement, but that they are seen as the main drivers for a circular transition.

Consumers
Similarly to the private sector, the environmental and social problems of the (fast) fashion industry are quite well-known by the consumers. Some of our participants have pointed out that mentalities and behaviors are starting to shift towards more eco responsible consumption patterns. As a reaction to this, more and more retailers are advertising a green/sustainable image.
Some aspects of circularity are gaining more ground than others. Secondhand clothing is becoming more popular, but that still represents only a small part of all consumers. Alternative businesses like clothing rental services have trouble attracting the public, because fast fashion remains the dominant norm: today's mentality and consumption patterns still revolve around cheap clothing. The fact that circular clothing is more expensive than fast fashion represents an obstacle for circular consumption to become generalized. Our interviewees pointed to the importance of sensibilisation and information (and within this category the fight against greenwashing).

The public sector
According to the actors we interviewed, the role of the public institutions is important and diverse. We give a brief overview of what the public authorities are currently doing to enable this circular transition. We will come back to this point later, to fit it into the typology.

Guidance and information
As previously mentioned, OVAM is the supervisor of Vlaanderen Circulair. They acknowledge the importance of gathering and passing on information and new developments to the private sector.
Together with the Flemish fashion and design centre Flander DC (subsidised by the Flemish government), they have developed a well-established guidance and information tool: 'Close the loop'. It is intended as an online tool to guide companies towards circular practices, while taking their specific features and possibilities into account. However, no follow-up is included in this tool, so whether these companies have acted upon the advice given by this tool and effectively implemented circular practices is unknown. According to some of the participants working on this tool, it has been used by 'most' fashion brands in Belgium.

Another tool that is being developed by Flander DC is a 'True cost tool', that will enable consumers to gain conscience on how the current prices of fast fashion hide an environmental and social cost.
Information is also provided under other forms, like webinars. It is the main service provided by Flanders DC and it is also central in VC's vision.

Creating partnerships
Connecting the ecosystem and creating partnerships among the different actors of the value chain is perceived as primordial by most of the participants. Partly because of the common challenge the sector is facing, but also because circularity intrinsically requires connection (across the value chain, actors, etc).
Many pointed out that meeting with stakeholders and creating collaboration is a priority. The public actors, especially OVAM and Circletex[4], highlighted their role in bringing together the different actors and stakeholders and assessing the needs and possibilities, and trying as much as possible to use these outcomes as a starting point for policy making. Some see their role as public actors more as guardians of this collaboration and exchange and stimulate others to act and try new things. Close the Loop tool also has this ambition, by creating a network of frontrunners, that they have made their ambassadors.

Research and innovation
Because the circular transitions have only recently gained so much attention, a lot of uncertainty and questions have risen. In order to understand how this transition can be operationalized, a lot of effort and funds are put into research, development and innovation, through subsidies/project calls and awards.
These studies can have different subjects: the technical and technological questions (e.g. the optimization of the sorting processes, recycling), economic questions (e.g. how to make circularity profitable), logistic questions (e.g. Circletex that focuses on reinventing the collecting systemand the development of digital product passports) and ecosystemic questions (i.e. how to connect the different parts of the value chain) were most mentioned in the interviews.
Regarding the features of these studies, there are different possibilities: as mentioned before, there are pilot projects carried out by companies, which are usually publicly funded, consortia involving public and private actors, academia, sometimes even consumers. A good exemple of this are the living labs that VLAIO[5] launched:

Regulation and funding
In a more classic approach, the role of the public authorities as the executor of command and control has been pointed out many times. The development of (ambitious) regulation is perceived as the most effective way to install wide scale transformation.
Since this transformation is expensive and most (small) companies don't have the means, public funding and subsidy is also perceived as primordial for this transition to happen. On

[4] Circletex is a partnership that has been created for supervision the textile value chain of VC. Their priority at the moment is to gather stakeholders and partners and investigate the way forward.
[5] VLAIO is the Flanders Innovation and Entrepreneuship centre, that supports and advices flemisch businesses and innovation.

this subject, the upcoming legislation on the EPR (extended producer responsibility) and DPP (digital product passport) were central. These are expected to have a big impact, and to precipitate the transition. These policies that are not implemented yet already have an impact because some companies are taking anticipatory action.

Discussion

Based on annex 2 that summarises the entirety of problems that were associated with the circular transition, we have ordered them based on Kaufmann-Hoyez et al.'s (2004) typology. In the last colom, we have linked those instruments to the labour implications that were mentioned by the actors. These labour implications are more of a transversal nature since they were rarely directly linked to the governance questions by the interviewees.

Legend:

normal - what interviewees said

italic grey - what public authorities are currently doing (according to interviewees)

italic black – links with labour

	Problem	**(Policy) solution**	**Labour implications**
Command and control	Consumers don't sort textile properly: they are currently thrown all together in textile bins (regardless of their condition), or even in the residual waste.	Better regulate textile waste sorting to avoid that textile gets incinerated with residual waste. Reinvent the current textile waste collection system (like integrating it in the current garbage system).	New collection system would require new collectors or for the current collectors to change their way of work (to integrate a textile) If the sorting of textile waste is partly done by consumers, it would make the work of sorting centres easier.
	Companies taking action do it out of good intention/ ethical considerations	Make the transition mandatory to get everyone on board → UPV: producers will remain responsible over their products until the end of life	Legislation is coming soon, in a short period of time a lot of circular practices/services will emerge (rental, repair, upcycling...), which will require a lot of labour (which currently is not being anticipated…).

	Big companies with lots of money can easily pay for certificates, fees and fines, without having to make profound changes (business as usual), even though they are the bigger polluters	Instaure effective control and sanction system that truly impacts (big) companies	
Economic (fiscal instruments and incentives)	Consumers are used to fast fashion, whose prices don't reflect the 'true cost' of the clothing. Consumers are not willing to pay the higher price for more sustainable clothing	Influence the prices of clothing to disencourage buying environmentally harmful clothes - Positive: encourage the purchase of sustainable clothes by helping covering the (higher) production costs of sustainable clothes - Negative: discourage the purchase of unsustainable clothing by penalising cheap fast-fashion companies → level the playing field between big, polluting companies and small sustainable companies → EPR: fee that will be charged on every clothing piece	*If the demand for more sustainable brands would increase through these measures, this could not only create a mentality and consumption behaviour change in the general population, but small businesses (that are considered the drivers for circularity) would have more financial room to experiment with new circular practices.*
	Small companies /circular businessmodels struggle to make changes because don't have the financial and human ressources	Level the playing field: prioritize the needs of the small businesses that generally struggle the most (but are seen as the creators of change): - positive: provide funds to allow small companies to experiment,	Cf. supra

		and cover development costs; make financial support as accessible as possible for them - negative: penalize (big) companies that don't make a (genuine) effort, that falsely communicate about their environmental impact (greenwashing), who's prices don't reflect the true cost of their products	
	Circular practices are labour intensive, which is expensive (i.e.: collecting, sorting, cleaning, check quality, repairing, upcycling)	1. Find cheap labour: - Through social economy - Through migration 2. Help cover labour costs 3. Invest in industrialization/ digitalisation (to avoid labour costs)	Social economy: create low-skilled jobs (but this depends on government funding to compensate for limited efficiency) All of these 'solutions' require some sort of training or skills: either low-skilled (like for social economy in sorting centres), or high-skilled (like digitalisation)
Service and infrastructure	(Small) companies don't know how to integrate circular practices/ don't know where to start (and often don't have the resources to hire a sustainability manager), partly because circularity is such a vast, complex notion.	Offer information, individual evaluation/diagnosis/guidance *Cf close the loop (Flanders DC & VC)* *[note: online tool has its limits for actual implementation]*	Changes in the companies' modus operandi will imply changes in the work (conditions) of the employees, on-site trainings, additional or changing tasks Many interviewees pointed at the importance of change management to get the staff on board.

	Lack of infrastructure for new circular business models to function (eg: efficient sorting methods, large scale washing services, recycling technologies)	Invest in R&D, develop such services and infrastructures *Cornerstone of VC*	The massification of textile waste will require new forms of organisation and new technologies
	Circular services will require labour and skills (skills that used to be common but have been delocalised, and new ones), but this is not anticipated (yet)	Develop circularity trainings, integrate circularity in existing (textile or fashion) trainings, integrate it in public schooling curriculum	Different types of jobs and skills will be needed: - in new companies with circular business models - in existing companies that are making circular changes - coordination and monitoring of the entire valuechain (most likely to be ICT) - transition experts/consultants → so both low skilled and high skilled are needed, and this should be anticipated
Collaborative agreements	Value chain/ sector is very fragmented, which complicates 'closing of the loop'	Need to get stakeholders (especially the small ones that are struggling) to come together and explore the best way to operationalize and upscale this transition, discuss their needs, difficulties,... Connect with international partners/stakeholders is at the core of VC'es approach	This is currently difficult for small companies, especially start-ups because they have a small team, they already need to do all sorts of things by themselves, they often don't have time to create partnerships and entertain this communication.
	Because of Belgium's federal system, there are 3 waste	Get three regions on the same page *VC is working on that (for UPV)*	

	management policies and 3 terminologies, which makes closing the loop on national scale difficult and slow		
Communication and diffusion	Bad consumption, use and waste habits of consumers Greenwashing	Sensibilisation campaign on sustainable fashion (on how to buy, ware and throw out eco-responsably) *"True cost tool" of Flanders DC can raise awareness*	
	Changing the internal functioning of a company requires the employees to change too	Promote the importance of change management and including the staff into the process *part of close the loop*	Might have to persuade/ change the mentality of the employees, there way of working might be adapted, might have to learn new skills/ get training
Tracability/ DPP			

Part 2: Digitalization and traceability

A central feature of this report is the role of digital tools and more specifically Digital Product Passports (or in the case of construction material passports). The case of the textile industry is the only case where DPP will be mandatory in the years to come. It was first mentioned in the EU's New Textile Strategy and the EU is currently working out the specifics.
This context sets this case apart because, as opposed to the other two cases, DPP's are not a hypothetical or theoretical concept, but a pending reality. As many have noted, the entire sector is aware of this upcoming legislation.

General research question 2

How is the development of Digital Product Passports (DPP) perceived?

Sub-research questions:

- What is the state of digitalization in the textile sector? What are the drivers and barriers to a digitalized textile sphere?
- How are DPP's perceived? What are they? What are they for?
- What are the main drivers and barriers for such development?
- Do they offer employment opportunities, in terms of job creation? Do they require specific skills?

Some actors, though it is a minority, had already adopted it before the New European Textile Strategy was published, as a transparency commitment towards their clients.

But since the textile strategy, the number of actors calling DPP service providers has grown exceptionally, and this is expected to increase even more when the regulation comes into force. Some actors are trying to anticipate this legislation and already test the DPP, some within the framework of a research project or living lab. But since there is still a lot of uncertainty about the specifics of the DPP, a lot of companies are waiting to get more information before acting. The first logical consequence is that the concerns that were raised during our interviews were generally of a very practical nature. The legislation is expected to be relatively easy to implement at first and then become more and more advanced progressively

Critique of the DPP in the textile sector argue that too much faith is attributed to it, doesn't inherently change fast fashion. They also stress that it is not realistic to think that a sector already under so much time pressure will have the time to scan every item.

Supporters argue that DPP offer many business opportunities:

- facilitate logistics of certain business models like take-back systems (that way clothes that are brought back don't need to be manually put into the system, photographed, put on the website, etc.)

- This new data might provide new insights, new features tailored to the needs of the customer (eg repair services nearby), and more detailed sorting at eol.
- DPP will facilitate e-commerce, and consequently make secondhand retail easier

Interviewees also mentioned a series of issues associated with DPPs:

- Technical: it is a technical challenge to gather information on the entire value chain and make sure all actors have access to these technologies to update the DPP
- Control: importance of control to guarantee the DPP will be filled in correctly
- Resources: Implementation is difficult for small companies. Big companies have ERP packages with which DPP can easily be adapted, they have the power to demand from their label supplier to integrate a DPP, or they have a team working on ICT.

4.2. Metallurgy

Introduction and context

The second case study explores the metallurgy sector in Wallonia. The research questions are slightly different from the other two because of the different context. We chose the Walloon region because of its long-standing tradition in metallurgy. Though it is widely accepted that modernising the industry is needed, this transition appears to be slow in this region, even more so than in the two previous cases. These elements make it an interesting case for this report because it complements the two others.

The metal industry can be divided into two categories: ferrous metals (iron and steel) and non-ferrous metals (such as aluminium, copper or zinc). The steel industry represents a relatively big part of the European industry, accounting for 2.7 million direct and indirect jobs (EPRS, 2021). The steel produced in the EU accounts for 11% of the global output, making the EU the second largest producer in the world (after China). In Wallonia, the metal sector accounted for 12% of GDP in 2019[6]. The walloon metal ecosystem counts 82 enterprises directly linked to metallurgy, and 695 entreprises directly linked to the production of metallic products[7].

However, with 4% of GHG emissions caused by the production of crude steel, it poses a big strain on the environment (EPRS, 2021). According to the European Commission, the main challenges for the EU steel industry are linked to the cost and availability of raw materials and energy, environmental and climate change regulation, and competition from non-EU country producers. Not only has the demand on metals increased in the past decades, but they are also expected to keep on growing with the expected growth of the world population and its middle class (Hagelüken et al., 2016). Given the increasing demand of metals, the EU stands for the challenge of dependence on raw materials and on resource efficiency.

Metals hold a lot of reuse potential because their quality and functionality doesn't degrade in the recycling process, making them "qualified as a permanently available resource" (Hagelüken, et al., 2016, p. 244). Regarding CE, in 2021 the Walloon region developed a strategy called "Circular Wallonia", with metallurgy as one of the six main value chains. Alongside this, another "strategy of intelligent innovation" was created called Win4C (Walloon initiative for Circular materials), where metals hold one of the four main axes. With these two strategies the Walloon region ambitions to become the "recycling valley" of Europe by 2030.

Though the traceability of the value chains is generally seen as a facilitator of CE, little evidence is found of digitalization for the sake of CE in the metallurgy sector in Wallonia. In terms of digital transition, there is the Walloon government strategy "Digital Wallonia" (2022) which includes a program on industries. Some digital technologies are being developed to

[6] http://etat.environnement.wallonie.be/home/Infographies/industrie-extractive-et-manufacturiere.html

[7] https://www.polemecatech.be/fr/news/lunite-deconomie-circulaire-du-pole-mecatech-presente-sa-feuille-de-route/

facilitate the sorting process of (heterogenous) metal streams, like Multipick and Characterize-to-sort, which is related to CE.

In conclusion of these two strands of exploratory research, we find that, as opposed to the other cases of this deliverable, digital tools that are at the intersection of CE, labour transitions and digitalization, like DPP's and material passports, are not yet in the picture for the metallurgic sector in Wallonia. We will therefore take a step back and investigate the sector's perception of the CE transition and whether digitalisation in general could play a role in this.

Data collection

The circular transition (and the digital transition) in this sector is driven by multiple public actors. They therefore represent the biggest part of our sample: we have interviewed actors from WIN4C, Circular Wallonia, Digital Wallonia and Digital Wallonia for Circular.

Regarding the private actors that participated, they either come from the recycling ecosystem or are companies that show an interest in the circular economy. Lastly, since the labour aspect remained underdeveloped in our interviews, we have also conducted an interview with someone from the workers union.

Results

Part 1: Circular economy in the Walloon metallurgy industry

The first part of this section is again dedicated to outlining the current state of circularity in the sector, as perceived by the actors we interviewed. The research questions are therefore the same as for the previous case study.

General research question:
What is the state of sustainable textile and circular economy in the metallurgy sector?

Sub-research questions:

- What are the mutual roles of the consumers, the private and the public sector? What are the drivers and constraints on the development of circular economy? How is this transition perceived?
- What are the main challenges and opportunities regarding employment? How do they relate to circular economy development and digitalization?

On a general note, the main challenges the Walloon metallurgy is facing today can be resumed as such: the growing asian competition, current and expected labour shortage, the energy transition and the access to (raw) materials. We won't thread into detail for the first of these challenges, since it is beyond the scope of our research, and they will be implicit in further sections. Regarding the latter two, since they are related to sustainability, we will briefly review them. On the one hand, since metallurgy is a very energy consuming and polluting

sector, a lot of industrials know they need to change their own energy consumption and emissions, especially since the political pressure for doing so is also rising. Reducing energy consumption and/or transitioning to green energies is therefore one of the big preoccupations of the sector.

The access to raw materials represents multiple challenges: first, it translates to a dependency on a very volatile international market. If a supply rupture occurs on this market, the entire production chain is jeopardised, which has become more salient since COVID19, when these supply ruptures were recurrent. This is the main argument that is presented to explain the need for a circular transition. As we will see in the next section, the rationality of securing access to raw material by developing secondary material streams is widely accepted, but its implementation is more complicated.

Circularity has become a prominent subject on the political agendas, as previously mentioned. As opposed to our first case study on textile, the dynamic in the circular metallurgy in Wallonia is more top-down with multiple regional strategies and structures aiming at stimulating the circular transition, while the companies' vision on the matter are more divided.

Dynamics and actors
The private sector

Awareness
There is a generalised awareness of the planetary limits and that metals are a finite resource. Especially since the amount and the diversity of metals that are being used have exponentially increased in the last few centuries and even decades, and supply ruptures have become more recurrent. But knowledge on what circularity exactly entails is very scattered: a lot of walloon industrials are unaware of what circularity exactly is, its merits and how to implement it. This explains why sensibilisation is a cornerstone of the regional CE strategy. Many actors associate circularity with recycling only. Wallonia has a well-established recycling sector that for many represents industrial pride. One of the main inescapable circular actors in this sector is Reverse Metallurgy. This initiative, that was created by a consortium of industrial actors and academics in 2013 must be situated in its context: the belgian steel industry has been declining since the 1980', leading to job losses, as well as the risk of knowledge and expertise loss. As a reaction to this evolution, some industrials wanted to come up with a project that would revitalise the industry, capitalise on this long-standing tradition and expertise. This group of industrials, which originally counted about 30 actors of whom 10 went through with it, came up with the idea of developing the metal recycling industry of Wallonia. Hereafter partnerships were created with universities and research centres and (European, Walloon and private) funds were collected. This is considered the first step in the development of a regional ecosystem around waste. At the same time, circular economy gained a lot of political attention at EU and Walloon levels.

Circular practices
Belgium and Wallonia are at the forefront of recycling at EU level. However, other circular principles, like new business models based on products as a service, repair, reuse etc. are either not mentioned, or perceived as something far off. Despite the efforts of the Walloon

government (cf.infra), many participants did not perceive real change towards circularity in the field.

Reasons for this are multiple: circularity is perceived as (financially) risky, or companies don't have the resources to make changes if they are not economically driven. Overall, the participants agree that the economic rationale prevails, especially since the asian competition on this market is gaining more and more ground and flooding the market with (very) cheap products. Competition pressurizes companies to optimise the production chain and cut production costs. The main motivations that are mentioned to develop circularity in this sector are therefore

- to secure access to resources (especially rare metals)
- to stimulate innovation and remain relevant
- to attract high qualified labour (given the pressing labour shortage) with environmental and social values
- to respond to growing environmental concerns among clients and public authorities

General public/consumers

The consumption behaviour of the public is perceived by many of our participants as one of the barriers to developing a circular economy, because sustainability doesn't seem to be a big concern. Many agreed that a part of the problem is that for metals, people are not conscious about how much it penetrates every aspect of our society and lifestyle. The industry is associated with pollution, difficult working conditions, and generally as a declining industry.

Some of our interviewees regret that little attention is paid to making this industry 'futureproof'. This is perceived as highly problematic for multiple reasons: it is more difficult to find investments with this bad reputation, it is more difficult to attract 'new blood' (qualified labour shortage is one of the big challenges the sector is facing today, and it is expected to grow in the future). But many of the participants point out that metals are omnipresent today, but also in the future: the energy and the digital transition depend on metallic products (whether windmills and solar panels, batteries, phones, computers etc).

The public sector

Over the last years, the circular economy has gained a lot of political attention and momentum. Which in Wallonia, is proved by the creation of two (very similar) regional strategies and structures: Circular Wallonia and the Walloon initiative for circular materials, WIN4C.

Circular Wallonia is the regional plan for developing circular economy under the ministry of economy, the administration in charge of sustainable development. It is divided into 6 value chains. The value chain metallurgy is coordinated by the competitivity pole for mechanical genius "Pôle Mecatech". Their focus lies on the operationalization of circular economy in the field, and mostly with SMEs. Their tasks range from sensibilisation, training, funding, creating a network and gaining international visibility. Sensiblisation is a big focus of Circular Wallonia and has the form of events, webinars and information sessions. A common problem is that the companies that are unaware of circularity are not included in their network and are therefore harder to reach. To deal with this, they have a personalized approach, that consists

of approaching said companies individually, reviewing their difficulties and pointing to the (economic) advantages of circularity, hoping to convince them. They are also developing a three-day training program called 'CIRCO', where two representatives of a company, one for the business aspect and the other for the technical aspect, can develop a circular action plan tailored to their possibilities. Pole Mecatech is also involved in the Factory of the future program of the Walloon government, which consists in evaluating (and possibly rewarding) companies based on 7 axes, one of which is sustainability. Lastly, there is the subvention aspect: since the biggest barrier to a circular transition for companies is financial, there is funding for projects, mostly proof of concepts. But also, services are provided to help companies apply for (european) funds.

Within the strategic innovation domain 'circular materials', WIN4C is the intelligent specialization strategy (ISS) for minerals, metals and polymers. The metal axis is carried out by the Centre de Recherches Métallurgiques, CRM group, and ULiège. Their objective is to try to become the 'recycling valley in Europe by 2030', which they try to achieve primarily by gathering the needed actors and creating partnerships. Rather than being an additional structure in an already fragmented and complex ecosystem, they try to have a transversal and complementary approach. They also fund and carry out research. We should mention collaboration platforms, which are platforms where problems that are experienced by field actors are studied. They intend to develop innovation that can be useful to as much industrials as possible. This way even smaller actors that don't have the resources to do R&D themselves can benefit. Circular Wallonia and WIN4C visions and workfield overlap, but WIN4C is more focussed on research and innovation, and Pole Mecatech more on accompanying companies to circularity.

Research

We dedicated a separate section to research because it concerns both the public and private sector. Most actors agree that there is a lot of research on circularity in Wallonia. A big part of this research is dedicated to technological innovations, with recycling as the main focus.
Pole Mecatech also created university chairs that will study new business models, with a chair at ULiège for the metallurgy sector. Some actors noted that this abundant research has too little impact on the sector. Others also pointed out that the access to funds (for research) is not equally divided. Big, powerful companies have more resources (time and money-wise) to apply for funds and subsequently do research than small companies, which tends to polarize the sector even more: big companies develop more and faster, and small companies remain small. Overall, it seems there is a fragmentation between technological development and economic and social aspects which make technology transfer difficult.

Discussion

Based on annex 3 that summarises the entirety of problems that were associated with the circular transition, we have ordered them based on Kaufmann-Hoyez et al.'s (2004) typology. In the last colom, we have linked those instruments to the labour implications that were mentioned by the actors. These labour implications are more of a transversal nature since they were rarely directly linked to the governance questions by the interviewees.

For this case in particular, the topics tended to be more fragmented between circularity and labour implications, digitalization and labour, technological development and transfer to business models, etc.

Legend:

normal - what interviewees said

italic grey - what public authorities are currently doing (according to interviewees)

italic black – links with labour

	Problem	(Policy) solution	Labour implications *Disclaimer: most links that are made with labour are very hypothetical*
			Regional programmes work in silos: everyone is working on their mission, bridges are missing (in this case the link between circularity and labour is not spontaneously made) Is not present in the reflections of CW *Are somewhat aware of this, cf. digital wallonia for circular*
Command and control	Asian competition is flooding the market with (very) cheap	Disencourage Asian imports, make sure (upcoming) legislation	The decline of the Walloon metallurgy is already perceived

	products, which increases the pressure to make cheap products rather than sustainable products European legislation is becoming more and more strict, but doesn't apply to this non-european competition. (+ mentality of consumers won't change if the offer doesn't change)	doesn't make competition with the Asian market even more difficult. *Economic instruments: protectionist measures = raise tax on imported products to make them more expensive*	as a threat for jobs. If (Asian) competition keeps gaining ground, Belgian companies won't be able to keep up, which will lead to more job and skill loss, as well as more economic dependence on other countries
	Because sorting waste is labour intensive (and therefore expensive in Belgium), a lot of our metallic waste is exported instead of seeing and using it as a resource. Legislation and definition of waste varies from one region/country to another, which makes 'closing the loop' more difficult. Massification of some metallic waste will be needed to make recycling worthwhile (financially).	Exporting waste should be much more regulated, it should be treated (and regulated) as a resource. Push for a coherent and conformer legal framework for the entirety of Europe	*Keeping all the waste here would (tremendously) increase the volume of scrap here. Which would immediately create (low skilled) jobs to deal with these huge waste streams.* *<u>Problem:</u> with current labour shortage that could be a problem to find (and train) this personnel* *Job creation is anticipated with RM, but in a very theoretic/hypothetical way* *Social economy is considered as a solution*
	Metallurgy is a conservative sector, if circular transition is not mandatory it won't happen	Make circularity mandatory (and provide funds for SME's to make this transition)	Is considered by some as the only way to generate real change in the short-mid term. It would impact (directly or indirectly) all

			the workers in the field. Others are already hostile to policy, if new legislation is too disruptive it will not be well received <u>Problems:</u> - Raises the question of means: not every company can make ('quick') or changes - Some companies already experience difficulties to innovate because of lack of skilled workers (and generally lack of interest in this domain)
Economic	Unequal playing field: Small companies don't have a lot of resources. Though there are multiple options for applying to funds, they often don't have the time/ressources. Big companies have more resources to capture funds. Big/powerful companies tend to form a tight network (RM e.g.) that is not accessible to all actors (i.e. smaller companies) "struggle to catch their attention"	- Orient research based on the needs of the (small) companies, map those needs *WIN4C: collaboration platforms to °research based on the industry's needs* - (Financially) support small companies specifically and make administrative procedures as light as possible *collaboration CW offers services to help apply for european funds (to help companies with limited resources)*	

		- Provide subsidy *Is being done by WIN4C and Circular Wallonia*	
	The administrative procedure of applying for funds also requires ressources and know-how, which gives an unfair advantage to big, powerful companies. Critique that though there is a lot of research, this does not translate to a change in the sector	Administrative procedures and call for projects need to be accessicble	Currently, the jobs that are created are mostly research positions, but in companies no change is witnessed (except maybe for recycling pilots,which generate a dozen of jobs)
Service and infrastructure	There is little overview over waste streams, though there are quite specific public records of it.	Use these records to get insights, gain control over waste streams, and connect the value chain *CRM (with help of public records) are currently mapping waste streams to get better insights*	*Would represent more work for public administrators*
	Companies don't have the know-how to integrate circular practices (cf. Factory of the Future program: improve social and environmental impact are usually the elements companies struggle most with)	Offer guidance *general approach of MecaTech: individual, talk everything through, take it step by step* *CIRCO: 3-day workshop to develop circular action plan (still developing)* *[note: no follow-up]*	Requires companies to make time to follow those workshops/trainings + observation: even when an evaluation and/or action plan is developed (by sustainability manager or someone enrolled in workshop), it is not easy to get

			management on board
	Qualified labour shortage (especially ICT), lack of maturity and expertise of what circular economy is, decreasing enrollment rates in metallurgical trainings	Create trainings on circularity in the metallurgy specifically or integrate it in existing trainings *Offer training format for companies* *Is being done with CIRCO*	<u>Vision:</u> Make metallurgy attractive again thanks to an innovative mindset and sustainable values (that are linked to circular economy) <u>Possible result:</u> *Create labour offer that is qualified in circularity*
Collaborative agreements // partnerships	Companies might take action internally but tend to work in their corner, though they might have complementary challenges There is a lack of connection in the ecosystem. No real collaboration yet between companies and public authorities and policy should be more based on data. Existing collaborations tend to be with the powerful companies, and the small ones are overlooked. Small ones don't have the financial room to invest their time in other projects	Create transdisciplinary collaborations tailored to the needs and possibilities of small companies.	<u>Problem</u>: there is already a labour shortage, small business don't' have the time to take on additional tasks
	WIN4C has the ambition of	Create an international network	

	making Wallonia the 'recycling valley in Europe' but this only makes sense if there is a connected European ecosystem. Given the international character of the metal value chain, talking about circularity only on a Walloon scale doesn't make sense There needs to be enough waste mass to make it profitable	with complementary skills and expertise *cf WIN4C: create international network and gain visibility* Create international waste streams	
Communication and diffusion	lLaggards are difficult to reach and persuaded	- 'Speak their language': Make the laggards aware of the economic opportunities that circularity holds (energy and resource efficiency, secured access to resources, improved image, resilience,...), *is the approach of circular Wallonia*	If everyone gets on board of circularity this would create a demand for circular skills and jobs (that are not anticipated yet)
	Consumers hoard their unused or broken electronics	*Communication campaign on the importance of bringing in those electronics*	
	Lack of interest of the general population in the role of metal which translates in loss of investment, fewer enrolments in	Communicate and generate a positive image of the sector and the importance of metal in society	<u>Desired effect:</u> Renewed interest of general population would translate into more enrolments in trainings and

	trainings, labour shortage		address the labour shortage

Part 2 : Digitalization and traceability

General research question 2

- What does digitalisation linked with circularity look like ?

Sub-research questions:

- What digital tools are linked with circularity?
- How are DPP's perceived? What are they? What are they for?
- What are the main drivers and barriers for such development?
- Do they offer employment opportunities, in terms of job creation? Do they require specific skills?

Digitalization in general

Before diving into the concept of traceability, that is central in the two other case studies, we will first look at what digitalization looks like in the metal sector in Wallonia. Digitalization in metallurgical companies today takes the form of optimization: making production processes more efficient through technology and advanced manufacturing.

We should note that these digitization efforts depend on the sector and the size. Big companies tend to invest a lot in digitalization, while smaller businesses are more reluctant. This latter has been attributed to lack of resources, lack of insights on what tools would be most interesting, but also a fear of being too disruptive towards the employees. Additionally, the qualified labor shortage is already very pressing, which makes innovation slower or more difficult.

Digitalization in this sector has a negative connotation of replacing human employees and leading to job loss. Yet, some point out digitalization can lead to more comfortable working conditions. Most participants stressed the importance of change management, of taking things one step at a time and starting with the things the employees are already familiar with and work from there on.

Digitalisation for circularity

More directly related to circularity there are the technologies that are being and have been developed in the framework of RM, for instance the mutlipick tool, which is an automated sorting device for metallic waste.

On the policy side, the program 'Digital Wallonia for Circular' to bridge the program Digital Wallonia and Circular Wallonia. The objective is in the first place to raise awareness on the existence of digital tools for circularity. It stimulates transdisciplinary collaborations by creating project calls for circular activities within companies assisted by a digital expert. They

also launched a study on state of play of what digital tools for circularity exist and/or are currently being developed or used.

Traceability and DPP

Traceability in metallurgy has two forms: traceability of the internal production process of a company, which is quite recurrent for efficiency reasons, and the traceability of certain products because it is mandatory for safety reasons, namely the automobile sector, the aviation industry, and the weapon industry. For the latter, these products need te be traced and called back in case of a default in the design/production.

Discussing traceability (and the digital product passport) as a tool for circularity, caused two reactions: either people were unaware of the concept, or people agreed on its theoretical merits for circularity, but know any use cases (yet) and saw a lot of problems and challenges. The advantages that were being put forward, though quite hypothetically uttered were:

+ a useful tool for mapping wastestreams
+ to keep track of the quality/purety of products
+ for transparency's sake
+ to change the perception of the public
+ could be useful for monitoring at a distance, maintenance, repair

One person pointed out that to gain an overview and control over waste streams this could be useful and that 'at some point' this tracing will become crucial. The growing complexity and heterogeneity of products was also mentioned as an opportunity for DPP. Another mentioned a research project that included DPP but there were a lot of practical problems (cf. infra). Additionally, when asking partners with what products this DPP could be tested in the framework of this same research project, this concept was so unknown to them that they couldn't even think of a product for which it would be interesting. Given the upcoming EU legislation on DPP for batteries, batteries were mentioned a few times as a practical implementation. One participant mentioned that it could be a way for the general population to gain consciousness of the importance of metals in society (cf. supra).

On the practical side, these were the problems identified by the participants:

- the cost were very high (and the profit margins in that sector tend to be low)
- technically, scanning the passport was difficult because of the inaccessible location of the product

In more hypothetical discussions of this tool, these were the challenges that were identified:

- for some products it might not be relevant, because circularity can 'easily' be accomplished without passports
- Given the length and the complexity of the value chain, it is difficult (maybe even impossible) to get everyone on board
- doubts about the competition aspect: companies won't want to put the 'recipe' of their product on the tag because their competition might take advantage
- it will require the implication of other sectors than metallurgy, namely IT

- probably will be difficult for small companies (cf digitalization) because of lack of resources
- some metallic products have a very long lifespan, so by consequent the (technology of the) label, scanning device and traceability will have to work for decades (which is a timespan that doesn't feel realistic)
- some products are so massively produced (e.g. tin cans) that providing them with a 'unique' label seems unrealistic

Overall, everyone agreed that for the moment things are not evolving towards traceability, that there is generally very little interest and maturity coming from the industry itself. Some thought it unrealistic, even utopic. In the best case, some see it as indispensable for a circular economy, but talked about as a far, hypothetical future.

To answer to the last question of this section, concerning the labour implications of this evolution, this tool didn't not incite reflection deep enough to incite the labour implications.

5.1. Construction

Introduction and context

The third and last case of this report is the construction sector in Brussels Capital Region. This sector is considered salient for climate mitigation because construction and the operation of buildings are responsible for 38% of global emissions and for 50-70% of city emissions (World Economic Forum, 2022). The construction sector is also the largest global consumer of raw materials and other resources, using about 50% of global steel production and more than 3 billion tonnes of raw materials (World Economic Forum, 2016). It is indeed the most material-intensive economic sector in the EU (European Commission, 2018). The current volume of resource usage calls for a reassessment of the current linear model of consumption and production, which is built on a "take, make, and dispose" view (Romnée & Vrijders, 2018), to transition to a circular model based on maintenance, reuse, remanufacturing and recycling (Tudor & Dutra, 2021).

Scholars argue that existing building stock can be a source of raw materials, and can serve as a "material bank" in the future for new buildings, provided that sufficient information on the material composition of the building stock and its availability is made accessible (Çetin & al., 2022). This increasing emphasis on the resource potential of buildings in urban areas made some authors question the relevance of a specific understanding of circular economy when applied to the construction industry. Benachio & al. (2020) provide such definition, by linking circular economy principles to the different life stages of buildings, from project design to end of life. They define circular models in the construction industry as "*the use of practices, in all stages of the life cycle of a building*[4]*, to keep the materials as long as possible in a closed loop, to reduce the use of new natural resources in a construction project*" (Benachio & al., 2020, p. 5). In other words, applying CE principles to the construction industry relies on 3 main pillars: 1) design and construct buildings that allow for the recovery of materials at the end of their life, 2) develop technical solutions to extract and valorize the material resources available in existing buildings (urban mining), 3) imagine new business models that encourage value creation throughout the life cycle of buildings and materials (Romnée & Vrijders, 2018). In that context, the potential offered by material passports in terms of exploration, circulation, and reuse of building products make them, if implemented properly, a relevant and powerful circular economy tool for the construction industry.

However, the adoption of circular economy models and/or practices at the micro level of the construction industry remains unorthodox, since linear economic models are still the norm, including in Belgium (Romnée & Vrijders, 2018). Guerra & Leite (2021) studied for example how 130 US stakeholders perceived the main enablers and barriers to the adoption of a CE model in the construction industry. According to them, the main enablers were education and cultural change, data availability, policies and market-based incentives and efforts to popularize new voluntary stewardship programs. Budget and upfront costs, the respect of schedule and project timeline, the lack of awareness and expertise about CE models (and their incompatibilities with mainstream current construction business models) and the absence of regulations and implementation guidelines were perceived as the main barriers by construction actors. Romnée & Vrijders (2018) made similar observations at the Belgian level.

They identified a series of “external” factors affecting a circular transition of the construction industry, including governmental political orientations, legal frameworks, technical and technological innovations, economic opportunities and job creation potential, the financial attractiveness of new business models and the promise of returns on investment. However, they also acknowledged that such transition relies heavily on the willingness of industry players to evolve. Despite this, circular economy is usually described as an alternative model oriented towards better use of resources and waste.

Regarding the labour transformation, the construction sector is expected to be one of the two sectors with the most job gains by 2050, with a growth of 12% (Climact & al., 2016), and the most impacted by the low carbon transition in general (Climact & al., 2023). Job creation in the context of such transition is divided into 3 categories: emerging jobs specifically created for the transition, existing jobs whose skillsets need to evolve to include “green” skills and existing jobs whose skillsets do not need to change (Climact & al., 2023). Indeed, beyond the creation of creation or destruction of jobs, a low carbon transition will require additional skills on top of mobilizing existing skills. While the sector is expected to boost employment, there are concerns about the labour shortages for Belgium with the country facing an annual scarcity of about 20,000 construction workers every year. Finding appropriate skills in the broad construction sector, in addition to recruiting qualified personnel, is one of the greatest challenges of the sector. The highest scarcity relates to professions such as trained technical personnel with a highly technical degree, engineers, project managers, and mathematicians. Additionally, the construction sector needs plasterers, painters, plumbers, bricklayers, carpenters, scaffolders, roofers, tile layers, building site workers, electricians and mechanics (European Construction Sector Observatory, 2021).

As we have covered previously, digital tools are often considered facilitators of circular economy. Because of their potential in terms of recovery and reuse, these tools are currently being explored extensively at the EU and Belgian research and policy levels. The EU Horizon-2020 research program funded for example from 2015 to 2019 a project called BAMB - Buildings as Material Banks (Atta & al., 2021), which explored solutions to increase the value of building materials, by reducing waste production and virgin resource use. At the EU policy level, digital passports are also mentioned in the Circular Economy Action Plan (European Commission, 2020), and in the “Ecodesign for Sustainable Products” regulation package, which should include a revision of the current Construction Products Regulation (European Commission, 2022b). At the Belgian federal level, the development of a “building passport” was also identified in the framework of the federal Energy & Climate Plan 2021-2030 as one of the key tools to assess the composition of existing buildings (Plan National Energie Climat, 2019). In the Brussels Capital Region, the development of “building passports” for residential buildings is one of the many measures mentioned in the long-term regional strategy to reduce the environmental impact of existing buildings (Bruxelles Environnement, 2020). However, this development is still in its infancy. Madaster, the first Brussels-based materials passport platform (i.e. a software and database to create materials passports) was only released in 2021 (Circubuild, 2021). In this context, the potential for development remains an open question and calls for further investigation regarding enablers and challenges with multiple perspectives (including technical, but also technological, economic, social, and/or institutional ones).

With this interdisciplinary perspective in mind, we will first review the current state of circularity in this sector and then assess the development of material passports and its enablers and challenges, from the point of view of relevant stakeholders.

Data collection

For the data collection of this case study, seven interviews were carried out with different kinds of circular actors (from political institutions, and from the economic sector under study) according to their expertise on relevant themes.

Results

Part 1: Circular economy in the Brussels construction sector

General research question:
What is the state of sustainable construction and circular economy in Brussels?

Sub-research questions:

- What are the mutual roles of the consumers, the private and the public sector? What are the drivers and constraints on the development of circular economy? How is this transition perceived?
- What are the main challenges and opportunities regarding employment? How do they relate to circular economy development and digitalization?

Dynamics and actors

A first general questions that was raised during some of the interviews relates to the way architecture and housing is seen in our society. As some actors have pointed out, architecture is perceived as a constantly changing. When a building is bought, it usually is renovated (if not distructed to be rebuild) to fit the taste of the new owners and its new purpose. Only, these tastes and function change over time, and by consequence so does construction. So today buildings are built or renovated with the implicit idea that they might or will be renovated again in the years to come, regardless of its condition. Which is inherently unsustainable: buildings are not build/renovated with the idea that they will remain unchanged in the decades or centuries to come.

The private sector
Much like in the other two case studies, the general tendency for the construction sector is scattered: some companies are testing circular practices, some are reluctant to change their habits, others are not well-aware of the stakes of circular economy. Circular practices are still rather uncommon, except for some specialised companies and when they are explicitly asked by clients. These frontrunners drive changes towards circularity in multiple ways:

- They set a good exemple and promote circular actions. They can share their experience and expertise and motivate others to follow in their footsteps.This can be done in different ways: by offering support/consultancy, through research activities,

by developing and introducing tools and guidelines, through conferences and trainings, by pushing for legal changes in line with their insights

- They help develop specialized infrastructure in the entire reuse chain: this involves dismantling, recovering and storing materials, and then preparing, packaging and cleaning them for resale via a store (online and physical).

We should note that for this case, circularity is associated with reuse (much like for metallurgy circularity was reduced to recycling). The main vision to render Brussels' construction sector circular (or at least the first step) is to replace the demolition part by dismantling. This dismantling consists of first assessing the materials that can be reused, then recovering those materials. Many have pointed out that this is tedious and time-consuming work. Then those materials need to be cleaned, their quality checked, brought to storage facilities (that are today underdeveloped) and inventorised. This material stock can then be sold (online or offline).

In addition to the original objectives, namely securing access to materials and creating economic activity, the companies or actors that have experience with circular practices, have noted some other positive outcomes. First, though these circular practices might not always be financially rewarding, it has increased the quality of work: allowing for more creativity and networking. Second, some tools, like BIM[8] and lean management, can improve management and the efficiency of construction projects.

The main barriers perceived by our participants are financial. One of the features of Brussels' construction sector is that companies are either big or small, with very few medium sized companies. Typically, the small companies don't have the resources to make changes or experiment with circularity.

The topic of standardisation was mentioned on multiple occasions. Some identify the lack of definition and indicators of what circularity exactly is as one of the problems today. Others point out that reuse used to be a common practice in construction and depended on the skills and know-how of the workers. They note that this call for standardisation not only isn't compatible with the unicity and uncertainty that is inherent to reuse, but also undermines the role of the workers. If, on the other hand, we were to capitalise and redevelop the know-how of the workers, it could be gratifying and therefore improve their working conditions.

The public sector

Given that energy inefficiency has been identified as one of the main causes for GHG emissions in Brussels, mass renovation is considered one of the big challenges for climate mitigation. Some respondents have indicated that this focus on energy transition in the construction sector entails the risk of overshadowing the discussion on material use, and by extension circular economy.

[8] BIM stands for Building Information Modeling and is a digital tool that allows to model and visualise construction projects

However, there is an interest in reuse, but today this does not translate to a big impact on the field. The aspects that are considered central in circular development are on the one hand material flow management: instead of importing primary construction material, reuse materials coming from localised urban mines. And on the other hand, the creation of economic activities.

In addition to the 'usual' role of public institutions, and as opposed to the other case studies in this report, public authorities can have a big impact on the construction sector because they own a lot of real estate. They can have a driving role by opting for circular materials in public construction or renovation projects. Many participants have pointed out the exemplary role the public authorities should have. Instead of prioritising costs, they should choose sustainable/circular options to ensure the development of these models.

Other than that, the role of public authorities in the circular transition mentioned during the interviews are the following: provide training, also as a way of raising awareness. BE has organised seminars, training, and helped other institutions like Embuild and Construcity to do so.

Some participants have pointed out that compared to other countries or regions, Brussels is good at analysing and evaluating architectural situations. Through the progressive choices public authorities make they set the exemple, which can then snowball.

On the reglementary side, legislation has become more and more strict, which is often not appreciated by the sector itself. But it is considered a main driver for change, and some consider it the most efficient way to make the circular transition, though it should be preceded by pilots and front runner finance to ensure it is adapted to the reality of the field.

Discussion
Based on annex 4 that summarises the entirety of problems that were associated with the circular transition, we have ordered them based on Kaufmann-Hoyez et al.'s (2004) typology. In the last colom, we have linked those instruments to the labour implications that were mentioned by the actors. These labour implications are more of a transversal nature since they were rarely directly linked to the governance questions by the interviewees.

Legend:
normal - what interviewees said
italic grey - what public authorities are currently doing (according to interviewees)
italic black – links with labour

	problem	(policy) solution	labour implications
			Increased job quality, more rewarding (because it requires more intellectual labor)
Command and control	As long as they don't have to, companies will keep on doing business as usual (because they don't see the added value of it)	Make circularity mandatory	Currently only if the client specifically asks for circular practices, is this option considered. If it were mandatory it would become the norm and create a positive spiral of offer and demand. Conditions: Require a lot of guidance/consultancies for companies to know what to do and where to start, trainings for different types of positions (whether demolisher, manager,…). Especially since today it is still very underdeveloped

	Disruptive legislation will not be accepted by the sector (high standards are already perceived as a constraint/ bullying)	Take it step by step, start out with (financing) pilot projects and work from there *reuse strategy of BE:* 1. *test phase of voluntary projects, with financing and guidance (incentives, tools like be circular and renolab)* 2. *training* 3. *(to come): °realistic regulatory obligations based*	The closer the legislation is to the reality of the field/ the habits of executive workers, the more likely it will be that they accept it and the easier it will be for them to implement. *cf change management: it takes time to get a team on board and up to spead, so progressive legislation is better*
	Some materials are not considered valuable enough today to take the time to recollect them	Start with a 'protected materials' list and gradually increase it according to the pace that fits the sector	Private companies will have to be informed of this list, there needs to be clear communication (with all companies, not only circular experts)
Economic (economic rationale prevails, both in the sector, as for the consumer)		Make second life materials more economically attractive, e.g. by reducing their VAT rate	
	Unequal playing field: A lot of (small) companies don't have the ressources to make changes. Given the tight budget of most projects, there is no room to make sustainability priority	Offer financial mechanisms to support small businesses	*cf supra*

Service and infrastructure	Stocking material (for an undefined amount of time) takes a lot of place, which is difficult and expensive in a city (like brussels)	Create small drop-off centres for second life materials with on-site sorting and recycling in the periphery of the city. (opportunity for PA since they own a lot of real estate)	Management and inventorisation of these drop-off centres requires personnel, good logistics (and a good software/program) *Cf. infra: Communication and diffusion instruments*
Collaborative agreements[9]	Public institutions own real-estate, and therefore have a client relationship with the private sector. Most focus is on energy efficiency and not material use.	Public institutions need to prioritise circular materials and consequently create a demand for circular goods.	This will push the private sector to develop an offer and will help diffuse circular practices (or at least reuse)
Communication and diffusion	Legal framework/ high standards are perceived as a constraint by the sector	Improve communication of PA to promote the stakes and values that are behind CE (contributing to a better world)	*Desired outcome* Raise awareness on the benefits of circularity, and get the private sector on board
	Circularity as an undefined vague concept. So there are a lot of visions, understandings, but no real indicators, strandards, thresholds + Increases the risk for greenwashing	Create clear guidelines	*Problem: even with clear guidelines, remains up to the company and their ressources to make circular changes (as long as it is not mandatory)*
	(linked to MP): To connect the offer of reusable materials and the demand for materials, good communication is essential.	Create a centralised platform that is accessible to everyone in the sector to connect the different parts of the value chain	Needs to be sensitive to the digital gap between actors

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	Bad image: because of poor (bad salary, long hours, arduous work) and unsafe working conditions, there is a lot of turnover, which results in the loss of skills	Promote a better image of the sector (and show that it is not just heavy dirty work, but also high skilled jobs)	
Traceability/ DPP	There is already a shortage of engineers. Aiming at digitalising CE (which would require even more ICT engineers) is doomed in advance		Vision: We need to aim at developing a low-tech, low-skilled CE and focus on developing on-site know how
	Long term vision and availability of information: MP's rely on the idea that renovation and demolition/dismantling will be continuous (otherwise you don't need to reuse materials). So the question of building for a really long (even indefinitely) period is not raised. Private owners that intend to sell at some point, might not be careful with the storage of information Quickly evolving technology makes planning for decades difficult	- Change vision and build for the long term (= definition of sustainability) - MP should be centralised in places that surpass the ownership/lifetime of owners (eg local councils) so it doesn't get lost	all actors of the chain need to know how to work with it (and update it correctly) - external consultants could be in charge of updating MP's
	There are no clear guidelines on what information should be gathered/ stored or what level of detail		Even if companies wanted to try out MP's, it is not clear how to do this and what information to include. If not centralised/standardised,

			everyone would do it differently which would be very inefficient
	Digitalisation for the sake of digitalisation doesn't make sense. Sometimes deep reflection/ a long term holistic vision on the use of some tools lacks	Digital tools should be coordinated to make a sensible whole	
	Still little use in Brussels	PA should spread its use by starting with public tenders Frontrunners (private of public) setting the right exemple Organize trainings/workshops	
	Development of tools by PA is often of poorer quality, more expensive for taxpayers	Private actors should develop IT tools	If it is a service provided by a private actor, it will be paying, which is not possible for financially struggling companies (especially if they don't see the added value of it)

Part 2: Digitalization and traceability

General research question 2

- How is the development of Material Passports (MP's) perceived?

Sub-research questions:

- How are MP's perceived? What are they? What are they for?
- What are the main drivers and barriers for such development?
- Do they offer employment opportunities, in terms of job creation? Do they require specific skills?

Digitalisation generally is perceived as a general tendency that also affects construction. tendency that is generally bottom-up and lagging in comparison to other countries. Once again, the difference between big and small companies is palpable: the big companies are far along with their digitalisation and have their BIM (building information modeling, 3D visualization of a construction project) because for bigger projects it simplifies coordination and limits mistakes and waste.

But for smaller companies the adoption of digital tools is lagging. Mostly for financial reasons and digital affinity, but also because in some cases it is perceived as a complication, rather than something that would make their workflow easier. Regarding the tasks that are at the heart of digitalization, it is especially well-developed for the conception stage, as well as for visualization purposes.

Other elements that were mentioned are:

- ✓ coordination and optimization, structuration of data for big projects
- ✓ to complement workers shortage (eg, paint jobs, cost estimates)
- ✓ limit transport (virtual tours)
- ✓ assess energy performance and overall conditions of a building, through scans, drones etc

On the potential of digitalisation to enable circularity, our participants have expressed different views. Some see it as an inevitable tool: to make the offer and the demand for secondhand materials meet, there needs to be a good inventory of available goods, as well as a good communication system between the different actors (in this case dismantlers and builders).

However, others have pointed at the problems with this vision: this high-tech well-connected version of circular economy would require ICT engineers, which are already hard to come by, and to connect all the actors of the field, they need to have the digital skills and resources to do so. Consequently, some of our participants have pleaded for a low-tech take on circularity, that would build on the know-how of the workers and their individual assessment. Additionally, they stress that too often digitalization is seen as an end rather than a mean and therefore lacks vision on what tools are best-suited and how to use them efficiently.

This need for inventorisation brings us naturally to the last section of this case study: the perception of material passports by the sector. The BAMB project was mentioned as the main driver for awareness, as well as the fact that MPs are quite well-established in the Netherlands with Madaster. Once it was up and running, it turned to neighboring regions, starting with Flanders in 2021 and slowly making its way to Brussels. Today it's mostly big companies that are involved in MPs. But for the Brussels Region it remains mostly a theoretical concept.

The Material passport is described by our participants as a document where data is gathered on materials present in a building, its composition and technical features. The biggest advantage is transparency and the creation of an overview of all the materials available for reuse or recycling in the city, which will also enable the connection between the different actors and the circulation of materials easy and well-organized. It would make reporting easier for the construction workers. It can facilitate preventive actions like maintenance, repair and the localization and removal of dangerous materials.

However, some concerns were raised during the interviews. On a general note, one participant pointed out that though MPs are meant for the long term, our current vision of construction is not questioned in this process: we continue to see (de)construction as a permanent given of our society, and though ideally the materials used would be circular, the question 'should we renovate/build and why' is not raised. To take it even a step further, for MPs to make sense, construction needs to be a constantly circulating sector, which is inherently unsustainable.

On a more practical note, this digital tool only makes sense if the entire sector is using and updating it, which is not a given with the current digital gap between (big and small) companies. A similar innovation was introduced about 40 years ago the 'data sheets' where this failure of systematic updates rendered it useless. However, someone countered this argument by saying that it is merely a question of routine, that ones you are used to this practice it doesn't take that much time or effort. Additionally, putting in all the data is very time-consuming (and therefore expensive). If it were made mandatory there is a high risk of data being entered inprecisely or incorrectly because of time pressure. The transparency that is seen as one of the main advantages and pursued objectives, also raises the question of trade secret and confidentiality.

For this instrument to work, some conditions need to be fulfilled. First, the data must be standardized and well-managed, since today there is a lot of uncertainty about what information and the level of data that is needed. These MPs should be managed by institutions that outstay the ownership or responsibility of a construction project. Otherwise, this data could be lost when ownership changes, or if changes occur in the company that was responsible for its construction. As mentioned earlier, others have stressed the importance of adjusting existing digital tools, like drones, BIM, IoT, to one another in a complementary and efficient way.

Regarding the impact on labour, multiple elements have been mentioned by the interviewees. First, some jobs would be created to control the MPs

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7. Annexes

7.1. Annex 2: E-commerce case study constraints and solutions

	Constraints/Challenges	**Solutions/visions**
Consumer	- CE remains niche and expensive, not a priority for most customers (that are used to cheap clothing). - Don't know/adopt circular practices yet (or don't know the benefits) - Uncertainty of second hand/ upcycled collections → if there is no demand from the consumers, companies won't change the offer → as long as cheap clothing remains available, the demand for sustainable clothes won't increase	**Generally:** Level the playing field: - Increase the quality (and therefore the price) of clothing (reflect true cost) Mentality and behaviour needs to change (in consumption, use and waste management of textile) Introduce slow change (that is easy, accessible, economic for costumers) **Role of public authorities:** - Sensibilisation and information (campaign) - Regulate greenwashing

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		- EPR: increase price (for circularity) + communicate and discourage impulse buys - Development of true cost tool (Flanders DC)
	- Textile waste management is lagging: still a lot of unused clothes at home - Collecting bins don't require any sorting from the consumer, so the entire sorting process is les to the sorting centres (which is a lot of work)	**Generally:** Reinvent collecting system: Logistics: more collection bins and collectors, more detailed sorting required by consumers *Is the main mission of circletex* **Role of public authorities:** Better regulate textile waste management of consumer
	- Difficulty of communication towards consumers: companies are afraid of criticism if they highlight sustainable actions too much, or if they don't do it enough) - Greenwashing	**Generally:** Develop critical thinking of the consumers **Role of public authorities:** Information and sensibilisation + regulate greenwashing Development of true cost tool (Flanders DC)

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private sector	'Bold entrepreneurs' (individual or a business): actions and ideas of a few don't create structural change	**Generally:** Start with niche innovation and spread it until it's mainstream *[classic transition scheme]*
	Not used to work with (interregional/international) partners (everyone working in their corner), very fragmented value chain Talking about small scale is not relevant to close an international loop European legislation doesn't address parts of the supply chain that are outside of Europe	**Generally:** Need to send out strong message/ united front as a sector (to consumer) *Solidarity and exchange among frontrunners* Need to develop international partnerships for upscaling and connecting complementary competences (is currently a priority for PA) **Role of public authorities:** Have a neutral position, so can gather people around the table, locally and internationally *already seen as a priority by VC (for policy making), circletex, living labs*

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	Unequal playing field: Small businesses struggle (in general), don't have (financial or human) ressource to experiment or make big changes (e.g. sustainability managers; apply for funds/subsidy calls etc) - Are scared (upcoming) legislation won't be adapted to their capacities - Greenwashing of big companies - Prices of big companies don't reflect true cost - International competition (who are not subjected to same regulation) - Current fees, labels, certificates are easily overcome by the big, powerful companies - Reluctance to change: currently only motivation is ethical (since eco not convincing and legally not required to	**Generally:** Level the playing field: Make transition easier and more accessible for the 'weaker' actors Some point to the crucial role of frontrunners/ early adopters to set the right exemple **Role of public authorities:** - Allocate budget that is adapted to (limits) of SME and allows them to experiment - Regulate transition (EPR, DPP) ambitiously but sensitively to/realistic for SME to get everyone on the same page → Consult them in planning process (is the approach of OVAM: assess needs through projects and derive legislation from then on) - Importance of control (against greenwashing) - Possibly make sustainability manager mandatory

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		- Regulation is the best/only way to get everyone on board (mandatory and not just good intentions)
	Economic: - Economic rational generally prevails (over social, envir) e.g.: producer are under a lot of time and financial pressure and have small margins - Labour intensive = expensive - Small profit margins don't allow for experimenting - Alternative BM's currently not profitable - Competition between actors with the same vision/mission (i.e. social economy)	**Generally:** - Make circularity economically interesting (or at least vitable) - Social economy could be a solution, but requires funds (to compensate inefficiency of the labour) - Focus more on mutually beneficial partnerships *Some participants believe that primary materials will become so expensive (because of ressource depletion) at some point that this will be the real driver for CE* **Role of public authorities:** Subsidy/ project calls are crucial (to cover development costs and allow for experimentation) Make circular actions economically interesting

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		e.g. reward for repair in France Upv: charging more for circular purposes will open new possibilities
	Uncertainty of reuse: unique input (because of condition) and output. The current system obsessed with standardization has no room, no open mind;	
technical	- Lack of infrastructures (collecting, sortings, cleaning, repair), so everything needs to be developed/invented - Lack of know-how (has been delocalised)	**Generally:** Need to regain this know-how through experimenting Learn from people that still have this know-how *E.g. Cillab: working on industrialising the process (today semi-industrial at best). Have hired a syrian migrant that has a lot of expertise in clothing confection* **Role of public authorities:** (Fund) research and experimentation *One of the main actions of PA* - Need to set standards for quality and control
	Specificities of fast-fashion: huge volumes of 'unique pieces' (all in different conditions)	
	Recycling: still early-days and the quality is limited	

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	Importance of quality + difficulty of measuring it	
	Complexity of defining and measuring circularity/sustainabilities (many entrances/options) no/not enough structure and clarity → requires an tailored approach + even if they *know* how to get started, doesn't mean they really take action	**Generally:** - Create an internal service/ team for wokring out circularity action plan and/or hire a sustainability manager (but this is not possible for most SME's) - Resort to external service *e.g. centexbel, but more technical than business; federations* **Role of public authorities:** - Provide guidance and information *Close the loop, role of Flanders DC*
	Control and information: - No information/overview of textile streams (companies often don't know where the clothing comes from or what happens when they are thrown away)	**Role of public authorities:** Instaure effective control system (more than fees because for the biggest polluters this is not enough of an incentive) EPR: puts the responsibility of clothing during their entire life cycle with the producer of clothes
Legal/ public sector	Legal: - Belgian/federal complexity → waste policy and terminology varies (+ regional competence)	**Role of public authorities:** - Regulation and tax reduction will create positive spiral of change

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	- Lack of overall/general vision, focus on some parts more then others instead of seeing the textile industry as a whole (e.g. UPV - recycling) Slow process of legislation (especially on European level)	- Develop instruments in a holistic way, not only focussing on certain parts of the chain *VC is 'lobbying' to get other belgian entities on board*
Labour	- CE is Labour intensive: collecting, sorting, controlling quality, cleaning, repairing, upcycling (for every loop people are needed) - Lack of human capital can become a problem for the emergence of new business models	**Generally:** 3 visions to compensate labour shortage: 1. Digitalization and industrialisation 2. Social economy (but requires government funds to cover high cost) 3. Migration (mentioned by 2 people) **Role of public authorities:** Financial compensation for this: - Digitalization and industrialization: might save labour cost on the long term, but requires initial investment (which is often not possible for SMEs) - Social economy: need a (financial) compensation for limited efficiency of social economy (cf. Kringwinkel)
	Knowledge and skills:	**Generally:**

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	- Required skills are not new, but loss of knowledge (delocalized) - Circular transition within a business requires that the entire team is on board - difficulty of finding qualified personal - Startup owners need to have a wide variety of skills (management, textile, marketing,...) because they don't have financial capacity (yet) to hire a team	Change management, take it step by step, consult (constantly) with staff **Role of public authorities:** Training centra need to develop curriculum (VDAB, CVO) Are developing, first as an initiation, now as an extensive course, in the future as inherent part of textile trainings However, this was the initiative of one person, no structural vision Integrate it in formal school curricula so everyone has basic repair skills and to to change mentalities and behaviours regarding textile Change management is included in the Close the Loop trajectories
	Jobs and employment: New jobs and businesses: • overseeing the entire value chain • industrialisation as a result of upscaling • Transition consultants New skills and jobs (in existing companies):	**Role of public authorities:** Develop holistic vision in advance of what a circular system would need in terms of human resources and anticipate those needs (so it doesn't restrain the transition)

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	low-skilled: • repair services • take back systems high-skilled: • CSR/ sustainability managers • Coordination and ICT engeneers (especially if industrialization and digitalisation is to happen) Evolving jobs: • More detailed sorting and collecting → all these expected evolutions need to be anticipated, for circularity to become a systemic transtition, but now there is only awareness of these needs and no anticipation whatsoever	
	Training: - Generally trainings in textile (especially technical once) have become more and more rare - Syntra-PXL launched an initiation workshop that got very little interest	**Generally:** Question of vision: do you anticipate the circular transition and create trainings, or wait for circularity to be more established and the need for skilled labour to grow

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	- Most actors point out that circular textile training will be crucial, but no (or very little) actual developments - Circularity is not integrated in current fashion trainings and few people change their habits - Will require time and money, also mentalitychange - Top down imposition of new MO often doesn't work	- Integrate it in every fashion school, *vision kelly: start with separate training, and in the future integrate it throughout* - Get staff on board, change management, collaboration Cf supra: close the loop **Role of public authorities:** Integrate it in public schooling as well (cf. supra)

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7.2. Annex 3: Mettalurgy case study constraints and solutions

	Problem/critique	Solution/vision
Consumer	There is a lot of potential in urban mines, people are hoarding unused electronics at home	**Generally:** People need to bring in their used electronics (for repair, reuse recycling) and sort them correctly **Role of public authorities:** Communication campaign
	Consumers buy the cheapest products, which are often Asian. They don't care about buying sustainable metallic products.	**Role of public authorities:** Disencourage Asian imports, make sure upcoming legislation doesn't make competition with Asian market even more difficult
Private sector	Companies don't know how to communicate about sustainability (too much/not enough)	
	Progressif ideas come from individuals (that don't necessarily find an outlet in management). There is a need for a natural curiosity (that can't be thought)	**Generally:** Attract creative minds by presenting the innovations and challenges of the sector. Develop and promote sustainable and social values.
	Unequal playingfield: Small companies don't have ressources. Though there are multiple options for applying to funds, they often don't have the time/ressources. Big companies have more resources to capture funds. Big/powerful companies tend to form a tight network (RM eg) that is not accessible to all actors (ie smaller companies) "struggle to catch their attention"	**Role of public authorities:** - Orient research based on the needs of the (small) companies, map those needs *WIN4C: collaboration platforms to °research based on the industry's needs* - (Financially) support small companies specifically and make administrative procedures as light as possible *collaboration CW offers services to help apply for european funds (to help companies with limited resources)*

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	Contrasting visions: instead of spreading funds, funds should go to the 'biggest industrial and employment levers' → raises the question of where that is : some say big industrials, others new business models	
	Economic: - Eco rational prevails (over social, envir) + at the moment CE is still perceived as a risky undertaking - and reluctance to change of some - There needs to be enough mass/ big enough material streams to make recycling economically interesting (which again is a disadvantage for small companies that don't use a lot of materials/ use exotic materials) - Lot of the metallic products produced in wallonia are meant for export, which makes it more difficult to have a life cycle approach (repair, reuse, etc)	**Generally:** - Gain control over material (waste) streams *CRM (with help of public records) are currently mapping waste streams to get better insights* *massification will be part of next RM phase* **Role of public authorities:** - Make the laggards aware of the economic opportunities that circularity holds (energy and resource efficiency, secured access to resources, improved image, resilience,…), *is the approach of circular Wallonia* - Provide subsidy *Is being done by WIN4C and Circular Wallonia*
	Some parts of the circular chain are not present in wallonia (but exist in other regions) / some materials are not valued enough to be treated here	- Either create missing chains in Wallonia (but might not be relevant) - Create partnerships with existing chains elsewhere
	There are few recycled metal suppliers + economic rational = primary metal remains dominant In the best case, recycled materials are as expensive as raw materials, so then it only depends on the choices of the company (whether they value environment or not)	
	Very little awareness of CE and its merits + laggards are difficult to reach	**Role of public authorities:** Approach everyone individually / personally / offer individual

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	Supporting structures (like MecaTech) tend to work with companies that already have an interest in CE	guidance *priority for CW / pole meca* *FOF/ecofactories: diagnosis (7pilars), CIRCO*
	Companies don't have the know-how to integrate circular practices (improve social and environmental impact are usually the elements companies struggle most with)	**Role of public authorities:** Offer guidance *General approach of MecaTech: individual, talk everything through, take it step by step* *CIRCO: 3-day workshop to develop circular action plan (still developing)* *[note: no follow-up]*
	Partnerships: - locally: companies might take action internally but tend to work in their corner, though they might have complementary challenges + no real collaboration with public authorities - question of scale: metallurgy is such a big and international industry that talking about the Walloon scale is not very relevant, would be better to look at the european scale	**Role of public authorities:** connect the ecosystem: - locally *research on this* - international/transregional cooperation to create a value chain that is complementary and makes sense on european scale *cf WIN4C: create international network and gain visibility*
	Complexity and length of administrative procedures (to get funds eg)	**Role of public authorities:** Administrative procedures and call for projects need to be accessible
	CE often reduced to recycling, little attention to other practices	**Role of public authorities:***Win4C and CW are aware of this and agree that we should go beyond that (but how…?)*
Technical	There is a lot of focus on innovation in the *processes* and not so much in the entire life cycle	**Generally:** Need for a holistic political vision Need for new 'coordinating' functions, that look at the entire value chain

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		upcoming european CSRD (Corporate Sustainability Reporting Directive) legislation will generate more transparency on entire life cycle and composition
	For big industries reconceiving design (ecoconception) represents a big change on the entire production process	**Generally:** *Pole Mecatech focuses more on SME's when it comes to econception*
	Recycling has its limits. - today the sorting is still pretty 'rough' - there are always losses 'through delusion' in the recycling process; so they are not endlessly recyclable. To guarantee the quality of (some) recycled metals some amount of raw material has to be added 'we will always need raw material' 'a future without mines is delusional' - More and more heterogeneous/complex products that are difficult to disassemble - To recycle metals a lot of energy is needed, in some cases even more than for primary production. If you bring back metal to its elementary state, all the energy that has been put into making it a finished product is lost and has to be done again.	**Generally:** - Technologies to finetune the sorting process should be developed *eg research projects (like GRAAL and RM)* - Push the notion of ecoconception to create the possibility of disassembly beforehand - Create partnerships between these different value chains (eg polymeres and metal)
	- Difficulty of actually implementing projects (lot of objection from local population, lot of conditions to fulful) eg project GRAAL has been looking for a location for 2 years	**Generally:** - Need to change the image of the industry so the local population is more receptive of new projects
	Vagueness of circularity: doesn't have concrete indicators/measures	
Legal/ public sector	Legal: - environmental legislation doesn't apply to foreign countries, so there's an unfair disadvantage	

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	If not mandatory, companies won't make the change voluntarily (metallurgy is a conservative sector) Lot of research, but no impact (yet) on the field	**Role of public authorities:** Make CE mandatory through regulation (eg EPR, developing criteria,...)
	Competitivity pole exists for 20 years, is it still as efficient as it could be (regarding the other big structures that have been created in the past years)?	Need to evaluate and possibly adapt the big structures to create a coherent whole
	PA have a big source of unused data (on waste)	**Role of public authorities:** Use this data to make analysis, map the material streams and make policy accordingly
	Most of our metallic waste is exported (to be sorted by cheap labor) + poses the problem of semantics of waste and how its definition determines policy (across boundaries): currently what is considered waste is not the same in belgium as in france (which makes closing the loop more difficult)	**Role of public authorities:** Exporting waste should be forbidden, it should be treated (and regulated) as a resource Push for a coherent and conformer legal framework for the entirety of europe
Political	Disagreement between some industrials (that are proud of current situation) and political (that is more recent and who's ambitions are seen as unrealistic by some industrials) incoherence of political discourse: - pro circularity, but reluctant to talk about waste - ambitious, but not realistic (because the production process is long and complex) - vision of green high-tech future but no valorisation of metallurgy	**Role of public authorities:** Political decisions need to be anchored in empirical data + cf supra: important to include/consult stakeholders in the elaboration of plans; create partnerships

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	Lack of acknowledgement of the strategic importance of metals in our society	**Generally:** Metals (and metallurgy) should be revalorized in society and general culture (through television, communication) **Role of public authorities:** Communicate on the importance of metals for society
Labour	Lack of interest of the general population in metals and metallurgy leads to… <u>Labour shortage</u>: - Because of bad reputation (polluting, declining, arduous working conditions) very little interest, which hinders innovation (and digitalization). Generally seen as one of the biggest challenges of the sector. Fragmented sector, lack of overview (which is needed to 'close the loop') <u>Trainings</u> RM developed a new master program, but generates little interest (especially from belgian people). Generally speaking a lot of trainings have idssapeared because of lack of interest Fewer and fewer enrollments in metallurgy training. The few people that are enrolled are mostly interested in the high tech parts, not in the 'traditional parts'/ the production process itself	**Generally:** Change bad image: improve working conditions and salaries Robotization, which still requires some monitoring (which are 'high added value jobs' *cf reverse metalllurgy* Need for coordination jobs, to overview entire value chain (and even across value chains to get a holistic vue) **Role of public authorities:** Need to change bad reputation and revitalise it (should be up to PA because if the sector does it itself, they will be accused of lobbying/propaganda) - Valorise and promote metal (and metallurgy) and the jobs in the public space
	<u>Knowledge and skills:</u>	**Role of public authorities:**

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	Are disappearing Circular (coordination) jobs will most likely be ICT : internal changes might be disruptive for personal + if the employees are not behind it it won't work "the humans are the main drivers for innovation"	*biggest motivation for circular agenda is to revive the economy and (partly) compensate disappearing jobs* Train current personal to update knowledge (instead of hiring new), but do it in a way and pace that is adapted to their capacities (need staff that is openminded, flexible, resilient) *Pole Mecatech/ CIRCO: empahsize the importance of change management, integrating staff etc*
	Recycling is part of existing curriculum, other circular concepts are not	**Role of public authorities:** Integrate other circular notions in curricula
Research	Lots of (funds for) research, but doubts about actual implementation (of these innovations). Critique of little follow-up or efficiency evaluation	
Generally	Triangle of responsibility: private sector x public sector x consumer, all point at each other to initiate change	

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7.3. Annex 4: Construction sector constraints, visions and solutions

	Problem/critique	Solution/vision
Clients	The economic rationale prevails, so except if there is a specific demand from the client, constructors won't make the change.	**Generally:** Private companies should propose sustainable/circular alternatives to the clients (to create a demand). **Role of public authorities:** Cf. infra: create a circular demand
Private sector	Legal framework/ high standards are perceived as a constraint by the sector If legislation is too disruptive it won't work, the private sector won't accept it (especially since they already see regulation as a problem)	**Role of public authorities:** Improve communication of PA to promote the stakes and values that are behind CE (namely: contributing to a better world) Take it step by step, start out with (financing) pilot projects to develop best practices and work from there *Reuse strategy of BE:* 4. *test phase of voluntary projects, with financing and guidance (incentives, tools like be circular and renolab)* 5. *training* 6. *(to come): °realistic regulatory obligations based*
	Construction is a conservative sector and economic rationale prevails: - Reuse is labour intensive, thus expensive (and lots of companies don't have the resources to make changes, cf. infra) → business as usual	**Generally:** - Frontrunners see the advantage of anticipating legislation and progressively make changes (adapted to the pace of the company) = set an example - Economic value of waste should change, it should be seen as a

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	- If companies wait for policy makers to make it mandatory it will create a lot of pressure, probably will be expensive and require external help (of consultants) - Some materials are not considered valuable enough today to take the time to recover them	potential resource and therefore become more expensive (and profitable) **Role of public authorities:** - Make second life materials more economically attractive, eg by reducing their VAT rate - Start with a 'protected materials' list and gradually increase it according to the pace that fits the sector
	Unequal playing field: - Very large, unavoidable companies - (Very) small companies A lot of (small) companies don't have the resources to make changes. Given the tight budget of most projects, there is no room to make sustainability priority	**Role of public authorities:** - Offer financial support mechanisms
	Divergent visions: - Need for standardisation: Circularity is a vague concept. There are a lot of visions, understandings, but no real indicators, strandards, thresholds This also increases the risk for greenwashing Lack of labels and assessment models, so though there is an interest from PA, it is not translated (yet) to practical impacts	**Generally:** Reuse used to be a common practice, that was up to the know-how of the constructors. We should redevelop this know-how and rely on the expertise of constructors to assess the quality of dismantled materials - Need for flexibility, in way of working and time **Role of public authorities:** - Create clear guidelines

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	- Standardisation doesn't work for circularity: Current system and way of thinking is accustomed to standardisation, while with circular economy every product is unique, singular Labels and guarantees don't exist for second life materials (e.g. energy efficiency) Uncertainty is part of disassembling: technical features of the material, time it takes, loss rate etc. This uncertainty is difficult to apprehend/ integrate Additionally, the bigger the project the bigger the uncertainty and its costs Companies are responsible for their buildings, they rely on the quality of their products. Assessing/knowing the quality of second life products can be difficult when its history is unknown	
Technical	Small scale pilot projects (like be circular) don't manage to become mainstream/ achieve a bigger scale Some projects are huge, which makes circularity much more difficult	**Generally:** Possible solutions (but doesn't comment on them): - Equip small structures so they can collaborate on big projects - Avoid/forbid (?) big projects because they are incapable of using 'unique' circular approach
	There is no efficient inventory of building materials, no data	**Generally:** a good/quick inventory is needed that collects all the data/ maps the urban mines (cf MP)
	Stocking material uses up a lot of space, which is difficult and	**Role of public authorities:**

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	expensive in a city (like Brussels)	Create small drop-off centres for second life materials with on-site sorting and recycling in the periphery of the city. (opportunity for PA since they own a lot of real estate) *urban mining strategy*
Legal/ public sector	Gap between sustainability discourse, but in in public construction and legal framework sustainability is still limited to energy efficiency of a building and not the materials that are used (and therefore not circularity)	**Role of public authorities:** Prioritise material reuse (especially as tenants)
	Incoherence in vision: construction and architecture is seen as ongoing transformation and progress, instead of really long term, multiple use vision	**Generally:** Change vision to a long term (sustainable) vision of construction, where buildings are built to last, and to be renovated every few years
	Circularity is still very niche. Laggards are more difficult to reach/see by PA (so they might not have a complete vision of the situation	**Role of public authorities:** *BE and Embuild are trying to create such a network*
Labour	<u>Impact on jobs</u> Generally: mass renovation is needed (because of energy transition) Regarding CE: entire reuse operation consists of a lot of steps/ takes and take a lot of time: dismantle, check quality, clean, inventorise/document, ⇒ there is a big need for labour Especially for multiskilled workers - engineers - executive jobs	**Generally:** - automatization - Improve quality of the companies, and working conditions/ wellbeing / safety at work - Offer on-site and worklinked trainings - Attract people that look for a career change - Promote a better image of the sector (and show that it is not just heavy dirty work, but also high skilled jobs)

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	° New jobs: - Reseller, - Dismantler, - CE expert/advisors that offer vision, advise and tools (more transitional/ temporary because in the end projects remains up to architect and clients) - Intermediaries: that connect bottom and top of the process - Inventory expert New job that would be needed, also means that more people are involved in projects which makes decision, discussions, coordination more difficult <u>Problem: Labour shortage</u> (especially engineers) - Wages have become better in other (European) countries so there are less construction workers that come to belgium. - Bad image: because of poor or even unsafe working conditions (bad salary, long hours, arduous work) - Skill loss because of turnover	*renolution*
	<u>Skills</u> Cf. supra: the implicating more actors makes decision making more difficult Loss of know-how (since reuse used to be the norm = exnovation) Standardisation of the sector over the years has minimised the	**Generally:** There is no need for additional actors, but for additional jobs and skills. So it is rather about evolving jobs: current fieldactors (i.e. architects/ property managers) need to acquire new skills and habits (e.g. inventorisation). *specificity of this sector: not very structured process, usually a few*

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	'human' aspect to it. So a lot of loss of know-how and confidence in the expertise of builders <u>Sought-after skills</u> (generally) - adaptability (being able to addapt to constant change) - versatility (innovative mindset: anticipate changes) - digital tools - intellectual skills (management positions eg, not only practical skills)	*actors that have a variety of skills and responsibilities (and new ones could be added to this)* However, you need to take the time and think the project through and better connection between different actors and stages
	Lack of connection and overview of construction process/ logistics chain, at the company level; circularity requires more planning and logistics	**Generally:** - Need to take the time to think about the circular opportunities of a project in advance - Need for more coordination and dialogue throughout the process and with the different actors involved
	<u>Training</u> - Trainings today are not standardised, so a discrepancy arises between those conceiving the project and those carrying it out - Construction culture is not big on training, don't offer them themselves and aren't very interested in the trainings offered by PA. - Some trainings offered by public institutions are too 'intellectualised' and for off on-site experience	**Generally:** - Need for 'classic' training (in school and on-site training), blend theory and practice - Trainings should be standardised Versatility: construction school should develop a vision of life long learning (and not a one time starting point)
	<u>Working conditions</u>	Relearn old practices and skills can be more pleasant and more

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	Some current materials and practices are unpleasant or even dangerous to work with	rewarding

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