Working towards the circular society

An explorative study on the barriers and drivers of (sustainable) urban manufacturing in the Metropol Region Amsterdam

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Urban manufacturing…

'… like in the old days, a woodworker in the city, a specialist baker, the small scale,
that makes the quality of life so much better…

… Because that makes us all very happy in the end.'

[Interview 5].

Preface

The way urban planning globally is carried out over time has changed many times and always will continue to do so I believe, which is one of the main reasons that make this a discipline that will always remain interesting for me. I sincerely hope urban manufacturing becomes part of the agenda of many cities as one of those changes, in a just way. My perception of urban manufacturing and their place and function in cities has changed continuously during this research, in which I have come to the conclusion, when looking at the results of this study, that they are a often indeed an overlooked industry. I do not envision factories from the past to return to take place into cities, hence, a rather diverse and modern urban manufacturing industry would make many cities more appealing, interesting and functional places again. Thereby, the transition towards a circular society would also have a great boost, in which I have learned a lot through this thesis and have become also more realistic. I have focussed on the circular economy as the main theme, hence, I wonder if I truly understand all its possibilities better myself. One of my personal recommendations for all involved in promoting and fostering circularity, which I already envision and apply in my daily life, is not to speak about the circular economy anymore, but, to speak about a circular society. I believe circularity is and should be beneficial for society socially and environmentally. Overall, the most important thing that I have learned is that there is so much more to be learned.

Furthermore, what I have learned is that I would never conduct a thesis again during a pandemic. This period has proven to be very challenging to me, mostly only being able to study at home with extremely limited contact with other students, something I always have enjoyed very much as part of being a student. I, therefore, want to thank all students and teachers that inspired and helped me throughout my educational career. Also and foremost, special thanks to my supervisor, Jochen Monstadt, for sharing many words of wisdom and who supported me during this period which I found very difficult, and made me smile at my computer screen every time we met. Also many thanks to all the respondents for sharing valuable information and participating in this research. I also want to thank my colleagues at Platform31 for many tips and tricks, whom I have met as part of an internship at the same time as this research, and thereby especially Barbara Heebels, my internship supervisor who learned me a lot.

And, last but not least, I am very fortunate to have people in my life who always have supported me throughout, without them, this journey would not have been possible. Therefore, I would like to express my gratitude towards them here.

I hope you enjoy reading this master thesis,

Liam Yung, 2021

Abstract

This research explores which and how certain barriers when implementing circularity apply among urban manufacturers in the Metropol Region Amsterdam and if and how intermediaries can be of support and effective in overcoming them. The circular economy is currently a trending but also complex topic among researchers and (city) planners and is seen as the next sustainability paradigm in overcoming many contemporary (urban) problems. If thoughtfully and thoroughly applied and implemented, the circular economy could benefit society socially, financially, and, most importantly, also environmentally significantly. The circular economy, however, still is not widely implemented and accepted across all sectors and parts of the world, although it is argued for by many. This also applies to urban manufacturers in the Metropol Region Amsterdam, where it appears that they are restricted and slowed down by several barriers when adopting principles of the circular economy and implementing circularity. While the results of this research also revealed there are also many hints several urban manufacturers in the Metropol Region increasingly are implementing circularity and also a few advanced examples can be found throughout. This has become clear through semi-structured in-depth interviews conducted with urban manufacturers as well as a few involved intermediary actors.

Thereby, it has become clear that sustainability by several urban manufacturers still often is considered as a 'costly hobby' which is blocking the implementation of circularity, where it was indicated that as well among the majority of consumers the dominating current economy is still ingrained. Therefore, cultural barriers overall, which seem to be hindering the acceleration towards the transition of the economy, need to become overcome in the first place.

Hence, this still seems to be a very complex task and the results of this research confirm that the mandatory change in the mindset of consumers as well as for the majority of urban manufacturers to accept and understand the circular economy, still will require several years or decades to take place. With the right guidance of intermediary actors that interfere in the right place at the right time, which have proven to be effective in stimulating and accelerating (sustainability) transition elsewhere setting things in place, this change could take place much earlier.

Urban manufacturers thereby could in the Metropol Region Amsterdam could be supported and facilitated through specific intermediary activities, to contribute to the different benefits of the circular economy and the city. As in the Metropol Region Amsterdam, they appear to be fragmented and are being pushed out towards more suburbanized and rural areas and within cities towards isolated business parks, as they increasingly become endangered by other necessary urban developments. Thereby, aligning and connecting actors and possibilities seems to be the foremost logical activities to carry out, to achieve a (more) sustainable manufacturing industry in the Metropol Region Amsterdam. And, overall, awareness should be spread concerning the circular economy, and, urban manufacturers thereby should no longer be seen as a niche industry, but, as an essential function that besides contributing to the circular economy, also could contribute to cities in many ways, such as offering jobs and increasing liveliness and vibrancy. This research aims to contribute to the acceleration of the circular economy through a better understanding of urban manufacturing nowadays and to make policy-makers and (city) planners aware of the (hidden) potential of urban manufacturers.

Keywords: Urban manufacturing, Circular economy, Circular society, Intermediaries, Metropol Region Amsterdam

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1. INTRODUCTION

In the last couple of decades, it has become evident that current urban economies have to change to keep cities functioning and livable, as they are expected to increase in population globally increasing energy and material consumption (Fusco Girard & Nocca, 2019, p. 1071). The circular economy (hereafter, CE) is therefore seen as the next sustainability paradigm, to overcome many (urban) challenges, to decrease energy and material consumption, by doing more with less to (Cramer, 2020), when thoughtfully implemented. Urban manufacturing (hereafter, UM) could thereby, directly and indirectly, benefit from and contribute to the CE, hence, they are increasingly being disconnected from and fragmented within urbanized areas. Intermediaries elsewhere have proven to be very effective and useful in other cities and regions in combining them; to promote and foster a circular manufacturing industry. This, however, is not always seen as a matter of fact, due to many stranded assets and actors that (therefore) purposively are less aware and motivated to cooperate. The CE and its potential is, thus, not always realized or obvious for many. Furthermore, it is also considered a highly complex topic, due to the many different ways circularity is and could be achieved and the many different held definitions and views. Amsterdam is also increasingly becoming more densely populated, where the current housing shortage is still above national averages, affordable housing is scarce and waiting lists for lower to middle-income tenants are long (Gemeente Amsterdam, 2018). Hence, a historical housing ambition is set to meet this shortage (Gemeente Amsterdam, 2018). Other essential functions for a growing city, such as places for (public) green space, businesses, and different kinds of infrastructure also need to be incorporated but have to deal with a historical ambitious housing plan, that the municipality of Amsterdam currently has. Urban planning and especially mixed land use thus become a complex matter, but, is also considered essential as it contributes to the liveability of places (Singh *et al.*, 2017). Mixed land use instead of single-use developments and areas is a policy already widely advocated in North American cities, where, for example, it is argued that it contributes to creating diverse cities, reduces sprawl and increases density (Moos *et al.*, 2018). It is also argued that having a diverse city by mixing of uses contributes to 'The Walkable City' (Bossuyt & Savini, 2018) and when planning the 'Circular city', the proximity of especially producers (i.e. manufacturers) are essential as they compress urban footprints by reusing goods and services (e.g. remanufacturing and 'urban mining') (Lane & Rappaport, 2020).

'Sustainable cities need space for businesses' (Ploos van Amstel, 2020) was therefore advocated in this regard, as cities often have the habit to meet the demand for housing by developing former urban sites of (heavy) industries. Remaining businesses often do not have space or capital available to expand and eventually move out or are urged to change due to the many restrictions to be able to blend in into new neighbourhoods and developments. Constantly pushing business out of the city into business parks near or at the edges of the city, by replacing them with mainly housing and service orientated business developments, has several drawbacks. Urban manufacturers (hereafter, UM), when being pushed out, thereby, become fragmented socially and physically. They become socially fragmented from cities and citizens who become less aware of their existence and benefits, as they are not included and no longer appear directly in their daily lives and routines. They also become physically fragmented, which hinders the deployment of sustainable (electric) transportation and resilient infrastructure (Juraschek *et al.*, 2018). The general accessibility of workers (often relying on public transport, especially in cities), and bundling supplies as businesses that rely on each other or seek collaborations, also become challenging, as UM are being pushed out of the city and away from each other with increasing distances (Ploos van Amstel, 2020). Moreover, it becomes more difficult to engage often and directly with customers (and other businesses) directly, as UM become less visible hindering interaction and awareness; UM need cities and vice versa. Lester et al. (2013), furthermore, state that 'restructuring of urban economies away from manufacturing' results in highly bifurcated

labour markets and besides this will continue to vex planners to the question how much and why industrial land should be preserved, a discussion that was 'waxed and waned over the past 30 years' (Lester *et al.*, 2013, p. 295). Although, outside cities, there is also more space, more assurance to stay longer and fewer restrictions for businesses.

Consequently, in densely populated cities, such as Amsterdam, where space is scarce and costly, especially places of production are forced to change, for different reasons. Such changes due to workplaces becoming smaller in size in itself and where the amount of suited workplaces decreases, include improvement of efficiency with new techniques and by combining processes. However, especially SME's do not have the capital to do so but also safety and overall quality could decrease in this case (Heebels & ten Kate, 2019). Suchlike changes also include adaptation to new and other demands that arise, and due to intrusive regulations. Such as the need and demand for clean production and high quality and sustainable (i.e. circular) products and services due to changing lifestyles of consumers and policy interventions, such as the Dutch national ambition related to the CE. UM in the Metropol Region Amsterdam (hereafter, MRA) in this regard already started to change and primarily face two interrelated problems: to be able to sustain as a sector in cities and to thereby find suited workplaces (near each other) and to adapt to new and other demands and trends, especially to integrate circularity. Intermediaries can hereby play a multi-faceted role; for the CE itself, as pointed out that in the first place the CE requires innovation, wherein not every company is (willing to) realize this, nor the potential of the CE. Intermediaries are additionally of value, since UM as describe above, are being pushed out and replaced. Thus, fostering and promoting circularity among and between UM in the MRA requires better coordination and a suited and efficient infrastructure, in which governments, as well as businesses in comparison to intermediaries, become increasingly less familiar.

1.1. Problem statement

First of all, much appears to be unclear and uncertain about the applicabilities of circularity among different sectors and regions, also among UM in the MRA, and especially those smaller in size. While larger manufacturers located in often secluded and less urbanized areas, however, prove that circularity could be achieved, often with the support of intermediary activities. Intermediaries have a long history of accelerating innovations within and across sectors, and, have proven that they can help to overcome many and different barriers. Also, key barriers for implementing circularity have been identified and described, but, not specifically and in-depth yet among UM. Similarly, the specific needs and requirements of UM in the MRA to be able to transform towards and contribute to a sustainable (i.e. circular) economy without affecting the livability of surrounding areas, are unclear. Several researchers have, hence, recently looked into and proven the potential of intermediaries related to promoting and fostering sustainability. Such as their contributions to organizing open sustainability (Patal et al., 2017), the roles of intermediaries in (sustainability) transition processes (Van Lente et al., 2003), and the different functions and institutional setups of intermediaries (Kivimaa et al., 2019). But, it is only recently that several researchers have started to describe and explore through which activities intermediaries exactly foster and promote sustainability transitions and cohering necessary (technological) innovations. Despite the few relevant studies and different contexts, however, the outcomes hitherto show in general what should and is done and between whom.

Lastly, there are also many researchers doubting if and how UM should even coexist within cities, how such a co-existence can be maintained in the long term. And how they hereby can work *with* instead of *for* each other (Clark, 2014) and can contribute to the CE. Overall, it is unclear how the future of UM in the MRA, and especially in highly urbanized areas looks like. As other and new developments that are also essential for the city, as in many other growing and expanding cities, also need to be fit in.

Therefore, this research focuses on the one hand on which and how key barriers for implementing circularity apply to UM in the MRA, which could further accelerate the transition towards the CE. On other hand, it takes a closer look at the position of UM in the urban fabric of a growing city and how this altogether could be stimulated without affecting the liveability of the city. Thereby, the roles and activities of intermediaries at both will be examined, especially to explore between whom the abovementioned activities are necessary.

1.2.   Aims and objectives

This research aims to better understand how key barriers of implementing circularity, apply to UM in the MRA; to see how such barriers apply to UM in different places and stages, to further accelerate the transition towards the CE. The common factor of the examined UM is that they all are situated in the MRA. Subsequently, as not all UM in the MRA are at the same stage in becoming more circular, this research thereby intends to include and examine highly developed manufacturers in terms of visions and implications related to circularity, as well as to include and examine how 'less potential' or visible practices (could) develop. Therefore, a wide variety of UM is intended to be examined. Thereby, it will be examined how and when certain possible barriers may apply that restrict or slow down (sustainable) UM, and, to find out who or what is or was needed to overcome them, to see if intermediaries, as elsewhere, could play a key role and which one(s). This research, however, is not designed to point out a specific actor or sector as a key intermediary, as this could lead to the perception that some actors or sectors are less or not important. Some actors and sectors indeed will be more directly relevant, but circularity, as abovementioned, is achieved and interpreted in many ways and sectors, and, therefore, solutions should be sought widely.

First, existing literature will therefore be examined to better understand the abovementioned topics; the CE, UM and intermediaries. Thereby and foremostly existing literature will thereby be looked into and used to underline the importance and benefits of (sustainable) UM, how it is understood and defined, and to look into its contribution towards the (circular) city and vice versa. The concept of the CE itself has already been researched widely, and, hence, a thorough investigation on related concepts or a comparison of different used definitions or bringing up an own definition is explicitly excluded from the literature review. On the other hand, however, a general understanding by looking into the 'basics' of the CE, and especially the outcomes when projected on a city-scale will be examined briefly. Lastly, intermediaries will be looked into, how they relate to thrive (sustainability) transitions and some of their role(s) and activities to have a better understanding of their function(s).

Besides the societal benefits of the return of manufacturing and a sustainable (i.e. circular) UM industry, this research fits in the recommendations of several previous related studies, filling in different research gaps. For example, it is stated that research could focus on 'what kind of intermediation takes place and is required in the acceleration and embedding phases of transitions' (Kivimaa *et al.*, 2019, p. 1073) regarding sustainability processes. Clark (2014) states that there is an empirical challenge for researchers in understanding 'the landscape of small manufacturers - their composition and their variation' (Clark, 2014, p. 436). Furthermore, and central to this thesis, this research draws on the recommendation of Kirchher et al. (2018), that state that exploring barriers for the CE among specific sectors helps to 'further refine the theoretical framework that we present in this study while providing additional insights for policy-makers regarding suitable interventions to accelerate a transition towards a circular economy' (Kirchherr *et al.*, 2018).

1.3.   Research question

Following the problem statement and the research objectives, which is aimed at better understanding how and which different barriers apply to UM in the MRA, this thesis is guided by the following central research question:

What are key barriers that restrict or slow down (sustainable) urban manufacturing in the MRA and how can intermediaries help to overcome them?

To be able to provide a clear and complete answer to the main research question, several following sub-questions are formulated, which are the following:

1. *Which key barriers apply to different urban manufacturers in the MRA that restrict or slow down their transition towards a sustainable or circular economy?*
2. *How are those key barriers in the MRA between urban manufacturers and concerned actors as well as among urban manufacturers themselves addressed?*
3. *Through which activities can intermediaries further effective encourage and accelerate different urban manufacturers in the MRA in their transition towards a sustainable or circular economy?*

The first sub-question is aimed at identifying which barriers that have been presented by Kirchherr et al. (2018) may apply to different UM in the MRA, and will be used as a basic framework. It will be investigated to which extent certain barriers may or may not apply in practice. The second sub-question intends to look into how and between whom key barriers are overcome, to explore whether and how intermediaries have played or play a role in overcoming such barriers and thereby which activities are seen as the most valuable assets. The third sub-question is aimed at better understanding what is essential in becoming (more) sustainable or circular among UM in the MRA, but also, what thereby is expected and required from intermediaries regarding ongoing urban changes and trends.

1.4.   Societal and academic relevance

The societal benefits of a CE are widely researched and addressed among different academic fields and practitioners. Besides the environmental benefits (e.g., reduced resource extraction, limited landfill and minimal pollution) (Remøy *et al.*, 2019), there are also economic and further societal benefits of a CE, such as good health and new and decent jobs (Fusco Girard & Nocca, 2019; Gemeente Amsterdam, 2016; Turcu & Gillie, 2020), the economic benefits are mostly of focus. For the European Union, current estimates indicate (or foresee) economic growth of around € 550 billion and the creation of 2 million new jobs are produced when adapting to a CE. New jobs, specifically related to circular UM, are linked to new kind of workers, that roughly can be divided into two groups, that will be increasingly essential. Firstly, it is expected that more jobs will arise for skilful and highly-educated workers that are required as true sustainable UM will use and adapt to new and advanced technologies and processes (Juraschek *et al.*, 2018). Secondly, it is also expected that the return of manufacturing will increase the demand for workforces for simpler (re)manufacturing activities, that can be filled by people with poor job prospects. The latter is not particularly tied to manufacturing, but to the way of thinking in a CE, where not only products but also human capital is considered more valuable.

Also, it is expected that UM benefits society by providing workshops and training nearby, enhancing people's awareness of where and how things are made and getting more people involved in recycling (Unterfrauner & Voigt, 2017). This often happens as a bottom-up project in itself (Gemeente Amsterdam, 2020), within the so-called 'repair-café', where consumers bring in their products to be repaired with help or even by themselves (Unterfrauner & Voigt, 2017). Already more than 20 repair

cafés have opened in Amsterdam, where they are mentioned by the municipality of Amsterdam in their strategy related to improving the CE (Gemeente Amsterdam, 2020).
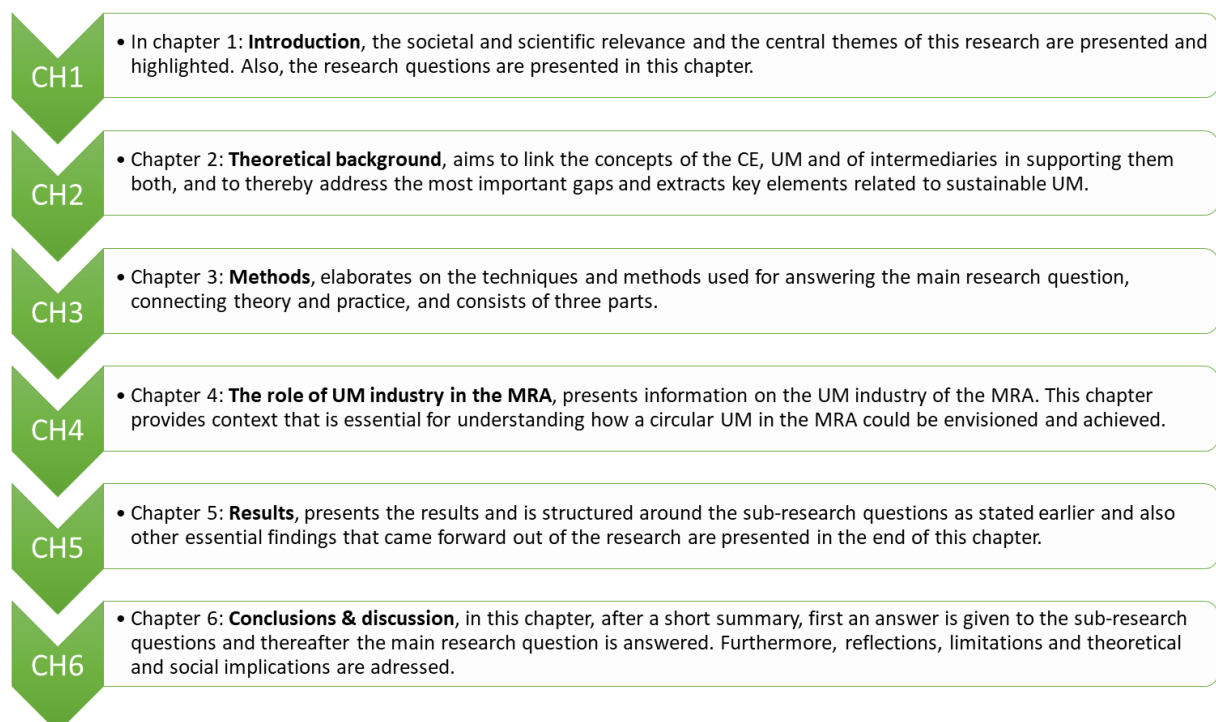
Benefits for society specifically related to the return of UM, are related to enhanced awareness directly and indirectly and liveability of places as they contribute to lively neighbourhoods and the reduced travel time of workers, making flexible working optionable (Singh *et al.*, 2017). With the proximity of (re)manufacturers, engagement with customers in general also becomes more accessible.

On the other hand, it should also be questioned if these findings are true, as a fully complete CE (as far as circularity can be complete) does not exist or is not established yet and there is also no consensus on when and how that will be achieved. Turcu & Gillie (2020) state in line with this assumption that the limitations of the CE approach for cities are only discussed by a handful of studies, let alone specifically for UM in the MRA. However, expectations, in general, look more optimistic and jobs will most certainly arise in general when adapting to the CE, but also 'old' jobs related to the existing urban economies of nowadays, the linear economy, will disappear (which possibly could be translated and changed to more circular ones). A remark should also be made regarding awareness, as makers still mostly are situated in less visible places and buildings and prime locations are hard to maintain for manufacturers.

Lastly, this research directly contributes to voicing UM smaller in size and many sole proprietorships, that often feel overlooked by policy-makers, especially within new developments where there is often less place for them. It also provides an insight on what UM in the MRA thrives and highlights the diversity of different kinds of manufacturing, and contributes to the discussion of the preservation and the return of visible manufacturers in cities and diversification of functions.

1.5. Reading guide

This research is structured as follows, chapter by chapter;

CH1
- In chapter 1: **Introduction**, the societal and scientific relevance and the central themes of this research are presented and highlighted. Also, the research questions are presented in this chapter.

CH2
- Chapter 2: **Theoretical background**, aims to link the concepts of the CE, UM and of intermediaries in supporting them both, and to thereby address the most important gaps and extracts key elements related to sustainable UM.

CH3
- Chapter 3: **Methods**, elaborates on the techniques and methods used for answering the main research question, connecting theory and practice, and consists of three parts.

CH4
- Chapter 4: **The role of UM industry in the MRA**, presents information on the UM industry of the MRA. This chapter provides context that is essential for understanding how a circular UM in the MRA could be envisioned and achieved.

CH5
- Chapter 5: **Results**, presents the results and is structured around the sub-research questions as stated earlier and also other essential findings that came forward out of the research are presented in the end of this chapter.

CH6
- Chapter 6: **Conclusions & discussion**, in this chapter, after a short summary, first an answer is given to the sub-research questions and thereafter the main research question is answered. Furthermore, reflections, limitations and theoretical and social implications are adressed.

2.   THEORETICAL BACKGROUND

In this chapter, the relationship between (public) organizations and businesses in steering sustainable transitions and the role of intermediaries in accelerating them is discussed (i.e. the integration of circular UM). Firstly, the theoretical debate on the definitions and meanings of the CE focusing on how it is perceived in the present day and the uprise and implementation of the concept of the 'Circular city' is examined. Secondly, UM, in general, will be explored, (the uprise of) different types of UM and the ability and need to adapt to principles of circularity and how this accelerate the transition towards it. Finally, several types, roles, and capabilities (i.e. performed activities) of intermediaries and especially of innovation and transition intermediaries are examined.

2.1.   *Understanding the circular economy*

The concept of the CE has increasingly been researched by many different disciplines and schools of thought, indicated by the rapid growth of articles in recent years (Geissdoerfer *et al.*, 2017, p. 176; Prieto-Sandoval *et al.*, 2018), with a focus on China mainly as a result of the "Circular Economy Promotion Law of the People's Republic of China" (Lieder & Rashid, 2016). This has led to many different meanings and definitions on the CE, and also several specific studies that have examined and compared them, where a study by Kirchherr et al. (2017) found and compared 114 different definitions. As a widely or globally accepted understanding of the CE is not available (yet) (Yuan *et al.*, 2008), the following definition, as proposed by Kirchher et al. (2017), will be adopted in this research;

> *''A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating 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, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations''* (Kirchherr *et al.*, 2017, pp. 224-225).

Kirchherr et al. (2017) found that in the past years, several other studies also have been reviewing the many different definitions of the CE. These studies focused on conceptualizing (i.e. organizing and understanding) are necessary, on the one hand, according to Merli et al. (2018), as it might be argued that a (too) narrow definition is not suited for a concept which aims at establishing a new socio-economic paradigm, and an overly narrow understanding ''… would harm such an ambitious vision' (Masi *et al.*, 2017, p. 18). These explorations and adding of new terms and rules may decelerate the transformation from a linear economy to CE and accelerate the idea that the CE is just another umbrella term and buzzword. While, on the other hand, the lack of a common, shared and clear definition could lead CE to a conceptual deadlock or lack of 'conceptual validity' (Hirsch & Levin, 1999). One can, therefore, say with certainty that the CE is a much-discussed and still complex topic and concept, and the possibility that related debates will occur in the future, is inevitable, according to Blomsa & Bergsma (2017), according to the typical trajectory of umbrella concepts. That the CE is an umbrella concept becomes evident when comparing and contrasting various frameworks in which circularity plays an important role (Blomsma & Brennan, 2017). Lastly, it is found in practice that the CE is and can be defined in different terms and becomes more ambiguously described depending on the amount and variety of stakeholders involved, as shown in figure 1.

Many also still consider the CE to be at an early stage for a transition, such as Ghisellini et al. (2016), stating that the CE and related solutions do not necessarily have to be efficient in its early stage, relating to the poor efficiency of the first steam engines that powered the UK industrial revolution for example. Also, Fusco & Girard (2019, p. 2) state that we are only at 'the beginning of this journey'.
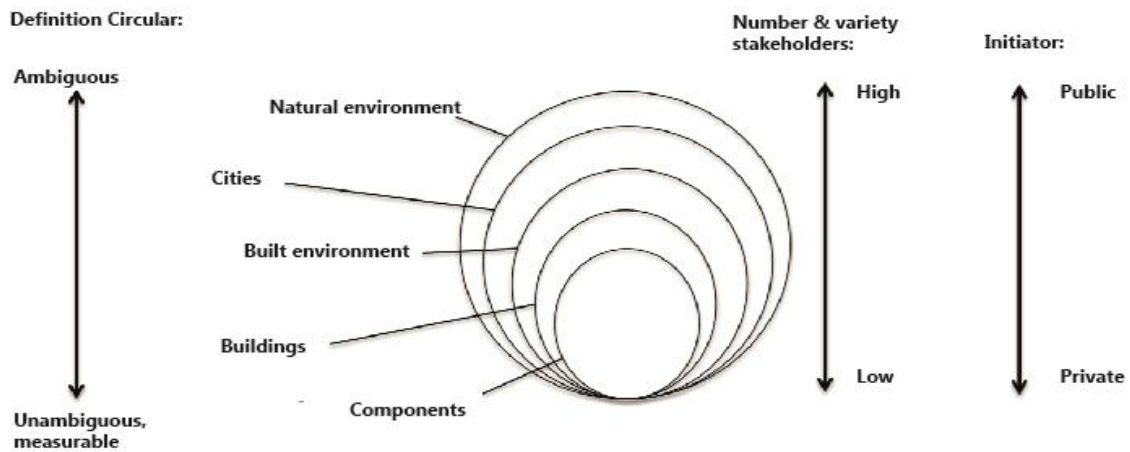
Figure 1. Defining what is 'circular' becomes more complex and ambiguous depending on scale, number and variety of stakeholders and if initiated by public or private actors. Source: adapted from Platform31 (2019).

Regarding the concept of the CE itself regarding its principles related to sustainability, many have argued for the CE as the new sustainability paradigm, and that it is, therefore, viewed ''… as an operationalization for businesses and cities to implement the much-discussed concept of sustainable development'' (Homrich et al., 2018, p. 534; Kirchherr et al., 2017, p. 186; Prendeville et al., 2018, p. 186). Businesses may, thus, seem to be (overly) actively involved in circularity-related activities, but may just be in it for their 'corporate responsibility' which in essence is a mask where behind 'business as usual' continues (Murray et al., 2017; Prendeville et al., 2018). Furthermore, many others argue that earlier sustainability concepts and schools of thought are viewed to have a strong connection with the CE/circularity, which also are examined and presented by many other researchers, such as Homrich et al. (2018), and shown in figure 2. This research, however, is not focused on further exploring and
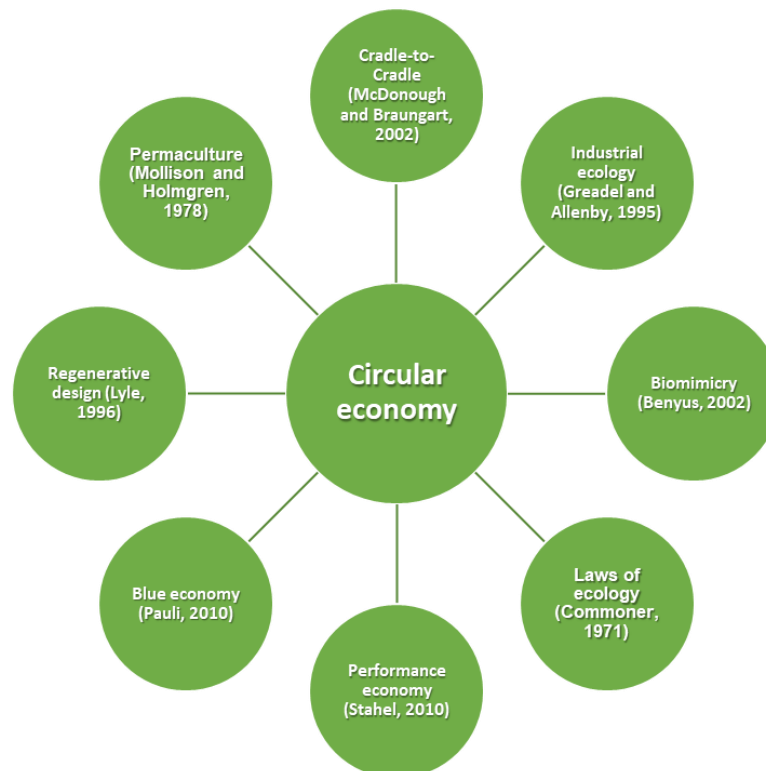

Figure 2. Schools of thoughts and concepts or principles that are linked to the concept of the CE and their source. Source: adapted from Homrich et al. (2018) and adjusted by author.

revealing the progress on different related concepts from their early days. In this regard, Bocken et al. (2017) also state that it is less important whether these ideas on the CE are novel or not, but rather to ensure that (circular) lessons learned from past attempts are fruitfully exploited in the current efforts.

2.2. Transition - a long term ambition

For the implementation of the CE, it is important to understand how current urban economies; how their ecosystems processes and their dynamics work, mostly organized and dominated by the LE (Fusco Girard & Nocca, 2019), which is still deeply rooted in our behaviour and mindset (Hartley *et al.*, 2020; Lieder & Rashid, 2016). According to Lieder et al. (2016), social awareness is crucial for a successful transition from a LE to a CE, as customers are an integral part of a CE. Among society, the movement of social awareness is ongoing and so far well supported by the public institutions and gradually gains support from industry (Lieder & Rashid, 2016). Changing the behaviour and mindset of individuals, and systems of cities and societies in their entirety is an extremely complex, challenging, and slow but also vital process (Jones & Comfort, 2018), also called a transition. A transition consists typically of four phases; exploration, take off, embedding, and stabilization (van Lente *et al.*, 2003). A majority of these challenges cannot be tackled and overcome independently, and require systematic changes on a global level, to overcome 'lock-ins' that are deeply embedded within current socio-technical regimes (Barrie *et al.*, 2017).

At the same time, local city and national governments, already are increasingly involved in the process of governing the transition from the LE towards the CE, participating in networks with many different actors and sectors. The involvement of and focus on cities is mainly because cities are expected to increase in population globally, making them the hotspots for resource consumption and pollution, increasingly being accumulated but also raising the innovation capacity that. Also, in different private sectors, mainly in larger cities, many initiatives can be found, such as the construction sector and in many industrial sectors, closing loops in systems to prevent spillages is in many cases already of great importance and considered as a standard. To a lesser extent, several citizens' initiatives can be found in many different cities across the globe. However, as it is important and noticeable how cities already are changing related to implementing the CE, this mostly emerges as an economic strategy, while scholars have rather focussed on '… either material and energy conservation or easing of environmental pollution (Yuan *et al.*, 2008)

2.2.1. Global - a worldwide transition

Several researchers have, therefore, looked into examples of cities globally, how they are governing to produce environments where circular initiatives can easily be stimulated and flourish. In this regard, China is the first country to implement nationwide regulations; to promote circularity in cities, the first law related to the CE as beforementioned was already drafted more than a decade ago in 2002. A majority of literature on the CE, thus, is possibly mostly related to Chinese examples and cities (Petit-Boix & Leipold, 2018; Prendeville *et al.*, 2018). However, for this thesis, the majority of examined literature regarding approaches and visions and how this is relating to policy changes and implementations in cities and related examples is more focussed on Europe and North America. Although, most (roughly one-third) of the available literature related to the CE is focused on China (Fratini *et al.*, 2019; Turcu & Gillie, 2020). Also, Fratini et al. (2019) state that a language barrier could hinder investigating societal approaches and visions on the transition towards a CE when looking at Chinese orientated literature, and, consequently, also focused on cities with 'post-industrial democratic contexts'. As in China, furthermore, most cities also more easily can implement regulations, because of the more dominant position of the national government to steer transitions in a top-down manner. Cramer (2019) in this regard state that especially in Western democracies, that '… without support from industry and the community, CE initiatives are not sustained' (Cramer, 2020).

2.2.2. The circular city

Looking further into the different types of societal and political approaches and visions there are many differences, to be found between cities in the global north, but also between Europe and the United States when adapting to principles of the CE. Examples of cities that are nowadays recognized as notable examples related to the CE, are found across the globe, as depicted by Fusco Girard & Nocca (2019), and shown in the list of table 1. These cities have all found a way to incorporate circularity in either policy regulations and/or have adopted many circular initiatives that are well established, with a programme/strategy/agenda at the city level (Fusco Girard & Nocca, 2019). The city of Amsterdam that is also examined by Fusco Girard & Nocca (2019) and listed in table 1, recently published its CE strategy for the next five years (Strategie Amsterdam Circulair 2020-2025). However, Fratini et al. (2019) only found a few scholars (12 references in total) that emphasise the role of cities, and that, in general, very few articles go much into depth in debating 'how' and 'what it takes' (and who) to implement CE principles in cities and urban contexts. On the one hand, this illustrates cities are expected to be the foremost and logical places where a difference could be made with the decrease of energy and material consumption, through principles of the CE. Mainly because cities have higher concentrations of resources, capital, and talent (Ellen MacArthur Foundation, 2017). While on the other hand, much seems unknown and unclear about possible and desired outcomes this implies, such as spatial implications and application at the macro-scale of the city (Turcu & Gillie, 2020). The 'Circular city' is, thus, seen and used as a popular term to use when planning for true urban sustainability nowadays in different cities across the globe.

One of the possible outcomes, as briefly abovementioned, that is predicted by fully adopting the CE principles, is the emergence of the 'Circular city', several examples of cities moving towards this with a programme/strategy/agenda are listed in table 1. A circular city is, as the name implies, a suggested city where all different kinds of loops, whether material or non-material, are 100% or as much as possible closed. Other and older previous concepts that (partly) overlap with this concept are the 'eco-city, with more than hundreds of eco-city projects (Ghisellini *et al.*, 2016), the 'zero waste city' and the

Table 1. List of examples of cities that have adapted principles of the CE or created a (long-term) programme/strategy/agenda, in random order. Source: adapted from Fusco Girard & Nocca (2019) and updated and adjusted by author.

	City / Country	Project name
1	London / England	Circular London
2	Glasgow / Scotland	Circular Glasgow
3	Amsterdam / Netherlands	Circular Amsterdam
4	Rotterdam / Netherlands	Circular Rotterdam
5	Paris / France	Circular Paris
6	Antwerp / Belgium	Antwerp Circular South
7	Brussels / Belgium	Be Circular Be.Brussels
8	Maribor / Slovenia	Roadmap towards the Circular Economy in Slovenia
9	Prague / Czech Repubilc	Roadmap towards the Circular Economy in Slovenia
10	Kawasaki / Japan	Eco town project
11	Kalundborg / Denmark	Kalundborg Industrial Park
12	Göteborg / Sweden	Circular Gothenburg
13	Marseille / France	*
14	Malmö / Sweden	*

'smart city', for example. These concepts have gained much attention already by many researchers, and are mostly the focus when adapting for urban sustainability (Prendeville *et al.*, 2018). Several authors, though, have looked into the notion of the circular city (Prendeville *et al.*, 2018) and have mentioned it throughout their work, such as Bolger & Doyon (2019), stating that especially local governments (i.e. municipalities) '… have the capacity to implement meaningful transitions towards sustainable development of the built environment'. Also Erickson & Tempest (2014) state that local governments could play a key role in urban sustainability issues, as they have extensive local knowledge of their environment (i.e. know how their ecosystems processes and their dynamics work) and mostly have autonomy on urban planning, water, waste and public transport and manage them.

Turcu & Gillie (2020) looked into how the city of London is governing and uses planning in the transition towards the CE. It was found that, although the Greater London region that is governed by the London Greater Authority strives for implementing the CE and adopted the CE in the 'London Plan', the local and smaller 'second-tier', consisting of 32 boroughs/municipalities, barely mention it (only eight out of 32 refer to CE in policy formulation) (Turcu & Gillie, 2020) and mainly focuses on waste flows. Also, in the Netherlands, a similar situation can be identified: whilst the national government has set an ambitious goal by a national top-down strategy and vision (Nederland Circulair 2050), binding policy regulations have hardly been adopted and this strategy has barely been translated into practice at lower, regional and local levels. However, in the larger cities in the Randstad (i.e. Rotterdam, Amsterdam, The Hague and Utrecht), the economic engine and highly urbanized region of the Netherlands, the CE is much more common to be found in policy programs and different initiatives (both public and private). The national government of the Netherlands thereby currently focuses on five sectors/chains that are seen as important for the economy but also affect the environment the most, in the transition towards the CE; (1) biomass and food, (2) plastics, (3) manufacturing industry, (4) construction and (5) consumer goods (Ministerie van Infrastructuur en Milieu & Ministerie van Economische Zaken, 2016).

Fratini et al. (2018) examined Amsterdam, among London and Paris, to '… address questions of how the CE and urban sustainability transitions are, on the one hand, imagined in the academic literature, and, on the other hand, translated into policies and actions in three specific cases' (Fratini *et al.*, 2019, p. 987). Concluding that it is important to understand the CE more than a 'technological fix', as found currently portrayed by the concerned cities. They found that attention in Amsterdam, in this regard, for example, is primarily given to resource flows, job creation, sectoral transition and innovation focused on waste, energy and construction (Fratini *et al.*, 2019) and less on social dimensions which are crucial 'for the legitimacy and uptake of the various ways of going circular'. They furthermore describe the municipality as the facilitator, stating that the CE imaginary in Amsterdam is closely related to the development of the 'smart city' and 'sharing economy'. Based on document analyses (e.g. plans, white papers, policy briefs, etc.), Fratinie et al. (2019) also found that the city of Amsterdam depicts itself as a pioneer in the transition towards a CE at the metropolitan level, to become an example for the rest of the world. Likewise, Jones & Comfort (2018) looked into Amsterdam, among London and Paris and how they relate to the concept of the circular city, to '… offers some general reflections on the role public relations and communications may play in the transition process' (Jones & Comfort, 2018, p. 1). Also according to Jones & Comfort (2018), the focus on waste management and resource flows are dominant when exploring the possibilities of the circular city, while Fusco & Girard (2019) argue that it should place human beings (i.e. health and well-being) at the centre of its policies.

Prendeville et al. (2018) looked into six cities, among which also the city of Amsterdam can '… provide a lens through which to understand the ways CE could manifest in a city' (Prendeville *et al.*, 2018, p. 176). In their study, they found that there is much more empirical data needed to be gathered on the topic of the circular city (Prendeville *et al.*, 2018). If circular cities truly exist, and their realization is feasible, their interpretation and implementation may differ (Jones & Comfort, 2018), even among cities within the same region. For example, they found differences in the perspectives on the CE in the municipal policy of Rotterdam and Amsterdam, in the Netherlands. Rotterdam's sustainability agenda has three main ambitions, in which the CE is one of five ways to work towards one of those ambitions, while in Amsterdam the sustainability agenda outlines five goals, one of which is CE; here the CE is considered a goal instead of a way to achieve ambitions (along with clean air, renewable energy, a sustainable city and a climate-resilient city) (Prendeville *et al.*, 2018). It is concluded that 'policymakers have difficulty grounding the concept of CE in day-to-day practices' (Prendeville *et al.*, 2018, p. 187), outlining that there is a general understanding among cities and its policy-makers on the urgency to change cities (towards a CE), however, they are often not able and urged to deliver the needed practical solutions (i.e. policy regulations and implementations). Clark (2014, p.435) states in this regard for example that the debate '… among US national-scale policymakers over the past several decades has not actually been about the ability to make strategic policy choices about manufacturing capacity but about the desire to do so'.

Besides looking into challenges and suggested solutions and essential actors, some tools for governing the circular city – if such one city is possible, is still debatable – are provided by some. Based on three case studies (Kalundborg (Denmark), Kawasaki (Japan) and Dunkirk (France)), Fusco Girard & Nocca (2019) argue that tools for governance in the circular city are needed. They suggest that governance in the circular city is collaborative, adaptive, experimental and reflexive and that urban planning in circular cities should be inspired by '… industrial ecology which is attentive to the analysis of urban metabolism flows' (Fusco Girard & Nocca, 2019, p. 36). Furthermore, they conclude that currently a set of indicators for assessing how a city is effective in moving towards the CE is still lacking (Fusco Girard & Nocca, 2019), although they suggest a broad list of indicators deduced from many papers, documents and reports.

2.3. Urban manufacturing

UM is increasingly understood differently, in terms of types and their contributions towards (circular) cities. This has resulted in difficulties in establishing efficient and supportive policy, due to the multiple definitions used in practice. For example, regarding the terminology of 'manufacturing', many other notions are accepted and used, such as; 'advanced manufacturing', 'value-added manufacturing', 'just-in-time-production', 'lean production', and 'prototyping' among others (Lane & Rappaport, 2020). Still, there are some general acknowledgements and aspects that belong to UM, for instance, that UM are a valuable addition for local and regional economic development, such as employment creation (Heebels & ten Kate, 2019; Singh *et al.*, 2017; Wolf-Powers *et al.*, 2017). However, employment creation is still a point of discussion, as to whom this will benefit. This is related to the fact that, on the other hand, UM traditionally is conceived to provide and require low-skilled 'low-paid assembly line jobs' (Grodach & Gibson, 2019). But on the other hand, UM is changing and adapting to new trends in urban economies, such as the emergence of the digital/knowledge economy, which increasingly requires more skilled and educated workers that can work with new technologies. Grodach & Gibson (2019) also point out that new forms of UM encompass advanced technologies, customised products and 'maker' scenes promoting locally distinctive enterprises and more socially forms of development. New forms of UM are more locally distinctive as consumers '… increasingly want to eat, wear, and use

products created locally through neo-artisanal production methods and to purchase goods customized to personal specifications' (Wolf-Powers *et al.*, 2017, p. 366).

Sing et al. (2017), for example, refer to some general aspects regarding UM, for instance, they argue that UM is related to small units. These units can maintain a smaller size due to technological development resulting in highly optimized mass production facilities, that produce little to no emission and waste enabling them to be positioned near living areas (Singh *et al.*, 2017). Furthermore, Sing et al. (2017) state that UM is not new but has changed, because of the increase in methods and tools that enable manufacturers to combine sustainability and compatibility with effectiveness and efficiency. Sing et al. (2017) describe UM, therefore, as follows;

> *''The term urban manufacturing means the production of goods close to conglomerates of humans and their living areas. The production process roughly consists of engineering, manufacturing and assembly. For urban manufacturing, either manufacturing or assembly happens close to the customer and the workers. Urban manufacturing is a different concept with highly optimized mass production facilities''* (Singh *et al.*, 2017, p. 275).

Also, some researchers, policymakers, and practitioners do distinguish between different kinds of UM, mostly based on their relative size, eventual target audience, and/or based on nuisance they cause to surroundings on different levels. Also, a distinction is made by several researchers between 'traditional' and new forms of UM.

Wolf-Powers et al. (2017), for example, refer to the 'maker-entrepreneur' part of the 'Maker movement' that is different from traditional UM. They state that maker-entrepreneurs can reach consumers easily through social media and internet marketing and found that new forms of UM are not always visible to business databases (Wolf-Powers *et al.*, 2017). In their research, they distinguish between three types of makers, looking into firms operating commercially and only included firms that manufactured or craft-produced physical end products. They distinguish three types of makers hereby; 'micromakers', 'global innovators' and emerging 'place-based manufacturers'. Wolf-Powers et al. (2017) furthermore state that these three different types of UM, compared to each other, contribute differently to cities.

Heebels & ten Kate (2019) looked into new forms of manufacturing and changes in the manufacturing industry, and distinguish between two types of manufacturers; the first type consisting of smaller craft-orientated enterprises where the focus is on small quantities of a specific product or service and the second type consisting of larger enterprises focusing on the manufacturing of products or product parts in large quantities. Furthermore, according to Heebels & ten Kate (2019), to stimulate regional innovation, also among other businesses, the interaction between these two types is important. The smaller type of craft-orientated enterprises can act as places where innovation is established, while the larger industrial enterprises can act as a catalysator for a circular business case in larger quantities for clients (Heebels & ten Kate, 2019). Also, Wolf-Powers et al. (2017) state that planners should continue industrial diversification.

But, according to Lane & Rappaport (2020), the types of manufacturers are as diverse as possible as the physical and policy contexts in which the activities of making take place, wherein 'other' industries as film production also could be considered. However, Lane & Rappaport (2020) also refer to some general conditions or standards related to UM, deliberately not considering the production of software development (which is an essential accessory), warehousing, packaging and distribution, and heavy industries that require large secure districts free of conflict (Lane & Rappaport, 2020). Ferm & Jones (2019) relate in this view also to 'new urban manufacturing'; a shift in a mature economy with smaller companies relying on greater innovation and proximity to the design process, that benefits

more from the agglomeration economies provided by the inner city than in the past. Moreover, according to Ferm & Jones (2019), new UM relies more on access to skilled labour because production, design and R&D are more intertwined.

Regarding the design and policy of UM, Lane & Rappaport (2020) state that this is becoming more complex due to the multiple definitions used in practice and therefore whether related specific policy applies or not. Grodach & Gibson (2019) looked into this matter, on how urban policy is responding to changes in UM based on cases in the U.S. and Australia. They found that 'manufacturing policy' is '… situated between entrenched visions of deindustrialisation and emerging notions of a renewed, advanced manufacturing sector in a knowledge economy' (Grodach & Gibson, 2019, p. 280). When looking at UM policies, they found based on their empirical evidence, that there is still a focus on 'post-industrial' solutions. That is, a focus that biases industries perceived as 'high-tech' over 'low-tech', and also falsely assuming that manufacturing is compromised of large enterprises seeking new greenfields in outer-suburban areas (Grodach & Gibson, 2019). They state that planners and other urban policy-makers '… have tended to view industrial uses as incompatible with urban mixed-use settings' (Grodach & Gibson, 2019, p. 289). Lane & Rappaport (2020) state in this regard that '… zoning laws, building codes, and economic development policies designed to segregate dirty manufacturing from the rest of the city have not kept up with these technological innovations' (Lane & Rappaport, 2020, p. 185). In reality, some manufacturing indeed requires large greenfield spaces with good transportation access, but many existing manufacturers nowadays, moreover require '… a mix of older buildings with flexible floor space and dense networks of tacit knowledge and inter-firm relationships more typically found in inner-ring industrial lands' (Grodach & Gibson, 2019, p. 289). Nonetheless, these specific important spaces remain unnoticed in the current established urban manufacture policy (Grodach & Gibson, 2019). It is concluded, that research tracing mixed-use zoning strategies including (sustainable) urban manufacturing, need much attention to ensure that cities adapt and react to all new needs and developments pressures, and especially the survival strategies of small firms (Grodach & Gibson, 2019).

Regarding the definition of UM, the abovementioned definition of UM given by Singh et al. (2017), may cause disagreement in the field. Because it only relates to enterprises working with goods, but as pointed out by Lane & Rappaport (2020), the context of making also depends on physical and policy contexts. To address this and the social impacts and desires of new forms of UM, the following definition is more suited and used for this thesis; *'Urban manufacturing consists of small or medium-sized transparent enterprises where products are (re)manufactured and assembled, depending on diverse craftsmanship skills and new technologies, whereby 'hacking consumption' (i.e. CE) and involvement of customers are taken into account in various stages and ways'*.

2.3.1. Benefits of urban manufacturing

Currently, there are several reasons why UM is becoming increasingly attractive for (circular) cities. Moreover, these are economic perspectives, which are more often emphasized and also used for differentiating between UM. Unterfrauner & Voigt (2017), also emphasize the economic opportunities for cities, that arise due to UM, but moreover investigated the potential of UM to be socially innovative, where they also refer to the 'Maker Movement'. Also Doussard et al. (2017) refer to the Maker Movement, as '… the revolutionary change of allowing artisans, tinkerers and digital-era inventors to move products from the workshop to mass production - without the infrastructure of the large manufacturing firm' (Doussard *et al.*, 2017, p. 2).

Also Lane and Rappaport (2020) seek to elevate the role of UM, related to four arguments with each their minor downside(s), besides also firstly emphasizing the social perspectives of UM. Here, related to the social perspective, they firstly refer to (1) equity, suggesting that manufacturing creates job

opportunities for disadvantaged people, while factory automation and robotics are at the same time increasingly replacing some tasks and raising the training and education bar for others (Lane & Rappaport, 2020), as also abovementioned and described by Grodach & Gibson (2019). The other three other arguments, are well-tested, but also still need to be qualified; (2) resilience, as a diverse economy reduces exposure to shocks and stresses of uncontrollable market changes, (3) efficiency, manufacturing districts ensure short routes that prevent transportation costs and environmental impacts when supply chains are nearby but otherwise keep job intensity low in warehousing and distribution districts, and (4) sustainability, as manufacturers can compress the urban footprint by reusing goods and providing special services (food, fuel, construction materials, buildings etc.) they have direct access to (Lane & Rappaport, 2020). However, as mentioned earlier, some types of UM require expensive and spatial remediation related to nuisance, especially in residential areas for example. As stated earlier, these conditions have yet to be proven to be seen as a natural condition for UM in practice, which some perspectives being neglected or promoted by choice more, according to different factors in but also between cities.

2.3.2. Barriers and drivers for (sustainable) urban manufacturing

Besides the abovementioned social and economic perspectives suggesting the integration of UM and to further develop adherent policy, the reindustrialisation and diversification of the urban economy (Grodach & Gibson, 2019), sustainability is increasingly being a central issue being pursued and another major benefit for more incorporation. However, the current predominant sustainability paradigm regarding resource scarcity – the CE – is not very much of attention and is not being implemented in practice yet, but is well suited for UM. Juraschek et al. (2018) also state that by collecting and treating waste generated in cities and turning them into new products, urban factories can close material flows towards a CE (i.e. urban mining). Regarding the relation between the CE and manufacturing, Rashid et al. (2013) specifically introduced the self-explanatory concept of Resource Conservative Manufacturing (ResCoM), as a solution to solve the problem of resource scarcity. In REsCom, using fewer resources by manufacturing with used materials, in this way, for example, a product that consists of used materials for 85%, could be equivalent to a new product but saves 50-80% less energy to produce (Rashid *et al.*, 2013). Also, the economic benefits of remanufacturing accounts for 20-80% savings in product costs in this example, when compared to conventional manufacturing (Rashid *et al.*, 2013). However, REscoM faces several major complications when used in practice, most of them related to uncertain quality, quantity and availability of the raw materials (returns) for remanufacturing (Rashid *et al.*, 2013), which in cities tends to be less problematic, due to the many different available resources and quantities brought in and produced by companies and citizens. In comparison to the former and current general concept regarding sustainability in manufacturing, closed-loop manufacturing, REscoM also bring in three new features; (1) products are designed with multiple lifecycles, (2) customers are part of the business enterprise, and (3) as well forward as backward chains are integrated into the same individual business enterprise. The integration of as well forward as backward chains in a single business refers to being able to have two functions (chains) simultaneously, by producing/launching and as well taking back in products to remanufacture them according to the REscoM principles. In summary, a REscoM product is branded as an RCP (Resource Conservative Product) and aims not only at bringing back products once by replacing (small) parts but can respond positively to changes in customer's preferences in remanufacturing and technological shifts that occur (Rashid *et al.*, 2013).

However, further integration of true sustainability (i.e. circularity) in general, and specifically for UM, is nowadays still constrained due to several factors and barriers, which are increasingly being researched. Kirchherr et al. (2018) state in this regard that, business and policy circles have proclaimed their support for the CE, but its implementation remains to be in the early stages. Specified business models are lacking, for example, that currently still focus too much on gaining economic benefits and

growth in the transition towards the CE, rather than opportunities for more sustainable businesses and taking into account degrowth (Lieder & Rashid, 2016). Even when a business is conceived as circular, it is difficult to truly understand if an enterprise is to continue with its 'business as usual'. Ultimately manufacturers (and retailers) have to switch from providing goods to providing services (Bauwens *et al.*, 2020).

Rizos et al. (2016) therefore looked specifically into the implementation of the CE into small and medium-sized (hereafter, SMEs), regarding barriers and drivers. They state that SMEs implementing and considering circular business models are facing several barriers, such as valuing related future benefits against current costs, a lack of knowledge and market push-and-pull factors, such as the relatively low demand (among consumers) for green products (e.g. Resource Conservative Products) and the availability and variety of technologies (Rizos *et al.*, 2016). Also, it was found by Rizos et al. (2016) that even if resource efficiency (i.e. circularity) was improved, it often was not linked to the concept of the CE. Both larger and small enterprises face such barriers, although to differing extents. Rizos et al. (2016) clarify this by the following example; '… a multinational company can support circular technology development through its research and development activities, small and medium-sized enterprises (SMEs) often depend on the availability of technology in the market. Moreover, while multinationals may be able to determine how CE concepts are adopted, an SME is, due to its size, often restricted to observing the trends in the market value chain in which it operates' (Rizos *et al.*, 2016, p. 2). Based on a literature review, Rizos et al. (2016) found the following seven barriers regarding the implementation of circularity; (1) company environmental culture, (2) lack of capital, (3) lack of government support/effective legislation, (4) lack of information, (5) administrative burden, (6) lack of technical and technological know-how, and (7) lack of support from the supply and demand network.

Subsequently, Rizos et al. (2016) found eight barriers in practice, derived from a sample of cases (30 SME cases were examined among mostly (40%) originative from the manufacturing sector) that had included one or more green solutions. Furthermore, the three most pressing barriers mentioned among the sampled respondents were 'the lack of support from the supply and demand network' (54%), 'lack of capital' (50%), and 'lack of government support' (25%) was mentioned, the least mentioned barrier found was the company environmental culture' (8%) (Rizos *et al.*, 2016).

Also, several drivers or enablers were found by Rizos et al. (2016) among the sampled cases. They found that the least mentioned barrier, the 'company environmental culture', was mentioned as the foremost enabler. That is, the mindset and commitment of the staff, sequentially followed by 'networking' and 'support from the demand network' (Rizos *et al.*, 2016). For as (recent) start-up companies it could be less complex and challenging to change the company environment culture as '… their company culture develops from scratch, which can be easier than changing practices in existing firms' (Rizos *et al.*, 2016, p. 11) and they already integrated sustainability as an important value.

Kirchherr et al. (2018) also looked into barriers regarding the implementation of the CE looking into evidence from within the EU, based on desk research, semi-structured interviews and a survey. They found several barriers that are distinguished into four categories; 'cultural', 'regulatory', 'market' and 'technological' barriers (Kirchherr *et al.*, 2018). These barriers, as shown in figure 3, are illustrated by Kirchherr et al. (2018) in the following 'typical' example of the throw-away beverage can system towards a bottle deposit and return scheme. First, novel technologies for returned bottles of the latter system are needed (e.g. inspection and cleaning technology, technological barrier), second, the players in the market need to diversify their activities for this system and thus their interplay (e.g. reverse logistics, as also abovementioned in the REscoM concept (backward chains), market barrier), third, novel policies to regulate novel technologies must be adopted (e.g. policies regarding chemical usages

of cleaning technologies, regulatory barrier) and fourth, cultural shifts are needed (e.g. consumers must learn to return bottles after usage, cultural barrier).

Cultural	Regulatory	Market	Technological
• Hesitant company culture • Limited willingness to collaborate in the value chain • Lacking consumer awareness and interest • Operating in a linear system	• Limited circular procurement • Obstructing laws and regulations • Lacking global concensus	• Low virgin material prices • Limited standardization • High upfront investment costs • Limited funding for circular business models	• Remanufactured products • Limited circular design • Demonstration projects • Lack of data (e.g. on impacts)

Figure 3. Overview of current key CE barriers. Source: adapted from Kirchherr et al. (2018) and adjusted by author.

In their research Kircchherr et al. (2018) refer to four barriers to aim for comprehensiveness and parsimony, however, they recognize that more (specified) barriers are mentioned and found in related literature. Also, it is stated that interactions between the four interrelated categories of CE barriers, could lead to 'chain reactions' towards CE failure, although, once identified and analyzed, can be targeted with suited (policy) interventions or the transition will fail or slow down leaving the linear economy system unchanged (Kirchherr *et al.*, 2018). It was concluded that the most pressing barriers among businesses and policy-makers are cultural barriers, namely, 'lacking consumer interest and awareness' as well as 'hesitant company culture', following Rizos et al. (2016). The least mentioned barriers that were found are technology related, with 'lacking ability to deliver high quality remanufactured products' as the least mentioned barrier (Kirchherr *et al.*, 2018).

In a more specific and different perspective, Lane & Rappaport (2020) point out the urban design as a challenging part of accomodating UM. The four challenges mentioned are; designing street edges balancing on integration and connectivity to the city whilst creating clear identity and protection from gentrification, spaces that adopt loading and storage areas use while promoting interaction among manufacturers, and streets that accommodate goods movement but also enable pedestrian mobility (Lane & Rappaport, 2020). However, they relate to policy regulations and administration as the biggest challenge, where many cities already experimenting with new zoning tools for industrial mixed-use. For an urban industry to thrive, financial impulses alone will be insufficient – a change in mindset is mandatory where the space of physical production must be envisioned as an urban infrastructure as vital to cities as water, energy, and transit systems (Lane & Rappaport, 2020).

Besides the abovementioned restrictions hindering (sustainable) UM, there are some recent examples found in practice of initiatives that illustrate the transition towards circular manufacturing. These examples highlight that manufacturers are now able to even deliver more energy than they use, have shorter supply chains and reduce their overall carbon footprint (Lane & Rappaport, 2020). However, a majority of literature focuses on examples of larger enterprises mostly located outside city borders not able to be mixed with residential functions completely. Urban initiatives, moreover, have not yet been explored broadly in-depth, however, some examples of circular manufacturing are highlighted by Darling (2020), who examined how manufacturers adopt circularity in manufacturing itself, but also in the design and construction of such places. Such an example is The Plant (Chicago, USA), a former three-story 93,500 square foot brick pork-packaging facility by Bubbly Dynamics, a social enterprise dedicated to creating replicable models for sustainable urban development in vacant industrial buildings located in a disinvested neighbourhood, located between residential and industrial uses (Darling, 2020). Nowadays, the ground floor is occupied by a beer company and brewhouse, a large

tasting space, and a pizza house, all businesses that welcome the public to gather and dine, and the upper two floors by a dozen interdependent food production businesses, which produce vegetables, bread, beer, honey, spices, and kombucha, among other food products that are divided into smaller spaces with non-load-bearing partition walls (Darling, 2020). These smaller food-based businesses use leftover products from each other creating a closed-loop system, as 'waste' from one process is used as nutrients for another, for example, '… the spent distiller's grains and yeast from the brewery are used on-site by the bakery for making bread and as a growing medium for mushrooms, which can then be made into compost and used by the farms operating in the building' (Darling, 2020, p. 144). The Plant is currently connected to the power grid of the energy company Con Edison but is hindered selling the surplus of energy generated on-site to a third party such as users and tenants of the building because Con Edison established in Illinois a landowner cannot make and sell energy (Darling, 2020). According to Darling (2020), such laws '… have delayed plans to bring online an anaerobic digester designed to divert over 10,000 tons of citywide food waste from landfills to produce biogas not only to sell but to use on-site to generate electricity and provide heating' (Darling, 2020, p. 144). Socially The Plant has focused on community building, supporting small businesses and job creation and is partnering with four public schools to provide science programming for students in grades 4 to 12 as well as workshops in topics such as aquaponics and pickling (Darling, 2020). Looking at the situation and examples of the Netherlands, many cases can be found, where most of the circular start-ups are prevalent to the sector of the built environment/design but also the manufacturing sector (both 26%) (Bauwens *et al.*, 2020). Moreover, according to Bauwens et al. (2020), most circular start-ups overall can be found in the Randstad (61%) (including Rotterdam, Amsterdam, Utrecht and The Hague) and in work in addition mostly business-to-business (B2B) (56%).

The abovementioned articles illustrate that there exists much diversity regarding barriers and drivers - also referred to as challenges and enablers by some scholars - for implementing sustainability (i.e. circularity) among different sectors. Practical solutions (i.e. enablers or drivers) to overcome barriers when applying principles of the CE into the business models of UM specifically, or manufacturers in general, have not been explored much in-depth yet. The most contributing literature found yet in this regard for this thesis, is provided by Rizos et al. (2016), not explicitly examining UM regarding in this regard, but included a majority of manufacturers in their sample of their case-study. In total, more than 30 articles are identified that examined barriers when implementing the CE, by looking into bibliographies of related literature, which all have been reviewed by Kirchherr et al. (2018), which is a very timely endeavour (De Jesus & Mendonça, 2018). Furthermore, Kirchherr et al. (2018) state that their research is the first large-N-study on CE barriers (208 survey respondents, 47 expert interviews), so far, and that from a sample size perspective, the study by Shahbazi et al. (2016) is the largest (41 semi-structured interviews) yet. Lastly, it was also identified by Kirchherr et al. (2018), that possible interactions between barriers and chain reaction mechanisms could lead to decelerating and blocking the transition towards the CE. Furthermore, none of the abovementioned contributions specifically or in-depth discuss and applied the barriers in the context of UM, or manufacturers in the Netherlands, or the MRA in detail. It is unsure if these barriers, therefore, apply to UM in the city of Amsterdam and to what extent. Kirchherr et al. (2018) therefore stress the importance to further investigate how barriers relate to each other and between and among different sectors, to help policy-makers formulate and implement suitable interventions.

Lastly, the examined articles also point out there is still much uncertainty and clear studies focussing solely on enablers, or drivers, that provide knowledge on how to accelerate the transition to the CE remain absent yet or are difficult to directly apply in practice. Antikainen et al. (2018) investigated the role of digitalization (i.e. cyber-physical systems) to accelerate the transition towards the CE, such as Big Data, data analytics, and the Internet of Things (IoT). Digital instruments could bring novel ways to

improve traceability and transparency throughout product lifetime and the collection of products and materials by providing product location in real-time (Antikainen *et al.*, 2018). What on the other hand becomes certain, as Kirchherr et al. (2018) and Rizos et al. (2016) underpin, is that especially cultural factors (e.g. changes in behaviour and mindset of both customers and businesses) decelerate the transition towards the CE in general.

2.4. Intermediaries

The transition from the global dominant linear economy towards a CE is considered as a transition towards sustainable development and a sustainable society, and, therefore, a sustainable transition. In sustainability transitions innovations are needed that help to accelerate the transition towards it and to achieve often committed goals (e.g. the Dutch national goal be 100% circular in 2050), in many different ways and stages, via physical products, but also through the ways services are provided and systems are managed and organized. Changes in innovations and services that are needed to start or accelerate a sustainable transition, however, are mostly hindered by high upfront investment costs, but, most of all, are (purposively) unknown to many. Therefore, in sustainability transitions cohering changes in innovations and other essentials assets are very often accompanied and initiated by intermediary actors, where they are seen as 'key catalysts' (Howells, 2006; Kivimaa *et al.*, 2019).

The transformations that go along due to transitions between actor groups, infrastructures, and technologies and contexts of application, result in changing contexts and consequently changes in positions and interplays between actors and, thus, require intermediary action (Kivimaa *et al.*, 2019). Kivimaa et al. (2019, p. 1062) state that attention on intermediaries in transition processes, however, '… has only relatively recently gained traction in the sustainability transition field', and that the previous research focuses on 'transition intermediaries' was more related to the urban and energy transition contexts. Other notions to indicate intermediary-like functions or actors that are used similarly are 'middle actors' and 'hybrid actors', or 'boundary spanners' (Kivimaa *et al.*, 2019). Howells (2006) summarized several studies examining intermediaries and the intermediation process in innovation and also provides an overview of various used related terms and definitions.

Several authors have also looked into intermediaries in transition, and or more specifically into transition intermediaries, such as Kivimaa et al. (2019), Gliedt et al. (2017) and Patala et al. (2017). Hansen & Coenen (2015) describe intermediaries as, 'organisations working between different social interests', and, for example, also local planners may perform intermediation in sustainable transitions. In sustainability transitions, governance and governing become highly complex due to the many different scales of operationalization and innovation that is needed. Also due to disagreement across different levels of government caused by unsynchronized and differing agendas, as a result of the increasing heterogeneous mix of actors involved and the privatization of physical structures needed for guiding sustainability transitions. Thus, the governance of sustainability transitions increasingly becomes a collaborative effort involving public and private actors with varied interests and incentives (Hansen & Coenen, 2015, p. 97).

Howells (2006, p. 716) argues that 'change agents' have '… had a powerful influence on the speed of diffusion and uptake of new products and services by household and firm adopters', and, that the first real interest in intermediary action concerning innovation was in the field of diffusion and technology. More specifically, this can be described as, intermediaries being more than having a 'linking role', helping transform ideas and knowledge transferred (Howells, 2006). Furthermore, some intermediaries may be to some extent commercially or financially supported (Kivimaa *et al.*, 2019), which could doubt their character as unbiased or neutral.

2.4.1. Types and roles

According to Matschoss et al. (2017), there is less 'close-up' (i.e. empirical) research on intermediaries in practice and extensive research on the roles and types of intermediaries. They state that there should be more research on '… how intermediaries negotiate between diverse local interests and how they negotiate between local and non-local interests' (Matschoss & Heiskanen, 2017, p. 87). Research on the specific functions intermediaries (should) have to guide and accelerate the transition towards the CE, central to this thesis, has only recently gained attention. Several authors have started to explore the possible and ideal types of intermediaries and which activities they (should) perform (in sustainability transitions).

Such studies, however, more often focus on cases and situations in rural areas which more often are homogeneous and have fewer (directly) involved actors, only describing which activities are performed wherein a clear and consistent intermediary actor is difficult to point or describe or relate to one or more of the sustainability concept or schools of thought as shown in figure 2. Thus, it is uncertain if and how the outcomes from such studies could apply to the context of this thesis, where in contrast there is a high degree of urbanization, and numerous functions and actors are situated.

Patala et al. (2017), for example, looked at the process of an industrial symbiosis network, that is found to be similar to principles of the CE, and whom were involved at the macro-level in Finland. It was found that 'official' intermediary organisations were involved, but, also universities, regional development organizations, other (local) firms and even local communities to promote actions in a specific region, act as intermediaries.

Regarding requirements needed in general to accelerate the transition towards the CE, Patala et al. (2017) state that CE practices require an open form of innovation that encourages creative and unforeseen solutions that are based on sharing resources and collaborations. Intermediaries can hereby be required to act as brokers to form such collaborations and stimulate radical forms of innovations, that is, the involvement of actors that traditionally do not work together creating partnerships across sectors (Kivimaa *et al.*, 2019; Patala *et al.*, 2017). When an intermediary successfully increases understanding between two or more actors, its services may eventually become redundant referring to the temporary character of intermediaries.

Kivimaa et al. (2019) looked into the different types of intermediaries, through a systematic literature review, that play a key role in sustainability transitions. Stating that is difficult pointing out 'true' key intermediary actor(s), and that more often, they are recognized by certain (broad) functions they perform. It was found that in a transition where multiple intermediaries are active, new intermediaries may emerge purposely and/or accidentally due to changing contexts that often take place within transitions (Kivimaa *et al.*, 2019). This could be due to the fact of certain intermediaries depicting themselves as 'champions' over others (Kivimaa *et al.*, 2019).

Furthermore, according to Kivimaa et al. (2019) especially the 'systemic intermediary' is crucial to guide transformations from a whole system perspective, and are concerning space, among other capabilities, able to disrupt existing socio-technical configurations on different scales. This is since they are seen as unbiased towards selected socio-technical alternatives (Kivimaa *et al.*, 2019). Conclusively, Kivimaa et al. (2019) state that a 'well functioning ecology of intermediaries', includes the deployment of each type of intermediary at the right time and way to speed up diffusion, further improvements and the institutional reform that is needed to accelerate sustainability transitions.

Van Lente et al. (2003), as one of the few early studies (Cramer, 2020), also specifically looked into the roles and functions of 'systemic intermediaries' in processes of sustainability transitions, that

in the time of writing emerged as new actors. In their research, they underpin the need and arguments for systemic intermediaries, based on an example around initiatives that aimed at introduction and diffusion of low and zero-emission vehicles, benefitting the transition towards a clean transport system (van Lente *et al.*, 2003), and viewed how strategic alliances were formed with and by systemic intermediaries. The systemic intermediaries in here replaced, to a certain extent, traditional 'hard' and 'soft' intermediaries, but, were not sufficient. They underpin the importance and emergence of especially the systemic intermediaries, which were useful and probably necessary (van Lente *et al.*, 2003), but their efficacy depends on the make-up of the innovation system at stake.

Regarding the return of manufacturers into cities and policy debates, Clark (2014) highlights the role of 'regional intermediaries', and how they support smaller manufactures by enabling them to develop as a localised and networked group based on an example of in the USA. So-called supply-chain intermediaries, labour market intermediaries and innovation intermediaries are hereby needed to '… embed and expand flexibly specialised production capacity in regions and create variation in capacities across places (Clark, 2014, p. 434). These regional intermediaries partially fill the void that is created by unaware policy actors lacking the commitment to invest in understanding manufacturing processes and thus adapting policy models to support and sustain localised manufacturing (Clark, 2014). Lastly, Clark (2014) states these regional intermediaries (particularly associated with small-firm production and the Maker's Movement), or Maker Movement intermediaries, that are part of a new model, promote existing local capacities and hereby seek for supply network partners nearby, also for eventual gaps in the supply chain (Clark, 2014).

2.4.2. Activities

In the previous subparagraph, it is pointed out that it is difficult to designate a single intermediary or actor to be linked to a certain matter or between multiple sectors or actors. Often, and, especially in sustainability transitions, it is likely that multiple potential actors, may be required for intermediation, that do not always will have a neutral or unbiased character. Consequently, the same applies to effective activities and measures undertaken in sustainability transitions. Due to the changing contexts and transformations in transitions, different actions and measures will be needed alternately and at the same time. However, effective intermediary activities specifically in the context of this research, improving sustainability among UM in the MRA, have not been studied or explored in depth yet. Moreover, the functions of intermediaries in sustainability processes have only been studied recently and empirical studies in this regard are sporadic (Cramer, 2020). When looking into activities that contribute to accelerating sustainability transitions, there are multiple ways of doing so, and different perspectives to take into account. Foremostly, when exploring effective activities or measures intermediaries undertake, it should be considered between whom intermediary work should be done. Or, as for this thesis applies, between whom intermediary work *could* be done; to discover where potential meaningful and fruitful solutions and collaborations could be fostered. Several researchers have, nevertheless, recently started to describe activities that have fostered sustainability and related innovations, but, mostly looked into a single case (i.e. individual sectors and regions). For example, besides looking into different types of intermediaries, Patala et al. (2017) also described activities in organizing open sustainability, by looking into an example of how industrial firms form and adapt to a sustainability-orientated network. The network was established around the concept of Industrial Ecology, which is based on the principles of the CE (Patala *et al.*, 2017). It was found that intermediaries here played a multi-faceted role in facilitating this network development. Van Lente et al. (2003), besides arguing for and debating the emergence and need of systemic intermediaries, looked into several functions, that serve as key elements among them, for changing innovation systems, but, acknowledged that more of such lists exists and could be found in practice. Kivimaa et al. (2019), besides looking into the typology of intermediaries in sustainability transitions, in which five

intermediaries are described, explain what each of them (should) focus on and why. It could be stated that generally most related studies looked into a case, and explored what is done by and between whom overall, in a more broad descriptive manner. Thus, it is not evident if earlier identified activities are effective elsewhere and always, as innovation systems vary (greatly) per sector and region as pointed above in paragraph 2.4.1. Also, it does not always become clear if such activities need to be belong to actors, or to (self) proclaimed intermediary actors. Furthermore, not all researchers refer specifically to 'activities', but also to 'functions' that have helped to stimulate a specific niche or sector for example. Lastly, there are a lot of overlapping findings in related research. Hence, to avoid a proliferation of lists of possible activities, three 'key elements' will be highlighted, as found by Van Lente et al. 2003, which are also mentioned by other researchers, yet, often described slightly different or more specified. Under these three key elements other more specified elements can be grouped. These three more general activities will be discussed, presenting a few of such described intermediary activities, with examples of related and more specified activities; thus, not all activities will be examined or listed, as this is also not the aim of his research, and, as earlier mentioned, this is a new and complex topic.

The following three activities carried out by (different) intermediaries are considered as key elements in (sustainability) transitions; *articulation*, *alignment* and *learning*, as found by Van Lente et al. (2003). These three main activities happen in the four different phases of transition processes, as mentioned in paragraph 2.2. Also, these three main activities have different meanings for different types of intermediaries and have different implications in each transition phase.

Articulation of options and demand includes the stimulation of technological variety and the search for possible applications. It also includes the awareness of possible futures. This mostly happens in the first phase of transitions, the *exploration phase*, where new options and varieties emerge which diminish older and current ideas and options, also known as Schumpeter's 'winds of creative destruction' (van Lente *et al.*, 2003). Also Patala et al. (2019, in this regard, see **raising awareness** as a key activity of intermediaries. In their case, therefore, seminars were held, promoting successful examples, emphasizing different benefits where their neutral role improved effectiveness. Here, it was found that economic and environmental benefits were emphasized, by highlighting successful examples. Also, Kivimaa et al. (2019) found that 'systemic intermediaries' especially articulate, negotiate and align multiple interests across niches. Furthermore, so-called 'user intermediaries', also articulate (future) demands, their user community has regarding emerging (sustainable) technologies and representing users at the interface of niches and regimes (Kivimaa *et al.*, 2019).

Alignment of actors and possibilities is another key activity, which initiates and strengthens linkages between the various parts of the innovation system. It includes the building and sustaining of networks and the facilitation of interfaces. Or more specifically, as found by Patala et al. (2017), **balancing locality and wider scale**, in which it in their case was ought not only to achieve a degree of standardization in the emphasized local scale but to cover the whole country, also referred to as 'local adaptation' (e.g. some regions had a higher (historical) dominant industry or a higher degree of SMEs than others). Hereby, a national coordinator is in charge of monitoring the activities and outcomes of the local intermediaries and searched for resource synergies between regions not identified in the workshops limited to the regional scale. Besides alignment of actors, also found that intermediaries by Patala et al. (2017) were **connecting actors**; a key method hereby are 'resource workshops', where firms co-located in the same region listed the excess resources as well as needs, this included both 'waste' and byproduct materials as infrastructure (e.g. laboratory space or testing equipment). Besides the more general workshops, also focussed workshops were held, where specific materials and participants were chosen beforehand. Furthermore, Van Lente et al. (2003) also emphasize that

workshops could be used to articulate and align the various perspectives and activities. Lastly, Patala et al. (2017) describe that more informal events for networking and information sharing were held in their case, especially at the local or regional level, for building trust and relational capital among participants. Kivimaa et al. (2019) found more specifically that 'niche intermediaries' make connections between particular and often isolated local innovation projects and with the wider world and 'user intermediaries' connect new niche technologies and practices to citizens and everyday life. They '... instruct users in novel technology by qualifying the characteristics and suitability of new technological options for different contexts, and by configuring technical and social elements of novelty' (Kivimaa *et al.*, 2019, p. 1071).

The last key activity is the **support of learning processes**, for example by enhancing feedback mechanisms and by stimulating experiments and mutual adaptations. More specifically, Patala et al. (2017) found that intermediaries are **facilitating information transfer**. In their case, intermediaries stimulated internal and external knowledge sourcing, through workshops as well as databases and learning from best practices (abroad), organized field trips for knowledge transfer and networking. The internal and external knowledge sourcing hereby refers to intermediaries that besides the workshops, the gathered (resources) data allowed intermediaries to recognize potential cross-region resource synergies. Also, **providing specialized knowledge** was another identified similar activity; firms were consulted that could act as research platforms, especially undertaken by firms that had a strategic interest. Also universities and research centres fulfilled this activity, where altogether a network of experts could be called upon, providing context-specific technical expertise. Thereby, 'process intermediaries help to turn visions and expectations into material actions, facilitate vertical and horizontal cooperation and handle external relations of the projects' (Kivimaa *et al.*, 2019, p. 1071). Altogether, the activities as described above, provide a glimpse of several activities that have proven to be meaningful in a sustainability transition or to promote and initiate related innovations and are presented in the overview of figure 4. This does most certainly not mean this is an ultimate list of effective measures to be taken and taken by intermediaries, hence, it showcases the directions that possible activities should be steered into. Therefore, this list is purposively and preferably kept short.
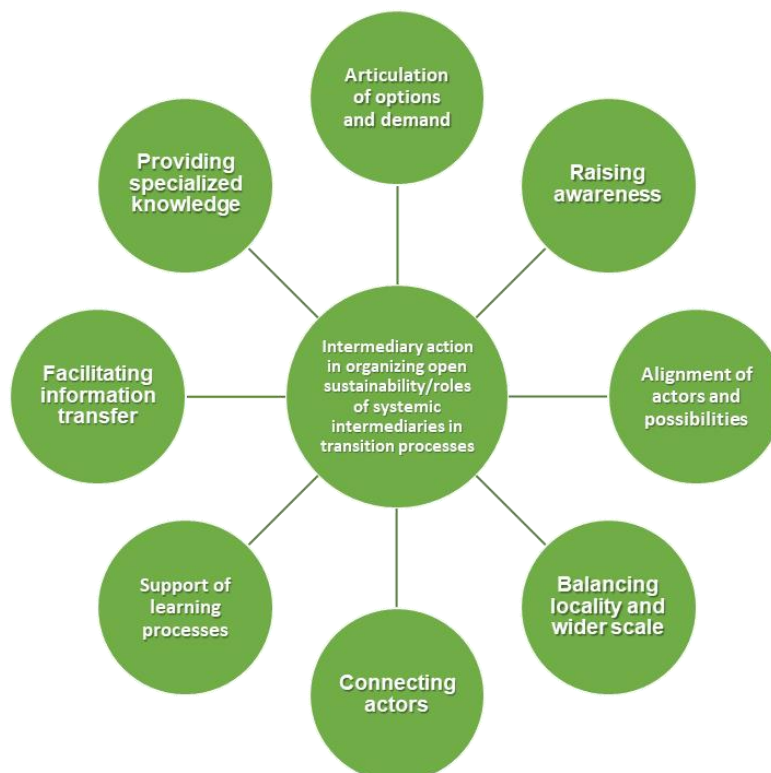

Figure 4 - Identified activities that accelerate sustainability transitions and initiate and promote related innovations. Source: adapted from van Lente et al. (2003) & Patala et al. (2017) and adjusted by author.

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2.5. Synthesis of the theoretical framework

Circularity is applicable in many different ways and places, in which it often becomes complex and difficult to distinguish true effective drivers or enablers, and who (i.e. which type of intermediary) should carry them out and when. Furthermore, the literature assessed by Kirchherr et al. (2018), and Rizos et al. (2016), confirm that there are also many barriers to the latter – businesses adopting circularity – and specified them moreover. Especially cultural barriers as 'lacking consumer interest and awareness' as well as 'hesitant company culture' as found by Kirchherr et al. (2018), emphasize first and foremostly the need for raising awareness among both businesses and policy-makers, in which intermediaries could play a key role according to Van Lente & Hekkert (2003) and Patala et al. (2017).

However, it is also recognized that more (empirical) research among and between different sectors on key barriers when implementing the CE as summarized by Kirchherr et al. (2018), is needed, as there are several uncertainties. These uncertainties hinder the assumption that intermediaries could promote a circular UM industry, and are related to the specific context of this thesis, the (circular) UM industry in the MRA, and, if and how these barriers apply in practice.

First, it should be connoted that studies looking into barriers when implementing the CE, mostly focus on respondents who already have some expertise or experience, and thereby mostly are not including respondents who are unfamiliar or unaware of the CE and its different benefits. Also, how such barriers apply to non-circular businesses who want or could become circular or businesses who are resistant remain therefore absent. Ultimately, barriers among businesses that are less favoured or expected to be less suited, need to be resolved, or at least better explored and mapped. Intermediaries can hereby be required to form collaborations and stimulate radical forms of innovations, with the involvement of actors that traditionally do not work together creating partnerships across sectors and different regions and places (Patala et al., 2017).

Secondly, it cannot be stated with certainty if assigned intermediaries effectively or directly could overcome culture-related barriers that are especially depicted to restrict the transition towards the CE, as especially brought forward by Kirchherr et al. (2018), and, if barriers in general with the help of intermediaries could be overcome. Kirchherr et al. (2018) only assume in this regard that 'a key player' is needed, including the possibility that the (local) government or any other actor could also fulfil this role, but, do not elaborate on any further relevant characteristics or examples. Further remarks on intermediating or multiple types of intermediaries remain absent in their findings.

Thirdly, the samples in the research by Kirchherr et al. (2018) consisted of SME's and not larger enterprises or sole proprietorships, and, fourthly, also not specifically focused on (urban) manufacturers. In conclusion, it cannot, therefore, be stated yet if such barriers also apply to (urban) manufacturers, among which also many different types exist (i.e. their composition and their variation, on which also empirical data lacks), and to what extent.

Regarding fostering and promoting sustainability (i.e. overcoming proposed barriers) and accelerating the transition towards it, towards a CE, various intermediary activities and roles are described in the literature in which their contributions and functions are only recently being explored. Several researchers have looked into how intermediaries can be divided (i.e. types and roles) and what their possible influence(s) are and have been in sustainability transitions. In this regard, there are, in fact, numerous types of possible intermediary actors, as an individual, a specified organization or a temporary partnership could be required to foster or lobby for a certain matter or sector or more general, for open sustainability. It could be, therefore, argued that looking into the typology and role(s) is vague or irrelevant. On the contrary, however, a well defined and functioning ecology of intermediaries '… in which each type of intermediary is deployed in the right way and at the right time,

can speed up diffusion, further improvement and institutional reform needed for accelerating transitions' (Kivimaa *et al.*, 2019, p. 1073), in which such studies focussing on the typology and role(s) of intermediaries could be seen as beneficial. Indisputable, however, is that empirical evidence on the function of intermediaries in sustainable transitions lacks and started only recently (Cramer, 2020). The same applies to exploring the landscape of small manufacturers (i.e. their composition and their variation) and how they exactly (could be) fit in and benefit cities (Clark, 2014), and for the proposed concept of the circular city (Prendeville *et al.*, 2018).

However, for both concepts central for this thesis (UM and the CE), intermediaries are expected to play a key role; in the return of manufacturing (into cities) and thereby and simultaneously stimulate and support new forms of UM wherein sustainability (i.e. circularity) is the main theme or becomes self-evident. According to Clark (2014), intermediaries are essential for smaller UM regarding overcoming restrictions in the supply-chain, labour market and innovation, for example. When looking into which activities intermediaries, therefore, should perform, or moreover, between whom and when, it seems to be there is not much compelling evidence. Here, research has been predominantly descriptive and the different contexts from which researchers have concluded, make it complex to generalize related results, to see if such activities could be proven to be successful elsewhere. Three key activities, however, are found within different examples in practice, that have contributed to sustainability transitions and organizing open sustainability. These are, generally; *articulation of options and demand*, *alignment of actors and possibilities* and *support of learning processes*. These activities are described and endorsed by several researchers, with some deviating or occasionally more specific explanations. When taking into account the most pressing barriers for implementing circularity, 'lacking consumer interest and awareness' and 'hesitant company culture', it could be argued that intermediaries hereby should focus less on governments and more on consumers and companies. Yet, the examined studies in this research point out that in most situations, higher scale governments still are invoked and seemingly essential as such.

This framework of assumed key barriers of Kirchherr et al. (2018) as presented in figure 3, will, therefore, be further examined among UM in the MRA. Moreover, it will be examined how they could be and are overcome, by intermediary activities, of which many examples exist in the literature, but, as for intermediaries in sustainable transitions, lack in empirical data and evidence as a novel topic. Hereby, in the first place and at the same time, the benefits of (sustainable) UM for the city and the CE will be examined and emphasized, ultimately leading to the acceleration of the transition towards the CE.

3.   RESEARCH DESIGN AND DATA GATHERING

This chapter elaborates on the techniques and methods used for answering the main research question, connecting theory and practice, and consists of three parts. Firstly, the research design, where the choices for the used type of research that is conducted and methods are explained. Secondly, information is presented on which data is needed and why and how this is gathered, the data collection. Thirdly, how data is analyzed and used to provide an answer to the research questions is illustrated, the data analysis. Lastly, the validity and reliability of the used research methods is discussed briefly.

3.1.   Research design

This research mainly aimed to better understand how, when and why intermediaries could play a key role in supporting UM in the MRA in becoming in overcoming key barriers as found by Kirchherr et al. (2018). To better understand how this is perceived, as the CE still is an ambiguous and novel concept to many (i.e. interpreted and implemented differently across sectors) and the practices and effectivity of intermediaries in sustainable transitions are also a novel topic, a *qualitative* approach was preferred. More specifically, this is done by foremostly interviewing several different UM throughout the MRA and to see whether they can or already are implementing circularity and to explore what or who constrains them in doing so. Therefore, it was also essential to explore the perspectives and experiences of intermediaries, to see if and which activities as described by Patala et al. (2017) and Van Lente & Hekkert (2003) are identified and used in promoting and identified a circular UM industry in the MRA are effective in doing so. The research approach is therefore *descriptive explanatory*, where relevant data before the study is gathered through in-depth semi-structured interviews using the barriers as found by Kirchherr et al. (2018) and intermediary activities as described by Patala et al. (2017) and Van Lente & Hekkert (2003) as an analytical framework.

This study explicitly does not aim at providing an exact or estimated overview of all UM (that adopted a circular business model) or to point out a favourable way to carry the transition towards the CE. This research also does not aim at evaluating how manufacturers are performing in urban contexts or to evaluate how circularity is implemented differently, but, why differences nowadays exist and how barriers could be overcome to collectively accelerate the transition towards the CE. But, focuses on a better understanding of how and if different UM could be stimulated in becoming (more) circular in practice, which directly and indirectly leads to accelerating the transitions towards the CE.

Accordingly, the *purpose* of this research is to; accelerate the transition towards the CE in the MRA, through UM, by exploring how they function and highlighting their diversity, and to maximize the potential of related intermediaries. The *objective* of this research can be summarized as; to explore the needs and requirements of the UM industry to transform into more circular ways of production. And, to thereby understand the role of intermediaries in addressing and facilitating these needs and requirements in promoting a CE in the field of UM in general, by examining how certain barriers which are identified and confirmed in the literature apply to them in practice and to which extent.

3.2.   Case study

A case study is, according to Yin (2009), one of the most suitable research strategies for conducting as well explanatory as descriptive research. The case studies research design allows capturing a better understanding of the complexities the CE has in everyday contexts, as there is also no form of control over behavioural events (Yin, 2009). For this case study, the units of analysis are UM in the MRA, whereby the boundaries established by the MRA form the geographical scope. Regarding generalization, using this case as a prime exemplar, for example, other cities in the Netherlands, is difficult. More on the external validity is explained in paragraph 3.4. Furthermore, the MRA as a case study to research is chosen for two main reasons:

- This research focuses on barriers for implementing circularity as found by Kirchherr et al. (2018), where it makes sense to explore this also within a region or city that considers itself to become a pioneer in implementing circularity and is certainly more advanced compared to other regions in the Netherlands. Hence, it should be stated, that it is also doubted by several, such as Savini (2017) on the Amsterdam policy for a circular society. Both the MRA and within especially the city of Amsterdam have explicitly, as earlier mentioned, brought forward and communicated their ambition as such externally. Thereby, this region contains several 'circular hubs', mostly to be found in the city of Amsterdam, where the concentration of experiments concerning circularity in different ways is the highest in the whole MRA region.
- UM are not located in one part of the MRA, hence, rather spread out and fragmented, as they are pushed out of highly urbanized areas across the region towards more rural areas and suburbs. The fragmentized and widespread of UM form a good basis for the interference of intermediary organizations to promote a circularity; as they have proven to be effective and active in cases elsewhere with a large geographical scope whereby planning and coordination in different ways become complicated.

3.2.1. Semi-structured in-depth online interviews

This research includes data mainly gathered through interviews. The data was gathered during a complex and challenging time of the COVID19 pandemic. Although, it was not impossible to gather data, creativity, flexibility, and, most of all, perseverance was needed. Hence, two aspects have been taken into account, that explains the use of semi-structured in-depth online interviews for collecting data in this research, which briefly will be illustrated.

First, during the data collection face-to-face on location was not possible, thus, interviews were held online. One interview, however, took place face-to-face, during the only period with fewer restrictions for personal meetings and travelling. The first interview could be considered a pilot interview. Minor changes were made with formulation and the order of questions after the first interview, as interviewing companies individually was a new experience. The following respondents face the same set of themes and questions. A pilot interview helps students with the flow of the interview and to filter out irrelevant questions (Bryman, 2016). Doing the interviews online has its pros and cons. For instance, online interviews require greater commitment and motivation as the internet is still an unfamiliar experience to most (Bryman, 2016), but, (usually) offers the possibility to record. As such, all interviews were recorded with the agreement of the respondents to be able to organize and analyze all data. Additionally, visiting the respondents was not possible, unfortunately, which can be very helpful to get a better overall sense of understanding the context of answers. Especially regarding most respondents of this interview, UM in the MRA, visiting the place of context, where the actual manufacturing takes place, would contribute to a better understanding. As respondents referred to their workplaces and how it all worked. Furthermore, doing interviews online has the advantage the interviewer is more attentive to what is being said and interesting points being made, as the interviews were recorded and could be played afterwards for transcribing.

Second, all interviews were prepared in advance in different ways, but, all revolved around the same topics. The topics list (see appendix 1) was based around the four barriers derived from literature, as found by Kirchherr et al. (2018), that together with related questions formed the structure of the interviews. It is important to bear in mind that flexibility is important in qualitative research (Bryman, 2016), to be able to adjust vague or complex questions into clear and relevant ones. Therefore, the interviews were open for changes, such as the order of questions, for a more open dialogue. Hence, all UM more or less were faced with the same set of topics and several cohering questions. The respondents working for an intermediary organization faced the same list of topics and

questions, of which, of course, not all were relevant. In both cases, this was, also, for example, depending on their professional activities, sector and location they operated in. Occasionally, there was more space to understand and discuss how UM works in practice nowadays, which contributed to understanding the composition and their variation. All respondents were furthermore screened on the forehand, by checking (basic) information on websites, if available. Such as the main activities involved and on the background of the respondents, as visiting examining the workplace locations was not possible, giving an impression that is missed by interviewing on location.

3.2.2. Document analysis

In addition, also the following documents have been assessed;

1. <u>Websites</u>, when available, regarding background information of all the interviewed organizations and all individual respondents.
2. <u>Reports</u>;
   - The <u>report</u> regarding the circular strategy of the municipality of Amsterdam for the next five years: *Amsterdam Circular Strategy 2020-2025*, municipality of Amsterdam.
   - The <u>report</u> *Amsterdam in cijfers 2019* of the department of Research, Information and Statistics (OIS), municipality of Amsterdam. Regarding figures and numbers on population and the housing market and overall general information regarding Amsterdam.

3.3.   Data collection and selected respondents

Two groups of actors are included in the data collection. As indicated in the theoretical framework, there are many different kinds of agendas at different scales at stake regarding promoting and fostering sustainability in general. Hence and therefore, this research also aimed to include the experiences and perspectives of different kinds of UM, in different areas of the MRA, aiming to include manufacturers with different ambitions, visions, and needs (concerning implementing circularity). This to help to clarify the challenges of UM at the beginning of adopting and implementing principles of the CE, as well as that of UM that already priotize this and have proven to be more advanced and proficient in doing so. Often, at first glance the differences between them might not always be noticeable or clear to outsiders, and they also cannot be divided strictly between two groups, hence, it should be connoted that in most cases the more circular advanced businesses clearly communicate this externally and thereby also use this as an unique selling point. Thus, motives and experiences of seemingly less favourable actors and sectors willing to participate are aimed to be included. Ultimately, also this groupneeds to be incorporated to contribute to the CE suitably. Hence, many (larger and industrialized) (urban) manufacturers have already started accepting and implementing the principles of the CE, which mostly remain in less urbanized areas or in (isolated) business parks because their vicinity endangers liveability due to concerning noise levels and odours omitted and also most workplaces and production areas for them are not suited in inner cities. Thus, this resulted in a mix of UM that aimed to included more or less advanced ones regarding adopting principles of the CE and those in more or less urbanized areas and in different parts of the MRA, to investigate the potential and possibilities of circular UM in different urban contexts. Hence, all UM were chosen with the only strict precondition of being located in the MRA, and can thereby be found within a 20 kilometer radius of the city of Amsterdam, except for one respondent situated at the Binckhorst in The Hague, a former industrial site being redeveloped. The insights provided by different UM will highlight how the UM industry could and should evolve to accelerate the transition towards the CE, from a manufacturers perspective.

Also, two experts within the field of intermediating (i.e. individuals active or working for official intermediary organizations) in sustainable practices were interviewed to obtain knowledge on the process of guiding sustainable transitions. Specific or key intermediary actors that are specifically concerned with promoting and fostering the principles of circularity in the manufacturing industry in Amsterdam are not in abundance. On the national and international scale, however, several organizations are actively involved in promoting the CE among manufacturers, however, such organizations are often less focussed on smaller and craft orientated businesses and operate and focus moreover on a larger scale. Such organizations possess the ability (i.e. human and financial capital) and knowledge to guide and connect existing initiatives that accelerate the transition towards the CE. Furthermore, these perspectives present the first insights into what intermediary actors should (and could) offer in this regard, for UM in the MRA specifically. This way, the majority of data on perspectives and experiences is related to the situation in the MRA, which subsequently are compared with the answers provided by the single respondent located in The Hague, also facing uncertain times due to nearby developments that are restructururing the whole area. Regarding the response rate, several respondents declined to participate, mostly due to lack of available time, a few due only willing to meet face-to-face and a few were not sure if they could be seen as a UM often due to their scale and or activities. The respondents that indicated not to be sure if they could be included in this research as they were uncertain if they could be considered as a 'manufacturer', indicate that the term might needs further exploration or a refined definition in the MRA, and also could imply that current related policy is not always easily applicable or clear.

Most respondents were found through search engines such as Google and using established networks and platforms. As Lane & Rappaport (2020) report, UM differs per region and even per city, therefore, a certain sector was also not of focus. When using search engines, more general search terms were used such as ('urban manufacturing', 'sustainable manufacturing', 'manufacturing businesses Amsterdam' (manufacturing business and industry were translated in Dutch as 'maakbedrijf' and 'maakindustrie')). In total four respondents were found through search engines. Also, the database of the intermediary organization Amsterdam Made was frequently used through which three respondents were found. There are several other (non)-governmental related networks or platforms focussed on supporting and identifying sustainable businesses (and citizens) with similar databases. Another database used was from the website of 'The next generation', an online platform that encourages Amsterdammers to live more consciously, with 'Ecopreneurs', through which one respondent was found. Through the network as being part of the project of Liveable Manufacturing, as part of an internship, two respondents were contacted who also participated in this research. This way, UM more experience and with higher recorded ambitions were found. All interviews were held in the months of august and september of 2020.

This research aims to also include those UM with less (visible) experiences or recorded ambitions, hence, approaching businesses with such perspective could lead to depict and frame them as such. Therefore it is decided not to include any names of (or the related materials/products they work with or produce) respondents or which businesses or organizations they represented, in guaranteeing anonymity (Bryman, 2016), a term often used either interchangeably with, or conflated with 'confidentiality' (Saunders *et al.*, 2015). Respondents were, thus, assured to speak freely, and, if any quotes or information would directly and clearly lead to them, they would be informed before publishment of the report. All respondents were informed of this before the start of the interview. Guaranteeing complete anonymity can also be seen as an 'unachievable goal', because of actors with more insights, true anonymity is, thus, by definition never achievable (Saunders *et al.*, 2015).

Concerning anonymising the respondents, hence, also to able to highlight the diversity of the respondents, (only) certain key characteristics are revealed. The 'SBI code' is a code used in the Netherlands to describe the main activity of a company and is provided to highlight the diversity of the interviewed respondents, also the number of employees is shown to indicate the size of the company. The overview of respondents is shown in table 3.

Table 3. Overview of respondents on which data is gathered. SBI codes are retrieved from https://bedrijvenmonitor.info/.

ORGANISATION TYPE	TYPE	SBI CODE	POSITION	INTERVIEW	NUMBER OF EMPLOYEES
URBAN MANUFACTURER	Private	3109 45402	Co-owner, Manufacturer	1	2
RURAL MANUFACTURER	Private	16101 31011 74102	Proprietorship	2	1
RURAL MANUFACTURER	Private	2229 32502 74102	Proprietorship	3	1
URBAN MANUFACTURER	Private	46491 47641	General Manager	4	50+/-
URBAN MANUFACTURER	Private	3092 46491 47641	Co-owner, General manager	5	2
URBAN MANUFACTURER	Private	16101 16102	Chairman, General manager	6	40+/-
URBAN MANUFACTURER	Private	1102 4634 55102	Food and Beverage Manager	7	10+/-
URBAN MANUFACTURER	Private	1051 47819 5621	Proprietorship	8	1
URBAN MANUFACTURER	Private	31011 9002	Owner, General Manager	9	5
INTERMEDIARY ORGANISATION	Semi-public	94996 94997	Managing director	10	N/A
INTERMEDIARY ORGANISATION	Public	N/A	Strategic advisor	11	N/A

3.4. Data collection and analysis

The data analysis process was extensive, also more since each interview was transcribed completely. All interviews were recorded, and, therefore, accessible and well organized. When certain matters were unclear or information or appeared to be missing afterwards, respondents were contacted again. Each interview was analyzed roughly afterwards directly, to get a better grasp on which topics more or less information was needed to achieve overall theoretical saturation. Analyzing ongoing activities allows the researcher to be more aware of emerging themes that could be asked more directly in following interviews (Bryman, 2016). For example, some UM were active in one or more similar sectors or shared similar methods or procedures in which it especially was possible to refine questions and how certain topics should be discussed in the next one(s). Altogether this way (substantive) inconsistencies were cleared. After the last interview, all interviews were coded with Nvivo, a software programme designed for transcribing and coding interviews easily, which, as abovementioned, are time-consuming processes. The interviews were coded using two different methods, together resulting in two lists used for coding. First and foremost, a theoretical coding framework was used revolving

around the four barriers and the intermediary activities (see appendix 2). Also, a coding framework in a manner more related to 'initial coding' (Bryman, 2016) was used. The most frequent codes were compared to each other, whereafter the most significant and relevant codes were used, focussing on which other initial codes to use. This led to the second set of codes (see appendix 3) on which all interviews also are coded which later were analyzed.

3.5. Validity & reliability

Semi-structured interviews are used as the main method of collecting data for two reasons, as brought forward by Bariball & While (1994). They are well suited for the exploration of the perceptions and opinions of respondents regarding complex and sometimes sensitive issues and enable probing for more information and clarification of answers (Barriball & While, 1994). In this case, this research might reveal that there is indeed limited capacity or attention from the municipality for further developing a (circular) urban manufacturing. Also, the varied professional, educational and personal histories of the different respondent groups precluded the use of a standardized interview schedule (Barriball & While, 1994). Also, semi-structured interviews can be used to overcome language barriers, that is, for example, among different kinds of manufacturers that do not speak in the same terms, as (re)production processes could be very different and whereby UM speak different jargon and technical languages. Upon internal validity and reliability of this type of interview, this is not ensured through repeatedly using the same words, but upon conveying equivalence of meaning (Denzin, 2017).

Respondents were carefully selected, providing reliability and internal validity of the results. Some several criteria or conditions implied using different sampling approaches and sources to find respondents. Respondents in this research are gathered by using two sampling approaches. Generic purposive sampling, as well as snowball sampling, are used (Bryman, 2016). Respondents are purposively sampled to achieve theoretical saturation (Bryman, 2016), based on several criteria, or conditions, instead of committing to interview an *x* per cent members of particular organizations or sectors. Saturation and sample size are hereby important but also difficult to determine in advance, as this is also depending on the willingness of respondents to agree to an interview. The four criteria or conditions for sampling respondents in this research to achieve an overall theoretical saturation, intended to include; (1) larger as well as smaller UM, (2) more and less experienced businesses regarding implementing circularity in their business models, (3) UM situated in urbanized as well as more rural situated ones, and (4) to include different sectors as there is not an over-represented group of UM present in the MRA.

Achieving external validity with this research, as earlier mentioned, is difficult. Firstly, since the UM industry, as indicated by Lane & Rappaport (2020), may differ from region to region. Secondly, as other regions and cities may not have the same advanced or no ambitions at all regarding implementing circularity whereby they do not depict themselves as becoming a pioneer in implementing circularity. And, thirdly, UM in other regions or cities have different urban fabrics and fewer or more urban developments planned that also influence how and if a widespread penetration of the CE is achieved. Hence, the results of this study could foremostly give certain explanations, implications and hints for suited and immediate changes in policy regarding promoting and fostering a circular UM industry in the MRA. Hence, this research attempts to in any case encourage policymakers and city planners to take action and to delve (more) into the matter of the CE and the UM industry in how it will and can develop to be able to make optimal use of both and to prevent those involved and active to feel overlooked.

4.   THE ROLE AND PLACE OF THE UM INDUSTRY IN THE MRA

The geographical scope of this study is the MRA, with a focus on the city of Amsterdam. The area of research, the MRA, is shown in figure 5 below. The city of Amsterdam is the financial and business capital of the MRA and also of the Netherlands and the fourth largest port of Europe (Fratini *et al.*, 2019). The city of Amsterdam furthermore also has a geographically central position in the MRA. And with currently around 821.000 inhabitants it is also the largest city in the Netherlands. From a governmental perspective, especially the municipality of Amsterdam is actively involved in the transition towards the CE in this region. In their latest strategy regarding the implementation of the CE, the municipality of Amsterdam depicted itself to serve as an example to inspire market parties as well as Amsterdam's residents and visitors (Fratini *et al.*, 2019; Gemeente Amsterdam, 2020), however, not specifically mentioned to inspire other cities. The manufacturing industry, furthermore, is not part of the latest circular strategy of the municipality of Amsterdam (Gemeente Amsterdam, 2020). Instead, the municipality of Amsterdam focuses on three other value chains out of the five chains formulated by the national governments, which are; (1) food & organic residual flows, (2) consumer goods, and (3) built environment (Gemeente Amsterdam, 2020). According to Fratini et al. (2019), Amsterdam, among other cities such as London and Paris, could be considered as an 'extreme case' in advancing and implementing the CE, as these cities '... *have purposively chosen circular economy as a productive imaginary with which to drive and shape urban transformations in the making' (Fratini et al., 2019, p. 978).*

Figure 5 - map showing the boundaries of the MRA, Amsterdam and several other (nearby) cities. Source: adapted from https://hollandcircularhotspot.nl/cities/metropole-region-amsterdam/.

The effort of the municipality of Amsterdam for accelerating the transition towards a CE (i.e. circular society), has been noticed and researched by several researchers, such as Savini (2017), which states this transition is mainly restricted by two barriers; the un-adaptive legal frameworks and culture of linear production based on supply-consume-waste models (Savini, 2017). But, Savini (2017) also connotes that different various solutions already have been commissioned and applied by the municipality of Amsterdam. In sum, these solutions aim to deregulate and inform as '... old rules do

not work and must be removed, and that old cultures do not work and must be changed through better and more informed communication' (Savini, 2017, p. 132). Savini (2017), furthermore, confirms that governments initiate and promote circularity, in which the municipality of Amsterdam especially contributes to their second aim by '… showcasing and linking a set of existing initiatives which can be epitomized under the label of circularity' (Savini, 2017, p. 132). In conclusion, the efforts of the municipality of Amsterdam are efficient, however, in a transition, it is evident that '… experiments and more communication do not necessarily lead to a radical change of the whole urban system of production and consumption (Savini, 2017, p. 132). In this way, hopeful and successful experiments will remain as experiments and disconnected from each other and the broader audience, rather than leading to structural change which eliminates the current take-make-waste system (Savini, 2017).

There are many initiatives, organizations and the ambition itself in the MRA to accelerate the transition towards the CE. The majority of such examples are increasingly being found in and around Amsterdam, and especially within certain hubs, the often so-called 'circulaire broedplaatsen' (literal translation; circular breeding grounds), such as De Ceuvel in Amsterdam North. An interesting recent development within the city of Amsterdam, more focused on UM more accordingly to principles of the Maker Movement, is Made Up North. This project is presented as located in the hectic and for creatives often popular area the NDSM-wharf. They describe the project as follows; '… an alliance of companies at the NDSM, schools, architects, stakeholders and other creatives who have been working for a few years on a plan to transform part of the former shipyard into a so-called manufacturing city, in which there is room for craftsmen, vocational schools, creative companies: from fashion to electric motors, from 3D printing to carpenters, as long as they make something' (Couzy, 2020). This plan describes and confirms that UM and related projects have to compete with other urban developments, as, even though the plans are advanced, the project is no longer going ahead, because, according to the alderman, homes are needed in this area. An impression of this project was envisioned was also already made and shown in figure 6.

Figure 6. The 'manufacturing city' as envisioned by Abels & Partners Architecten, surrounding and maintaining the current restaurant Pllek. Source: adapted from https://www.parool.nl/nieuws/alternatief-plan-voor-ndsm-een-wijk-voor-ambachten-en-vakscholen~bd82ffd1/.

In their latest development plan (Ontwikkelplan Circulaire Economie MRA, 2018), furthermore, it is stated that by 2025 the MRA will place itself among the top globally regarding circularity. Regarding the UM industry itself, the MRA argues for 'modern forms of UM' that are to be found in 'creative/productive' living and working areas (Metropoolregio Amsterdam, 2018). There are also many manufacturers to be found throughout the region, and, for example, a guided network community, Amsterdam Made, consisting of around 150 manufacturers working towards a more sustainable and local economy in different ways and forms is already established (Gemeente Amsterdam, 2016). Hence, the majority[1] of manufacturers is tied to the current urban economic system, the linear economy. Manufacturers are, to a lesser extent, established in the city of Amsterdam itself, and, if so, more centred in and around (isolated) business parks. This is due to the high amount of inhabitants and the scarce amount of locations available, where (new) developments in popular areas have become an expensive, complex and often sensitive matter in Amsterdam, especially for smaller UM seeking to survive and to fit in. In the coming years, as such, the municipality of Amsterdam (as many other urban municipalities) expects that a significant amount of affordable and sustainable housing is needed, as pointed out in chapter 1. Hereby, liveability for inhabitants as well as the proper functioning of sustainable UM is not broadly discussed and explored or a popular topic, on which the abovementioned research project is focused. This study, thus, sheds light on how UM in the MRA as a declining and overlooked industry, could be preserved in a way suited for the future (i.e. circular) and its surroundings (i.e. without affecting liveability). This will be done by looking at how key barriers that are identified and described in the literature for becoming circular are at play and are (or could be) overcome with the help of intermediaries.

Some regions in the MRA stand out in terms of types and forms of UM, whereby UM are and have been more located in certain areas than in other areas in the MRA, for example, the Zaanstreek, located an area which is a stone's throw away north from the city of Amsterdam and perhaps the oldest industry regio of Europe. The Zaanstreek in particular has a long history with wood processing and the food industry. Manufacturers are, to a lesser extent, established in the city of Amsterdam itself, and, if so, more centred in and around (isolated) business parks. This is due to the high amount of inhabitants and the scarce amount of locations available, where (new) developments in popular areas have become an expensive, complex and often sensitive matter in Amsterdam, especially for smaller UM seeking to survive and to fit in. In the coming years, as such, the municipality of Amsterdam (as many other urban municipalities) expects that a significant amount of affordable and sustainable housing is needed, as pointed out in chapter 1. Hereby, liveability for inhabitants as well as the proper functioning of sustainable UM is not broadly discussed and explored or a popular topic, on which the abovementioned research project is focused. This study, thus, sheds light on how UM in the MRA as a declining and overlooked industry, could be preserved in a way suited for the future (i.e. circular) and its surroundings (i.e. without affecting liveability). This will be done by looking at how key barriers that are identified and described in the literature for becoming circular are at play and are (or could be) overcome with the help of intermediaries.

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[1] The exact amount of 'circular' and less or 'non-circular' UM in the MRA is unknown, due to the ambiguity on the concept of the CE which makes it complex to measure circularity, thus, an exact overview of UM that have been able to adopt principles of circularity or have the ambition to be (more) circular is also not available.

5. DATA ANALYSIS AND RESEARCH FINDINGS

This chapter presents the results of the qualitative analysis. The results are obtained through eleven in-depth semi-structured interviews with various manufacturers throughout the MRA and two officials working for an intermediary organization involved in both or either the CE and UM. The objective and the subquestions of this thesis structure this chapter; first, the findings on which and how certain barriers apply for becoming more circular among UM in the MRA are presented. The key barriers as presented by Kirchherr et al. (2018) for implementing circularity and how they may or may not apply among UM in the MRA are presented hereby. Thereafter, how (i.e. which intermediary activities are identified or needed) and which such barriers are overcome, and by whom and how they (ideally) should be overcome will be presented.

Besides the research objective and subquestions, the theoretical framework (chapter 2) connoted that there is a lack of empirical evidence on the topic of the circular city, intermediaries and through which activities they effectively contribute to sustainability transitions and on how the landscape of smaller UM (i.e. composition and their variation) looks like and operates and functions in today's practice. The circular city is still a complex and ambiguous concept, and is, therefore, not included in the data gathering, and, thus, not in the results. How intermediaries effectively contribute to sustainability transitions and how the landscape of smaller UM looks like, operates and functions nowadays, on the other hand, contributes to the objective and subquestions, and is, therefore, taken into account in the results. Regarding the lack of empirical evidence on the landscape of smaller UM, in this research, mostly UM smaller in size were included, but, also a few larger ones are examined, on which both also will be reflected. For instance on how and what the city provides them and vice versa. All interviews with UM also started with a general and informative part where an acquaintance was made with the type of company, the interviewee and general information emerged in which the makers and their activities were extensively discussed. This also includes discussions with the interviews on their views on sustainability and on the position of manufacturers in urban environments and reasons for whether or (when) not to become more sustainable. Their views on sustainability among UM, and on sustainability in general, will also and finally briefly be discussed.

5.1. Key barriers for becoming more circular

The findings on the barriers will be presented in the same sequence as discussed and handled by Kirchher et al. (2018). Thus, first, the cultural barriers will be discussed which have been pointed out to be the most pressing ones by Kirchher et al. (2018), subsequently, results on market, regulatory and technological barriers will be presented. The results are usually described from the angle of the full sample, however, marked differences, if identified, will be discussed from a specific stakeholder angle (with the stakeholder groups being 'urban manufacturers' and 'intermediary actors or organizations). Furthermore, the results are supported and elaborated with quotes from the semi-structured interviews.

Before handling the results per barrier, some notable and more general findings will be presented. In total, fourteen barriers were identified by Kirchher et al. (2018), divided into four categories, which have been juxtaposed with all the eleven interviews, roughly confirming them, but, also revealing several minor differences. For instance, two out of the proposed fifteen barriers were not identified within the interviews of this research. The two barriers which are not identified (i.e. directly mentioned) are 'Lacking standardization' and 'Limited funding for circular business models'. None of the interviewees discussed or brought up these two market barriers during the conversations. The **most addressed barrier** was the market-related barrier, '**High upfront investment costs**', which was **mentioned in nine out of the eleven** (82%) interviews, followed by the cultural barrier, 'Lacking

(consumer) awareness and interest', which was mentioned in six out of the eleven interviews (55%). Subsequently, 'Operating in a linear system', 'Obstructing laws and regulations' and 'Lacking ability to deliver high quality remanufactured products' were mentioned equally (36%), in three out of the eleven interviews. Several conversations within the conducted interviews brought forward four barriers or examples that are not directly relatable to any of the fifteen barriers. These examples, could, however, be attributed to two out of the four categories of barriers; three out of these four references could be specified as a technological barrier and one example could be specified as a market barrier. These four examples will respectively be mentioned when presenting the results of each respective category. Furthermore, it should be noted that most barriers or mentioned examples are not related exclusively to a single category, meaning that there are several examples brought up in the interviews that are and could be related to two (or more) categories. And, lastly, most examples are found among the most broadly mentioned barrier 'High upfront investment costs', in which sixteen examples or situations are relatable to this market barrier. In sum, most references mentioned by the interviewees, are related to cultural barriers, table 3 provides an overview of the abovementioned results.

Table 3. Bariers to the CE – interview results.

Categorie	Mentioning of each barriers in percentage and rank (in brackets)		Amount of references
Cultural	Lacking consumer interest and awareness	55% (2)	14
	Operating in a linear system	36% (3)	8
	Limited willingness to collaborate in the value chain	18% (5)	3
	Hesistant company culture	18% (5)	4
Market	High upfront investment costs	82% (1)	16
	Low virgin material prices	9% (6)	1
	Lacking standardization	0%	0
	Limited funding for circular business models	0%	0
Regulatory	Obstructing laws and regulations	36% (3)	6
	Lacking global concensus	27% (4)	4
	Limited circular procurement	9% (6)	3
Technological	Lacking ability to deliver high quality remanufactured products	36% (3)	6
	Lack of data, e.g. on impacts	18% (5)	3
	Too few (large-scale) demonstration projects	9% (6)	1

5.1.1. Cultural barriers

In the theoretical framework it was depicted that when adopting circularity, among businesses and policy-makers, cultural barriers were found to be the most pressing. Hence, this was reviewed among the interviewees. It appeared, as briefly mentioned above, that also among the respondents of this research, in sum, the most barriers are culture-related. All cultural barriers were mentioned through multiple examples, with seven respondents mentioning at least one example that was related to cultural barriers. The most mentioned cultural barrier among the respondents is 'Lacking consumer awareness and interest', six respondents have experienced culture-related difficulties, in line with the findings of Kirchherr et al. (2018). Respondents indicated that not only consumers lack awareness and interest, but, also policy-makers and businesses they cooperate with, in different ways. References were, furthermore, related to other businesses (nearby), partners and local governments, lacking awareness and interest. Thus, there is not a specific group of actors lacking awareness and interest among the mentioned examples. However, there are marked differences in what they lack.

'Lacking consumer interest and awareness', regarding consumers, for example, appears to be relating that they are not (fully) aware of the different businesses putting in more effort in more sustainable business models. Or, as one respondent pointed out; *'… we have forgotten how to do something sustainable' [**interview 6**]*. Vice versa, it appears that businesses are not always so sure through which ways they could (better) contribute to sustainability. This comes into being due to an abundance of possibilities becoming more sustainable, being already implemented by nearby businesses, with a (local) government that is not supportive and clear in informing, or, as a respondent formulated, regarding the production and use of green energy generation;

> *«I think that plan really has to come from the state to make people aware of something and actually make things happen. Because it is so unknown now, there are so many different companies working on this, that you don't really know when and if you are doing right.»* [*Interview 1*].

This struggle is also described in the literature by Rizos et al. (2016), which stated that especially SME's that are familiar with and already adopted circularity, are hindered in doing so due to a 'lack of government support/effective legislation' in this regard. In addition, customers are often uninterested due to price differences, although the MRA and especially the city of Amsterdam projects itself as a pioneer in becoming circular, its citizens still are (kept) less willing to contribute in paying (more) for this matter. It was indicated by a respondent that in this regard that, although being able and having the possibility to incorporate more sustainable materials and methods, that *'… the market is too small with people willing to pay for it' [**interview 1**]*. In addition, it was mentioned that *'… as a small company it is still too dangerous to profile yourself as a sustainable company in the reuse of materials' [**interview 1**]*. Willing and being able to incorporate sustainability does, thus, not always imply that there will be enough potential customers, and, in addition, Kirrcherr et al. (2018) state it is difficult in changing and convincing people to change awareness and interest. Another respondent, situated in a business park in Amsterdam Noord, came up with a similar statement, after several attempts in offering a vast amount of leftover materials for reuse. Stating that nobody nearby is alert or willing in picking up leftover materials, which ended in throwing away all the materials when moving to another place *'… because nobody comes to pick it up',* and, sustainability in general, is *'… not really a topic of conversation among entrepreneurs' [**interview 9**]*. UM often end up with a lot of materials, especially in niche sectors and markets, because they are often tied to the wishes of customers resulting in demanding unique and custom made products. Another respondent came up with the following statement regarding the lack of interest, for example, in leftover materials;

> *«… we are used to burning our waste, and that we do not like buying second-hand things, so people's behaviour, that everything must be new in new houses, that is in investments but also in behaviour.»* [*Interview 11*].

Another respondent who makes active efforts and is working with leftover and recycled materials, states that both the local municipality and potential consumers lack interest and are not fully aware of more sustainable options and practices. The respondent mentioned that *'… the municipality probably doesn't even know what I'm doing'* and that *'… consumers do not see what is being offered' [**interview 3**]*. It appeared that intrinsic motivation and ambition developed over years was the foremost reason the respondent was (still) involved in becoming more sustainable. This intrinsic motivation was actively being communicated to the outside world, hence, it was indicated most customers were not interested and found the respondent through word of mouth for other reasons. Furthermore, several respondents mentioned that their efforts in general in being and becoming more sustainable rarely are being discussed with customers and in their supply chain partners, and, these conversations are shallow and very brief. 'Lacking consumer interest and awareness' could, however, be solved by

educating others, one respondent also explicitly mentioned that a cultural change in schools and universities has to take place, that people *'…may and must therefore also see that adding something to society is also very important'*, but, in addition, came up with the following statement; *'…I can lecture and teach, but I think I should first be able to prove that what I do works' [**interview 2**]*.

'Operating in a linear system' as a second-most mentioned barrier implies that it is important to note that, although a manufacturer has committed to becoming more circular, the essential infrastructure is not guaranteed or even resisted. Or, as a respondent explains;

> *«If you want to promote circular entrepreneurship, you often see that it is not just about one company that wants it, but, that company needs partnerships in the [value] chain and sometimes also in the region and also needs help from institutions (e.g. regional governments or implementing organizations). So, very soon already have a small network that wants to bring a circular concept to the market. And, that network has the obstacle that there is an existing way of acting and that network must and can solve that.» [Interview 11].*

Many respondents feel they are the only ones in their environment adopting circularity or thinking about ways to achieve this. On the other hand, most UM are unique in doing so, which offers the chance to sell this as a unique selling point. But, it appears that although this could be seen as a unique selling point, the demand is often still too low. And, as pointed out earlier, if doing so, as a small company it is difficult to then compete with more 'conservative' nearby businesses in the same sector, offering the same products for a cheaper price. Being located in a larger city, thus, brings the advantage that there are more potential and willing buyers, but, also a disadvantage as *'… circular companies cannot (properly) sell their goods, because linear companies are cheaper or have an advantage (i.e. because of current contracts, ingrained habits and opinions). You're just used to doing certain things in a certain way and that's a resistance for a newcomer' [**interview 11**]*. It was found by one respondent that 'Operating in a linear system' is the foremost pressing barrier of all, for UM in general in becoming more circular. Referring to 'stranded assets' (e.g. contracts and installations) much businesses often have to deal with and are tied to.

'Limited willingness to collaborate in the value chain' was also mentioned by several respondents through a few examples. For example, it was indicated that obtaining leftover or material for recycling and reuse is a complex and often costly matter. And, when engaging and seeking *'… such a company just shows what they want you to see. There is not enough supply.' [**Interview 1**]*. Consequently, when being allowed or being able to get access to (nearby) leftover or recycled material, a respondent expects that his customers would not be willing to pay more for more sustainable options, and, that especially private individuals would *'… be even more difficult about money'*, and*, '… that is ultimately the 'killer' for green plans; that companies do not want to pay more for it.' [**Interview 9**]*. In addition, one respondent mentioned that willingness should come from within; '… *if I stand for or do something, I want to decide that for myself and I personally find people who assign things for others to be very hypocritical' [**Interview 1**]*.

A **'Hesitant company culture'** was the least mentioned cultural barrier among the respondents, contrary to the results of Kirchherr et al. (2018), where it is mentioned as the second most pressing barrier. This is likely to be due to the fact some UM were not at all or less involved in implementing circularity in their business models, hence, not faced this barrier to its full length. Also, on the other hand, this might be because UM that embraced and implemented circularity from the beginning, as a start-up, for example, have such principles as a matter of course. A 'Hesitant company culture' may be caused by 'Lacking consumer interest and awareness', which subsequently is the result of 'Low virgin market prices' (Kirchherr *et al.*, 2018). For example, as mentioned above, it is indicated that ultimately

customers who are interested in sustainability, are not willing to pay extra, due to the plenty nearby and often cheaper options due to 'Low virgin material prices'. This might give the false prospect that there are not enough interested customers or businesses, as a result, necessary investments may be missed or not even discussed within. Funding, according to Kirchherr et al. (2018), often is due to this 'gut feeling' (of business leaders) doubting towards the CE, which embodies the barrier 'Lacking consumer interest and awareness'.

5.1.2. Market barriers

Kirchherr et al. (2018) found that in literature many authors referred to market barriers as a consequent barrier for the transition towards the CE, but, also that De Jesus and Mendonça (2018) contradicted this in their literature review. Contrary, they found that technological barriers are even more pressing (De Jesus & Mendonça, 2018) on 'the road towards the Circular Economy'. Among their respondents, Kirchherr et al. (2018) confirmed that market barriers indeed play a key role in hampering the transition towards the CE, with two of their five most pressing barriers identified being market ones, placed second after cultural barriers. They found 'Low virgin material prices' as the third most pressing barrier, and, 'High upfront investment costs' as the fifth most pressing barrier. In this research, the two other market barriers **'Limited funding for circular business models'** and **'Limited standardization'** were not explicitly mentioned through any example by any of the respondents.

'High upfront investment costs' was the most mentioned barrier among the respondents of this research, sixteen references in total were made that are related to this barrier. Commonly, as portrayed and found by many other researchers, the transition towards the CE often requires financial investments for various reasons. For example, investments are needed for new technologies and equipment that are more efficient in different ways, but, also for changes in workplaces due to a new way of working (i.e. new and different processes). One of those investments, for example, could be for integrating 'backward chains', as explained in paragraph 2.3.2., where a business takes into account the reparation and restoration of products, by also taking back their sold products or offer related services and mechanisms. Naturally, such investments are also dependent on many other factors, such as willing consumers that in the first place become and are aware and willing to cooperate. Nowadays, many UM willing to engage with the CE, that want to become a leading example, are dependent on (governmental) subsidies. However, necessary installations to become engage with circularity and such a leading example, are often still *'… often complicated and expensive and also time-consuming'* *[Interview 1]*. Also, the majority of materials are still often sourced elsewhere, as nearby options in the city still are very expensive, whereby it appears that urban mining is still a challenging, and, foremostly, a costly practice. Urban mining is, thus, not impossible, but, often seems to be hindered by regulations and therefore not tried as it is expected to be very costly in effect. One of the respondents had the following view on how different types of UM (concerning size) looked upon implementing sustainability with investments costs;

> *«In the manufacturing industry, just like with people, you have frontrunners, the pack and the laggards. You could say the frontrunners are part of the transition team and make the implementation programme/agenda. I think that the main group you are talking about, the SMEs, see sustainability as a major expense; if we have to, we have to and we do it wholeheartedly. But it does cost money, for example, about sustainable energy consumption/saving, then that is approached as; 'I do what I have to do by law and what do I find useful for myself to put on extra, but it gets in the way of me when it comes to a 'level playing field''.»* *[Interview 11].*

The CE therefore often becomes a 'costly hobby' as the target market is ought to be very small, *'… I would like it if people with a lower income could also buy my cheeses, that is not always the case.*

Something that I personally find difficult, that that is not the case' [Interview 8]. Those willing to pay often live in more popular neighbourhoods. Therefore, for UM engaging with sustainability, it seems a logical fit to be located nearby shorten routes; *'… the link between producer/maker and consumer is missing in my view' [Interview 3]*. One respondent doubted this thought, stating that *'… you have to 'lure' people a bit. I don't know about the ability to sit in a residential area with trucks etc.' [Interview 7]*. Having a suited workplace almost anywhere in Amsterdam, hence, already is very costly, for the average UM who is willing and for whom it is possible to engage with circularity, besides the nuisance that is often hindering this in the first place. Furthermore, they have to compete for space with many other UM that are less willing or suited to engage with circularity. Or, as one respondent connoted currently situated in a rural area, but, willing to settle in Amsterdam for different reasons, such as seeking creative collaboration; *'… it is impossible to sit in the Jordaan, it is really too expensive there. Sole proprietorships need more support in this … If I ended up next to a […], that would result in nice collaborations, we could reinforce each other.' [interview 3]*, while being 'stuck' in a location where the local municipality is not aware of sustainable ambitions and activities in general, as indicated. 'High upfront investment costs' due to new technologies and equipment can also be solved from within, however, most UM do not have the financial capacity to set up whole separate R&D department or innovation team, thus, depending on others providing information on trends and possibilities regarding sustainable innovative technology and techniques. Related to the fact that UM often are situated in isolated monofunctional business parks, communication and marketing have become an increasingly essential asset. One respondent mentioned in this regard that, *'… a small sole proprietorship with communication problems, for example, simply cannot afford a large communication agency'*, and, hence, *'… the tips among themselves are more valuable and tailor-made' [interview 10]*. One respondent noted an innovation team was set up by winning a contest set out by the MRA, but, funding in general and hereby finding partners remains a difficult task. Kirchherr et al. (2018) portray that a 'hesitant company culture' might be the cause (of UM) in finding the (right) funding partners is difficult in practice, possibly because the potential benefits of the CE are not considered often enough. One respondent noted in this regard, that a (sustainable) UM industry, therefore, should be subsidized, as in other places;

> *«… like in the old days, a woodworker in the city, a specialist baker, the small scale, that makes the quality of life so much better. There simply has to be sponsored like in San Francisco. Just like social housing, it just has to be. Money has to be spent on that, otherwise, they will all disappear. They are all already disappearing because it is just getting too expensive. Rents are becoming too expensive and such, so I think there should just be a policy. Because that makes us all very happy in the end.» [Interview 10].*

Lastly, 'High upfront investment costs' often play a role because smaller manufacturing companies involve unique, handmade, tailor-made runs and products; *'… the expense is really too small and we have to make a huge investment for something minimal' [Interview 5]*. **'Low virgin material prices'** are the main cause of cultural barriers, according to Kirchherr et al. (2018), and, in this research, there was only one respondent that explicitly mentioned this barrier. The respondent stated that most leftover materials are not or poorly designed and suited to reuse, and, therefore, *'… picking up or buying a new […] is cheaper then'*. Hence, the respondent explained, *'… the offer is certainly there, but, it is not always usable' [Interview 9]*. The advantages of using leftover or second-hand materials and products, thus, appear to not outweigh the disadvantages, which mostly seem to be cost-related, leaving many potential possibilities and willing UM to not pursue the next step on their own. Or, as experienced and pointed out; *'… often you run into that it often costs a lot and that is precisely the challenge; to come up with things that are just as expensive, but more durable [Interview 7]*.

The market barrier related example, which is not attributed to any of the barriers, was related to how to profile and present as a smaller UM willing and being able in becoming more sustainable. Internally it is often more common to discuss options and ways to become more sustainable, hence, this can lead to problems when communicated externally;

> *«… we do not necessarily present ourselves as a sustainable company. If we can work with it, it will always be our priority, but as a small company, it is too dangerous to profile yourself as a sustainable company in the reuse of materials. Simply because the market is too small with people willing to pay for it. At a certain point, you will run out of things because the market is simply too small and willing to have a custom piece made, let alone with sustainable (expensive) materials. So it is not really one of our points with which we advertise that we only work with certain types of […], although we really want that, so the customer is really king.» [Interview 1].*

Another respondent furthermore explained to this that it does not always add value and goals and ambitions are not essential; *'… it can keep you sharp. I'm also not really that enthusiastic about people who say that out loud/often. I think you just have to do it right and if people ask you can explain it yourself.'* **[Interview 7]**.

5.1.3. Regulatory barriers

The literature lists many examples of regulatory barriers that slow down or hold back the CE (Kirchherr *et al.*, 2018). Although, in the work of Kirchherr et al. (2018), regulatory barriers do not come forward as one of the most pressing barriers. Contrary, De Jesus and Mendonça (2018) place regulatory barriers as the second most pressing, based on their literature review on barriers and drivers of the CE. To be more precise, it is stated that regulatory barriers, moreover, could be used or seen as 'soft factors' (according to hard/soft heuristics), as an enabler as well as a bottleneck obstructing the transition towards the CE (De Jesus & Mendonça, 2018). Regulatory (or institutional) barriers are considered a soft factor since the effects of policy and rules are not so much direct as they are indirect; they trigger reactions that are incumbent on themselves (De Jesus & Mendonça, 2018).

The most pressing regulatory barrier found in this research is **'Obstructing laws and regulations'**, mentioned through examples by a small majority, by six out of the eleven respondents. Obstructing laws and regulations are also identified in paragraph 2.3.2. in the example of The Plant in Chicago, where selling or sharing a surplus of energy on-site was held back. A similar example is found in the research of Kirchherr et al. (2018), where a respondent mentioned that its ambition to recycle materials to use it in products, was being restrained, where instead materials were transported elsewhere, over even a national border. In this research, several comparable situations are mentioned, where respondents explained to be able and willing to process recycled and leftover materials or products, but, instead, those mostly end up being burned or transported for recycling to unknown locations far away. One respondent, for example, explained getting hands on local (leftover) materials still is difficult, and, that it was not possible to obtain materials released by the local municipality; *'… they were […] right next to our building, we just couldn't get that'* **[Interview 1]**. Additionally, when asked why investments regarding sustainability are not forthcoming, the indirect effects of policy and related rules as stated by De Jesus & Mendonça (2018) were typically illustrated. It was explained that investments were left open, due to laws regarding sustainability are becoming increasingly complex or vague; *'… you would rather wait with an investment regarding sustainability, because you do not know with what you are doing well'* **[Interview 1]**. The following quote, furthermore, illustrates how existing environmental policies influence the definition as to what is, and what is not, for example, waste (De Jesus & Mendonça, 2018). When asked how and if it was possible to experiment and enact with the

use of nearby leftover and urban resources (city trees to be cut down), the respondent declared the following;

> *«The problem is that the certificates in this regard (EFC/PEFC) are based on a set of rules laid down in the TPAC, which is a global quality mark. They are based on the 'forest definition', city trees do not meet the forest definition, that is really very stupid. The tricky/weird thing about this that stands in the way of sustainable development is that the government has to adhere to criteria that state that they can only buy FSC/PEFC certified wood, so the bottom line is that they can't buy their own wood.»* **[Interview 7]**.

Additionally, according to the respondent, it appears that this is most bothersome for developers that want to involve more wood in their constructions, but in the Netherlands, are hindered in doing so due to this situation. Apart from construction, this appears to be less relevant for niches and smaller manufacturers, according to the respondent, which can adapt and experiment more easily. Furthermore, regarding certificates for sustainable practices, it was stated, in general, '… 'it' is now too fragmented.

This comes down to the earlier mentioned example of how urban mining is often hindered, in which in this case not due to costs but, due to hindering and strict regulations. Besides the direct environmental benefits of urban mining, several respondents explained that products crafted with nearby materials, such as a dining table made from a single tree that originates from the Vondelpark in Amsterdam, is often handled with great care for a long time; *'… a product should be treated like any other heirloom, you handle that very carefully. It would be nice if I could share that story'* **[Interview 2]**.

Besides laws and regulations that slow down or block UM in adapting circularity and in becoming more sustainable in general, they are troublesome in other ways as well. For instance, one respondent connoted to be willing to take the lead, regarding sustainability, in making colleagues (more) aware, or, moreover, to be part of official institutions. However, it appears that a certain rule that applies for all in the sector (food industry), does not allow this, thus, her opinion and arguments are not heard directly; *'… you have the Association for […], but, unfortunately, I can't access it because I don't have any animals myself'* **[Interview 8]**. Moreover, many food producers nearby and in cities are likely not to have any animals, thus, as a result, some Makers are by definition already excluded from being affiliated with related institutions. Also, in general, and in the first place, most UM are hindered in carrying out their daily activities in cities due to strict measures against odour, noise and logistical nuisance, which makes this a prior challenge to deal with. However, through the new Environment and Planning Act (Omgevingswet), this could be regulated better and less complicated, although this act is still unknown and vague for many.

This points out the second most mentioned regulatory barrier within this research, **'Lacking global consensus'**. Ambitious goals are often set to speed up and stimulate processes and actors, however, regarding circularity, this regularly leads to discussion. However, it is still debatable and debated what the right and feasible goals are, what whom should do, and how to implement what in general is considered the right thing to do. One respondent explained, which on daily basis works with the goals as envisioned by the Dutch National government, in becoming 100% circular by 2050; *'… everyone knows it makes sense, but, you do need to be able to set out the right goals. And, that also has to be supported, that takes a lot of time. The program states a 50% reduction of unsustainable raw materials by 2030, but, what does that mean exactly? That question is now a research project, which is what the PBL does'* **[Interview 11]**. These goals were set out in 2016, hence, it (surprisingly) is still unclear how this should be implemented in its entirety, while these goals are still being advocated. None of the

respondents mentioned being working towards this goal, or towards any percentage in becoming circular, when asked about any goals to achieve in becoming sustainable. Several respondents were critical about how other, mostly larger and well-known chains operate and communicate in becoming more sustainable. One respondent, for example, found that a well-known chain that on their website communicates about 'responsibility is actually 'greenwashing'. This according to the respondent, is most often *'… is mainly a marketing story'* **[Interview 3]**. Furthermore, it was stated that what is considered 'handmade', also is false; *'… then the screw in it is probably the only thing that is screwed in. Yes, I find the things they pretend they don't live up to enough, as an initiate.'* **[Interview 3]**.

'Limited circular procurement' was the least mentioned barrier among the respondents of this research. Circular procurement *'… presupposes a different, more functional view of demand - one in which performance is often of pivotal importance. As a result, the concept of "ownership" is seen in an entirely different light. Alternative revenue models such as product-as-a-service offers (e.g. Greenwheels) or sale-repurchase agreements can be useful here'* (Pianoo, 2021). In practice, getting started with circular procurement still seems to be limited and complex, as manufacturers also often use very specific components. Furthermore, for example, one respondent mentioned not to understand why VAT costs are taken into account for the same amount for upcycled/recycled products; *'… I have to pay VAT a second time, that might be weird. Why do I have to pay VAT a second time for something I sell to a consumer a second time?'* **[Interview 4]**. The respondent, furthermore, suggested that a discount somehow would be reasonable; *'… why can't I get a VAT discount for that part of my end product, which is based on recycled parts? So that I either have more margin and/or can offer a better price to customers. Why isn't there a lower VAT rate for products with a certain degree of circularity?'* **[Interview 4]**. Branding such products as an RCP as mentioned by Rashid et al. (2013) could offer a solution to stimulate this process. None of the other respondents mentioned 'Limited circular procurement' through any examples.

5.1.4. Technological barriers

The ways technical solutions are available and convenient seems to be a key aspect for the CE to gain widespread penetration (De Jesus & Mendonça, 2018). For example, regarding UM and urban mining, it is indicated by some of the respondents that they want to use leftover materials, hence, what is being offered and by whom is not always consequent and clear (apart from the regulatory barriers hindering this in the first place). Hence, vice versa, some respondents mentioned they end up themselves with by-products which only very rarely are reused or recycled and mostly end up as 'waste'. Storing them is, therefore, often, not attempted, as a respondent mentioned; *'… I now have the experience of 12 years of running a company and storing things, so I may have become a bit easier in giving away/giving. Because I know that otherwise, it will just sit on the shelf. Because I know it just takes up space. So I do throw things away earlier'* **[Interview 9].** Thus, De Jesus & Mendonça (2018, p. 81) state that *'… the availability of information and communications technologies (ICTs) is considered a facilitator in the dematerialisation of the economy'*, and, that, '… *the reuse potential increases as technological options increase, enabling more material recovery'*. Kirchherr et al. (2018) report that among their results, technological barriers were not pressing, it is even placed as the least mentioned barrier, contrary to what is being stated in the literature. One could assume that this is related to the sample group Kirchherr et al. (2018) focused on, as these only included examples from a database of only more advanced (best-practice) initiatives and businesses regarding implementing circularity. It is very plausible respondents in their research purchased and started with essential technologies and equipment or developed them themselves as part of the 'maker movement' where R&D and manufacturing increasingly and often are intertwined within the same enterprise.

Nowadays, there already are a lot of different ways manufacturers can and are using novel technology to become more sustainable, one respondent was assured that nowadays, in general, there are enough options to try; *'… technical barriers are barriers if you don't know how to do it, but we do.'* **[Interview 11]**. This specific notion was also quoted by another respondent; *'… they are often things that have been happening for hundreds of years but that have been forgotten a bit … we have forgotten how to do something sustainable.'* **[Interview 6]**.

For example, to improve the reduction of carbon emissions among UM, equipment and tools could be improved that are more efficient in terms of energy use (e.g. by sharing facilities) or shorten the route of transport and how products are transported (e.g. combined (electrical) transport). These options are most well-suited to be applied in urban contexts, hence, are being hampered in the first place by market and organisational assets that need to be 're-wired' (De Jesus & Mendonça, 2018; Kirchherr *et al.*, 2018). Also, one respondent indicated that in more becoming sustainable, essential available technology currently often is not suited (yet) for more local and remote (smaller) manufacturers.

Hence, not all manufacturers state to be able and willing to purchase more energy-efficient tools and equipment or to invest in a more sustainable workspace. Several respondents noted (their) products cannot be shaped or changed due to certain specific demands of customers, which makes them unique and separates them from mass production. 'Custom-made' is often the benchmark of many UM and used as a unique selling point, where many often are convinced there are not any options to make their products themselves more sustainable without changing the aesthetic and functionality;

> *«We opt for quality rather than for everything to be really neat/pure/sustainable. That is a bit of the 'catch', for small companies we have to do everything close by/in small batches, but still, deliver high quality. Therefore (because we are so small) we have (1) fewer choices and (2) fewer possibilities. So we can't start a very big project to see how everything could be better in terms of sustainability, because we are so small.»* [Interview 5].

The most mentioned technical barrier is the **'Lacking ability to deliver high quality remanufactured products'**. Besides several UM that are assured that their products cannot be altered without affecting aesthetic and functionality, a respondents mentioned that regardless of the ambition in becoming sustainable, know-how and techniques appear to be absent or unclear; *'… you do want to edit some things, especially concerning sustainable materials, but, then you don't possess the technology/knowledge and it also isn't nearby'* **[Interview 1]**. Information transfer through ICT solutions provided by a platform or directly by an actor could potentially inform UM and investigate together where improvements could be made if products themselves are not able to be modified. However, another respondent already working with leftover materials mentioned that such a platform would not be of any help or needed; *'… I'd rather do my own research. I'm quite stubborn about that'* **[Interview 3]**. Furthermore, it was mentioned that circularity needs to become incorporated early in the design of products (circular-by-design) to be able to deliver high quality remanufactured products; *'… the […] we use now are made by terms of the linear economy, they are not made to maximize ease of maintenance or are very modular in design'* **[Interview 5]**. This example could also be linked to the barrier **'Limited circular design'**. Joint purchasing in this regard was discussed in the interviews, often is suggested in the literature, which seems to be another logical fit essentially in urban contexts or areas with many manufacturers. Hence, in practice among UM this still seems to be complex and not applicable as; *'… everyone has their own preferences and* agreements', and, *'… you have to bring/pick up a few things afterwards and then the price difference no longer weighs up'* **[Interview 9]**.

The abovementioned correlates with the barrier **'Lack of data, e.g. on impacts'**, according to Kirchherr et al. (2018), and, also as briefly already mentioned earlier; this leads to investments that are not

forthcoming. Also, data on the impact of the novel available technology, tools and equipment on short term should is lacking or insufficient; *'… practice shows that people then have such an installation, for example, and they only know what the return is after 2 to 3 years.'* **[Interview 1]**. This is certainly a problem taking into account the uncertainty of many UM about their future where moving installations can be expensive and difficult. Also, non of the respondents mentioned having data on their impacts whatsoever, nor does any external organization offer or instigate (i.e. local governments) this. Respondents were also, in this regard, asked if there were **'Too few (large-scale) demonstration projects'**, if they looked up to anyone or anything for inspiration or to be convinced in becoming more sustainable, or if this was lacking also. It appears that not a single person, sector, business or actor was pointed out clearly. Some of the respondents mostly mentioned looking up to one or two other businesses that were more advanced in adapting circularity, this was not always a business in the same sector or region. Also, some of the respondents mentioned not to seek elsewhere for fitting solutions where the own creative mind was the most important. One respondent regarding this barrier, however, mentioned working with so-called 'Moonshots'; breakthrough projects that successfully demonstrate for a specific chain how circularity could be and is implemented. When asked how respondents would like to be informed or influenced by demonstration projects, some answered that social media is an exceptional way for smaller UM, especially for those that could be identified as part of the Maker Movement that already are more digitally aware, a symposium for knowledge transfer was mentioned also to possibly be beneficial. Furthermore, one respondent noted that others in the region already are looking up to them; *'… we really do walk our own path, we are actually the frontrunner and it is more the case that other people look at us'* **[Interview 6]**.

Lastly, three examples were mentioned that can be classified under several technological barriers, which are mainly related to the fact that residual materials and products are too unsuitable, or, UM do not know (or expect to) how to improve their activities or products in becoming more sustainable. For instance, one respondent mentioned that his business is not able to reuse most materials (i.e. lacking techniques or tools and equipment), although *'… the offer is certainly there, but it is not always usable',* and, stated similarly to another respondent that there is not much else to be improved in terms of sustainability, illustrating technological barriers often have multiple subordinate causes;

> **«We have also replaced the fluorescent lamps with LED lamps and I can't really do much more. And no customer ever asks for it, least of all that they are willing to pay more for it.»** *[Interview 11].*

> **«Our production process is actually so basic that, what we do, we do, but more than that it's hard to imagine what we can do.»** *[Interview 5].*

5.2. Intermediary activities

In addition to exploring which barriers, if any, play a role in becoming (further) circular and to what extent among UM in the MRA, it was also examined whether several intermediary activities as described in the literature that appear to be effective elsewhere, also (could) apply here, or should be applied. It appears that all intermediary activities that are described in the theoretical framework are also identified in this research, of which one can initially say, with some snags, that this is a hopeful start to (further) stimulate and accelerate UM in the MRA in adapting to circularity, which will be described. Also, although this research is not aimed to point out a key intermediary player, particular organizations were mentioned throughout many examples, which will also be briefly explained.

5.2.1. Identified activities
In the theoretical framework, three categories of activities are described, roughly summarizing what is considered to be effective (i.e. proven to be functional elsewhere), to stimulate and promote the CE.

Similar to the barriers of Kircherr et al. (2018), there are several subcategories of intermediary activities, where the more general umbrella groups of activities from summarized activities from Lente & Hekkert (2003) and the more precisely described list of activities (roles) from Patala et al. (2017) in this research are combined. All of the activities are identified within this research. Occasionally, there was an activity attributable to a category of Van Lente & Hekkert (2003), hence, not necessarily so attributable to the more detailed examples of Patala et al. (2017). Also, on several occasions, through some examples there is no direct and clear link concerning the activities recognized, hence, does it give a clear picture that an activity in question would be very desirable and is lacking. Several related examples will also be mentioned and discussed.

Within **'Alignment of actors and possibilities'**, it was found that **'connecting actors'** was an activity identified within particularly by one of the respondents, also by several other respondents of which were in touch regularly. Nowadays, this is a core activity for the respondent, which initially started its business by using leftover local materials for unique products and preparing them also for others to use; '… *we are now mainly an intermediary between the arborists and the municipality of […] and the manufacturing industry.' [Interview 6]*. It was explained that this role over the years had become increasingly important, being positioned between several smaller businesses, and, nowadays, the majority of production is more related to preparing leftover materials for others. The respondent noted that this often happens in an informal setting, and, accordingly, unfortunately, less with citizens yet. According to the respondents, this was not stimulated or initiated by any public institution, hence, it was being embraced and approved. In addition, the respondent is directly connecting actors by passing jobs on to other and smaller businesses, as it was indicated others possibly and often are more suited for certain demands. Lastly, the respondent was connecting actors by hosting workshops and congresses; '… *we have already organized two small conferences to see if we can not group these initiatives / get our own platform.' [Interview 6]*. **'Balancing locality and wider scale'** was identified by Patala et al. (2017) and included several tasks, hence, mainly to achieve one main goal. The activity is similar to 'Alignment of actors and possibilities', hence, there is not a particular focus on actors or several options, but, comparatively more on achieving a goal or pursuing principle. In the case of Patala et al. (2017), the goal of the intermediaries was to achieve a degree of standardization of activities in the whole country for industrial symbiosis, this, however, did not imply that all manufacturers should pursue the same goals or in the same way. Through *inter-regional coordination*, a national coordinator took into account the regional profile, such as the amount and size of businesses, as well as, for example, the dominant sector(s) and the history of a region. One respondent connoted that this is a task for the local municipality, hence, in the eyes of the respondent, unfortunately, was missing. The respondent stated that if there was any clear plan concerning sustainable manufacturing or (educated) young entrepreneurs who are willing to cooperate, in general, much more could be done; '… *a plan that looks at our income and expenses and at what 'level' we are in terms of company. So that we can appropriately profile ourselves with help of the municipality to become more sustainable.' [Interview 1]*. This portrays how policy-makers are not fully aware and in touch with UM (anymore), and how UM already are struggling with changing urban contexts and those who are willing remain, therefore, unreachable. Current policies, plans and agendas are too vague, complex or not suited for the many remaining, especially smaller, companies. It seems that most of today's plans seem to assume that there are or can be set up all kinds of infrastructures enabling all to pursue the same goal, which, firstly, many do not support or understand, and, secondly, many cannot use because cities change and will continue to do so. Especially in cities, there must be greater awareness that UM must and will also adapt to all kinds of changes and as a result, cannot cooperate one on one (anymore) on all kinds of vague or too high sustainability objectives as desired; it must be better looked at how they can contribute in a different and suitable, perhaps indirect way. Clark (2014) explained that (different types

of) 'regional intermediaries' in here especially could support those smaller and more localised manufacturers. Lastly, in connecting a lot of actors for a (more) sustainable manufacturing industry by creating a community, which was one of the core activities of one of the respondents, it was mentioned that is essential to be aware of different kinds of UM, as also done by Wolf-Powers et al. (2017) and Heebels & ten Kate (2019). And, thereby, to look for tailor-made solutions, in which a clear division and overview, according to the respondent, is essential, by dividing them (i.e. by variation in size, sector, overall progress so far and how their supply chain works);

> *«We do this by subdividing them, so we have the fashion makers, the food makers and the product makers. Those are larger groups. However, we do indeed have the circular makers and the social makers, so we always target groups that have the same expertise and they are in the same environment with the same target group, the same customers, the same suppliers. And they have a lot to tell each other and they can reinforce each other very well because they all have addresses and say 'oh then you should have a look there' or 'oh, you can do that like this'.» [Interview 10].*

'Articulation of options and demand' is the second key activity in which it was investigated whether it could be identified, with the associated more detailed and related subcategory, **'Raising awareness'**. 'Raising awareness' is attributed to 'Articulation of options and demand' as Van Lente & Hekkert (2003, p. 10) also already refer to this in their description, '[…] includes the stimulation of technological variety and the search for possible applications. It also includes the awareness of possible futures'. Especially in the first phase of transition processes, according to Van Lente & Hekkert (2003) as mentioned in section 2.4.2., 'Raising awareness' is essential. In the early stage of especially sustainability-related transitions in which many actors still behave estranged or reluctantly towards each other and novel technology and systems, some will and need to demonstrate early on paving the way in what can and should be done. Especially regarding the UM in the MRA, it was confirmed by one respondent that raising awareness and creating connections especially in the first place is essential; *'… the manufacturing sector was totally unknown five years ago; what it exactly meant and was. Of course, everyone was familiar with the larger well-known businesses such as Brandt & Levie en Brouwerij T' IJ and few others. We really mapped that out and connected about 150 makers.' [Interview 10]*. Often, awareness concerning sustainability in general, and, especially circularity and its benefits, needs a boost or extra attention, for example, by being affiliated with certain organizations and parties, a respondent explained; *'… that is purely opportunistic, that has news value. We are then written about again, you just have to do that PR, there is no strategy behind it'. [Interview 4]*. Raising awareness, furthermore, is also done through UM itself; a respondent indicated that through products themselves people are becoming more conscious regarding the environment. By using familiar nearby leftover materials or by reusing (by)products, there is more appreciation for the environment and how to deal with materials, the respondents connoted, besides the fact that is used as a unique selling point;

> *«People are really happy that they can buy/have a product from their own street, it is often a very emotional event when a […] disappears from their/a street nearby. People become really happy when they find it in the form of, for example, a cutting board.» [Interview 6].*

'Raising awareness' is therefore not only done by, for example, influencing and informing others through advertising, as probably seen by many. Concerning the promotion of UM industry in the MRA and circularity, it is especially done through the production and products themselves; through the experiences and associations thereby. By presenting how things can be done differently, in a more sustainable way by making certain choices, seems to be an important driver for several UM in this research to raise awareness. Especially for smaller manufacturers and sole proprietorships, a unique and sustainable production process and the products themselves are often a way to raise awareness

and get attention, especially regarding consumers, as they are often scarce in time and funds as pointed out earlier. Lastly, raising awareness was also identified regarding the promotion of UM itself in an example; *'… We also do things at schools, so we try to bring the craft to the schools.'* **[Interview 6]**.

One respondent, indirectly referred to 'Articulation of options and demand' when explaining his (daily) activities, not by directly articulating the options and demand, hence, by contacting others to find out what the possibilities are; *'… I have more contact with the local contractors, which is usually a bit strange, about […] that have to go and money for the removal of […]. Then I say I will dispose of the […] for free, if they put it down in certain sizes'.* **[Interview 2]**. This example could also be affiliated with 'Alignment of actors and possibilities' or 'Connecting actors', however, the intention of the respondent in this example is not to establish or create connections. Hence, it was more intended to achieve exposure and imagine real possibilities by informing others there is demand for local raw and leftover materials and products. Unfortunately, the respondent indicated, in his vicinity, there is no market, platform or any actor that is raising awareness for businesses to offer leftover materials to others. The abovementioned example could, hence, also be related to 'Raising awareness'. Another respondent described a similar situation, stating regarding a sustainable UM industry in the MRA that is especially important to actively involve as many relevant actors as possible making UM aware of different options and demand, through a so-called 'partner club'; *'… you really make them aware of the existence of those parties and that partner can send offers through us. From either 'I want to give a training' or 'come by sometime to look at this and this'.'* **[Interview 10]**. Related to awareness, which is more difficult to measure, is exposure, which also is important for many UM, according to the same respondent. As pointed out earlier, many UM are not longer situated near their consumers, each other and partners, hindering exposure, thus, additionally, the respondent explained this was a goal to achieve when being asked about which scale was the focus;

> *«At the same time, we are B2B and B2C. So we serve the makers, so it's business to business, but we're also for exposure, then we actually want to show the consumer what Amsterdam is rich in high-quality goods. And in this, we certainly focus on the international, in fact, the tourist who comes here to Amsterdam. We're really like; it is of course 100 times more fun to take home a nice high-quality product made in Amsterdam than an Iamsterdam scarf.»* [Interview 10].

The last viewed key activity is **'Support of learning processes'**, which is related or can be subdivided within the activities **'Facilitating information transfer'** and **'Providing specialized knowledge'**. According to De Jesus and Mendonça (2018), as pointed out earlier, intermediaries should focus on these or related activities which can help to overcome technological barriers, which are found to be the most pressing, respectively. 'Support of learning processes' was identified as a core activity directly, hence, one respondent noted that he tackles this himself without external support when asked how knowledge regarding relevant and inspirational examples was obtained; *'… it sounds crazy, but a lot of the contact goes through YouTube and Instagram and through a number of groups such as a […] forum and Facebook groups. There I really exchange contact and knowledge and especially technical matter.'* **[Interview 2]**. Furthermore, the respondents indicated this could also be applied similarly for others and the information is already available; *'… I think there are enough channels that spread the right information and that it will be found.'* **[Interview 2]**. Another respondent, contrary, mentioned that 'Support of learning processes' is (still) a key activity on which was being focused, when asked to describe its organization; *'… on the one hand, a network for Amsterdam makers for knowledge sharing and that is actually the best thing for the makers.'* **[Interview 10]**.

Furthermore, 'Facilitating information transfer' was also identified, being described through two examples. One respondent mentioned that this was not a relevant activity, yet, however, it was indicated the intentions to do so in the (near) future are present; *'… we do plan to do something like this, this fall, something for the hospitality industry. So a kind of symposium, perhaps online, where we exchange information'. [Interview 7]*. Another respondent mentioned a similar situation, more related to the internal knowledge sourcing as described by Patala et al. (2017), through the following example;

> **«… once a month we have business tables and then we really ask 'are there any questions and with whom would you like to talk about them?' And then we organize that. And, so we recently sat down with some social entrepreneurs, for example, and the question was; 'how can you better link your people with a distance to the labour market to the rest of the team'. And that was a super fun session. So much comes out of that and we can eventually write a blog about it. We can send that back into the network for the people who weren't there.»**
> **[Interview 10].**

Lastly, 'specialized knowledge' was not consequently being provided by any respondent nor was it recognized as a core activity. Hence, it was earlier mentioned by a respondent this was an activity that could and would be carried out if sufficient experience was gained.

5.2.2. Identified key players

All respondents were also asked with whom they expect (and prefer) to collaborate in the future and if so why and in which ways, as to make an impact this often is inevitable, as indicated by a respondent; *'I also see that the only way for the things I do, making […], that I can't do it alone to make an impact. And that it is indeed important to work with multiple companies.' [Interview 2]*.

Despite expectations, local authorities, according to the respondents, remain hesitant or completely absent; in not a single of the mentioned example of the respondents, the government (or any other organization/institution, group or individual) was brought up as a potential key player to help to carry out the activities as described above or to offer direct and consequent support in becoming (more) sustainable. One respondent expressed this expectation, of working together with a local municipality, as Stadshout is already doing, an organization supplying local (leftover) wood for builders, architects, furniture makers, artists; *'I think it would be very nice to look at things like Stadshout with the municipality, to look at expanding possibilities. For example, how could you complete the circle even more?' [Interview 2]*. Some of the respondents themselves more often take on the role of intermediary as also described in the case of Patala et al. (2017), as a respondent also explained; *' … you can act as an example, and that while you look deeper into things, that the government supports you in this utilizing a surcharge or installation or maintenance. This is often complicated and expensive and also time-consuming.' [Interview 1]*.

It appears, moreover, that the ambitions regarding sustainability that have been expressed by various parties, including the municipality of Amsterdam, are merely experienced or known among the respondents in practice yet. However, there appear to be discussions that indicate that the municipality of Amsterdam wants to put such themes on the map and is exploring them. This emerged when a respondent was asked if and how local social inclusiveness was in collaboration with businesses currently; *'We also talk about this with the municipality of Amsterdam, for example, we recently had the area broker [...] over, I think the deputy area broker/quartermaster for this district for the future. She also said that this is important for the municipality and this also appeals to me very much in my role.' [Interview 7]*. That the ambitions are not yet noticeable for everyone could be since some UM in the MRA identify themselves as niche businesses that are hard to reach and complex to improve, a respondent explained; *'… I don't think they reach us quickly either, also because we are in such a specific*

*sector.' **[Interview 5]**.* Hence, although especially the municipality of Amsterdam is inextricably linked to the various processes and themes discussed in this study, through a few examples it became clear that expectations, in any, are not always met. The municipality of Amsterdam is, hence, as most respondents focus on or work in the city of Amsterdam, the largest regulatory decision-maker, and, therefore, often still (seen as) a key actor. The influence of public institutions is noticeable, for example, as consent and negotiations regarding leftover materials and resources, if explored and possible, can only go through the municipality. The majority of respondents, however, did not explicitly mention their local public institution (i.e. the municipality of Amsterdam) having direct influence nowadays on their transition in becoming (more) sustainable. One respondent, in this regard, explained this role the municipality of Amsterdam has, precisely regarding the (re)use of nearby (leftover) materials and resources;

> **«… by making resources available. For example, the municipality now removes […], but it doesn't really matter where that […] ends up, whether it ends up at the landfill or companies. Another example is space, municipality(s) often have access to sites that are not (any longer) used, in my case you can use this space for […] storage. And in terms of schemes, subsidies, … » [Interview 2].**

The municipality of Amsterdam is also seen as a key player when considering commissioning especially for one of the respondents; *'… the municipality of Amsterdam indeed is one of our largest clients. 60-70% are commissioned by the municipality.' **[Interview 6]**.* Hence, it should be specified that this was an exceptional example that had many preconditions attached to it in terms of serving the greater good, nonetheless, none of the other respondents indicated that they received orders directly from the municipality in these proportions or without conditions. One specific example wherein the municipality of Amsterdam lacks, furthermore, as mentioned earlier, is in supporting smaller UM that are willing to settle in the city of Amsterdam. Several other respondents have suggested that being located in or in proximity offers many advantages, besides seeking creative collaborations as pointed out earlier. Especially for smaller businesses and sole proprietorship facilities could be shared, for example, as explained; *'… that you support each other, less rent, short lines of communication etc…' **[Interview 3]**.* Furthermore, it was stated that being located in the city has its pros and cons regarding transport; *'… the advantage is that everyone can easily get here by bicycle, it is a fairly central location. The disadvantage is that suppliers have to go into the city with their smelly truck.' **[Interview 7]**.* Being located in or near the city, additionally, as explained, guarantees a certain amount of sales, especially in the city of Amsterdam new, unique and sustainably crafted goods would have that insurance; '… the city of Amsterdam is large enough that you also have a certain sales guarantee. And Amsterdam is also fairly open to new things that come onto the market.' **[Interview 6]**, *'… they like new things' **[Interview 7]**.* In this regard, it was also asked if any respondents felt they had to compete heavily with others, which appeared not to be the case among any of the respondents. In addition, it was indicated by several respondents that within the city of Amsterdam being located as a UM in an isolated business park is questionable; *'… There's not really an inspiring vibe or anything like* that' **[Interview 7]**, *'… a place in a business park is not an inspiring place.' **[Interview 8]**,* while at the same time *'… making […] in a raw area, in a warehouse, is fun'. **[Interview 7]**.* One respondent explained that being located in the city at all, is not preferable, hence, indicated that being located further away also has disadvantages;

> **«I am far enough from the city that there is space to store material at a relatively low cost. I am close to my sales market, which can sometimes be important. But I'm also rural enough that I have some access to raw materials. You can see that at companies located in the east**

of the country, that raw materials are even cheaper there and the quality of products is also much higher. But they do not have that sales market (near), for example.*» [Interview 2].*

One of the largest projects as a result of several public institutions cooperating that has been set up to accelerate the transition towards the CE in the Netherlands, as part of agenda 'Nederland Circulair 2050', is 'Het Versnellingshuis'. This project focuses on working together with entrepreneurs, buyers, suppliers and ultimately the consumer through all kinds of sectors to research which essential (systematic) changes should be made and what thereby could be done, including the manufacturing industry. Again, none of the respondents mentioned being aware of this project (or the projects and collaborations that have subsequently arisen) or to be working together, hence, only one respondent mentioned be familiar with the project when briefly brought up and discussed; *'Yes, I do have contact details. But, I think that's a whole different branch of sport, I couldn't express my thoughts there properly.' [Interview 3]*. Besides Het Versnellingshuis many other institutions and organizations are affiliated with accelerating the CE in the Netherlands in different ways (e.g. specific sector, region or public/private/consumer-orientated), with some of them focussing more on the environmental or social benefits, such as 'Social Enterprise'. Social Enterprise was mentioned twice, and, some other related organizations were also mentioned through a single example, but a dominant key actor or organization was not identified among the examples of the respondents in this research.

It was also asked if the respondents were familiar or already are working or have worked together with Amsterdam Made, in which several respondents mentioned indeed to be familiar and to have contact. It was indicated that through Amsterdam Made some respondents within this research had found each other; *'I met them in Amsterdam Made, through a 'like', then I read about their activities. Then I emailed them and contact was established.' [Interview 3]*. One respondent mentioned that especially through the network of Amsterdam Made mentioned to have many contacts and (small) projects events; *'... I believe I have been affiliated for 3 years. But I think they contacted me. That collaboration is very nice. All newspaper articles in which I am mentioned were created by Amsterdam Made. I have also made many colleague contacts at Amsterdam Made, for example, to spend a day with products on a certain market'. [Interview 2]*. There was also critique on the way Amsterdam (currently) operates, in terms of really supporting UM practically; *'Well, at Amsterdam Made I don't really feel that they are working hard. They pretend to be there for the 'maker', but if I see something on their social media only once in the past few months, I have reservations about that.' [Interview 3]*. Furthermore, it was explained the exposure which is an important part of Amsterdam Made, could be increased or expanded; *'I find them quite passive. I would say, write a blog every week, in which makers are highlighted.' [Interview 3]*.

5.3. Urban manufacturing in the MRA

Finally, as part of the results, brief information on why respondents are changing or are supporting those changing to become (more) sustainable and on which perspectives they (want to) focus. This contributes to the discussion of whether sustainability plays a role among UM in the MRA, as it is often claimed in policy and literature that sustainability is thriving and being embraced broadly, resulting in (seemingly) overambitious and unrealistic agendas and goals.

5.3.1. Reasons for becoming more sustainable

There are three main perspectives or benefits underpinned in the literature concerning implementing the CE; environmentally, societal and financial. While all three benefits of the CE were recognized in this research, most respondents focus more on a specific perspective or benefit. Several respondents mentioned to be aware of and understand the different kinds of benefits of the CE, while some of the respondents mentioned that creating awareness among consumers concerning where and how

products nowadays originate is a main driver. Also, a few respondents explained to be intrinsically motivated be engaged with (sustainable) manufacturing, when asked how they are motivated, and could not point out an argument or benefit;

> *«I think it comes naturally to me, that I'm conscientious, I find it hard to do things that don't make the world a better place. But it's also not that I'm an angel.» [Interview 2].*

> *«… because we want to and because we want to prove that it is possible … In principle, we are intrinsically motivated to do this.» [Interview 4].*

> *«… that went without saying, we started with nothing, we started doing what we can do at no cost … we didn't really choose it very consciously. It just felt like the most logical way ... transferring the love for the craft is also part of us.» [Interview 6].*

> *«I also think it's normal that you look for solutions for waste in a creative/sustainable way, for example.»[Interview 7].*

Respondents which are more engaged in becoming (more) sustainable were asked if there was any tipping point that has led to particular choices or views within their business. One respondent, for example, indicated that news regarding illegal practices and fake hallmarks in the wood industry that rapidly diminishes forests globally was a reason for making particular choices. None of the respondents mentioned feeling obligated by the government to make more sustainability-related choices for themselves or others.

Several respondents referred to the environmental benefits of sustainable manufacturing; *'… in the whole process, we try to do that in the best possible way that is good for the earth. It is all quite broad so to speak, but in practice, it is very concrete for me on a daily basis.' [Interview 7]*. Whilst it is indicated in paragraph 4.1.1. that for (smaller) UM it is complicated to profile as a business engaging more with sustainability, there were also a few respondents that indicated this was explicitly communicated externally and part of their business model;

> *«I am concerned with the environment, so I am looking for ways to (re)use materials (such as plastics) so that you do not burden the environment by removing fewer raw materials from the environment.» [Interview 3].*

> *«Our ideal is that these […] simply remain in the city in order to stimulate the local economy as well and to stimulate all kinds of circular/ecological flows.» [Interview 6].*

> *«I just wanted to do something right, by generating a fairer price for the farmer that takes nature into account with […] making.» [Interview 8].*

The societal benefits of the CE are often highlighted in literature in combination with UM they are connoted with the Maker Movement, which mostly is related to preference using local workforces and employing people with poor job prospects; people who do not have the right education, training, skills and therefore are often not readily employable. Among several respondents in this research, the social aspect of the CE appears to be already underpinned and already implemented, and also being a central theme of a few;

> *«We think it's important to give untapped talent a second chance, […] production is ideal for gaining self-confidence and enjoying going to work. To have a goal and to get started with a great product … We, therefore, try to give a second chance on the labour market through training courses for people who have to (re)enter/(re)integrate … so offering people a*

sheltered place, for people who are deployed on very specific tasks, then you actually also have a care function.» [Interview 4].

«… a number of volunteers who work with us have some psychological ailments ... for example, we have two people from the retirement home, who come along for a day. They can't do much, but they can do simple tasks. And they just belong to the group. We also have, for example, a very good carpenter who suffers from anxiety disorders, who has been rejected. He can still flourish with us at his own pace and rhythm. Sustainability indeed goes beyond raw materials … In principle, the entire company must also be okay on a societal level.» [Interview 6].

«We can still cope with a small group, but with the growth, we will be able to offer more regular jobs, so that we can also involve neighbours such as lonelier neighbours or the elderly.» [Interview 7].

«Social entrepreneurship has certainly become big in the last 5 years.» [Interview 10].

Besides employing people with poor job prospects that benefits society that is often expected to go along with 'the return of manufacturing', it also is beneficial and logical for (smaller) UM themselves to consider, a respondent explained; *'… that 'social aspect' has a very good function; of course they are often all small(er) companies, with smaller print runs. It is therefore too expensive in any case, with 200 or 1000 copies of a product. So how do they solve that; by working with people who are at a distance from the labour market, in other words, to compensate for the costs.' [Interview 10].*

Only one respondent mentioned to be or become (more) sustainable and to engage with the CE for the financial benefits. It was mentioned that sustainability shortly is not foreseen without changing the functionality or its aesthetics products being manufactured and due to specific demands of customers, whilst it was explained that financial benefits foremostly would be interesting to look further into this; *'… to see if we can share a floor or employees and train people'*, and, that using an electric shared transport provider currently is being used to save costs; *'One thing we do, in terms of transport, is that we use a GreenWheels subscription, which is cheaper for us.' [Interview 5]*. The massive financial benefits as projected by the EU, for example, were not known by any of the respondents, and respondents seem to look upon investments regarding the CE within their business still as a huge cost element. While once the CE trajectory will be picked up and the financial benefits would be explored, it would have more chances to succeed, it was explained; *'… we also think that the circular economy will develop if it generates money, and that is possible.' [Interview 4]*. Hence, nowadays, especially for smaller UM it is difficult to become (more) sustainable;

«We opt for quality rather than for everything to be really neat/pure/sustainable. That is a bit of the 'catch', small companies have to do everything close/small, but still deliver high quality. Because of that (because we are so small) we have fewer choices firstly and secondly fewer possibilities. So we can't start a very big project to see how everything could be better in terms of sustainability, because we are so small.» [Interview 5].

Several respondents mentioned that they wanted to create more awareness among consumers, to make them more conscious of which products they are buying and to let them take more care of them for a longer time, for example, as also pointed out earlier through an example. One respondent specifically stated to be motivated having consumers getting more aware that things are being made nearby and to offer insight into the production process; *'… it is also that I want to teach people where […] comes from and how it is produced'. [Interview 8]*. As stated earlier, creating awareness is not always done through advertising, as many smaller UM also do not have the time or financial capacity

to do so. Hence, it was explained that products themselves crafted with great care and with an eye to the preservation of the earth could make a great impact; *'... if you listen to the story of one thing, you can see that story in other things as wel l ... For example, they could look differently at tropical hardwood furniture that they already have and the consequences thereof.' [Interview 2]*. Thus, it was furthermore explained, initially, people tend to be attracted to unique or custom made pieces; *'... people come to us because of the design or the lifestyle and then we do 'retargeting', about the social/sustainable story. That's a second step.' [Interview 4]*. It was also recognized that creating awareness is not always effortless or straightforward;

> **«So every piece of […] also has a piece of origin and a certificate and you can see on a map where it comes from. That takes quite a lot of time and energy, but it gives so much added value to the product, plus knowing the maker also gives added value. Then you get more feeling that it was made especially for you.»** [Interview 6].

> **«The reason I am in Amsterdam now, which is actually not very logical, is that it is clear to people how the […] is made and where it comes from, so that it is simply visible to the consumer.»** [Interview 8].

Lastly, all respondents were about their point of view concerning 'sustainability' nowadays, and if that point of view on sustainability was a central topic among all employees, and if this was discussed internally on daily basis and in which ways, for example. While almost all respondents have discussions regarding sustainability with like-minded or internal discussions, it was indicated discussions externally rarely occur, also not with direct partners and suppliers. Several respondents appear to be strongly opinioned on what is and should be perceived as what is 'sustainability' nowadays and what thereby UM offers and which possibilities should be utilized. Most opinions were focused on improving the environment and several respondents claimed that the way(s) they produce on themselves already is or are the most effective. Themes or concepts that most often were brought up were; locality, small-scale production, lease contracts and transparency;

> **«… in my opinion, it is about; locality, story and sustainability in the broadest sense of the word. Local, because I prefer to have as little transport as possible, local […] and local sales market. And that is possible for my company, but there are companies where this is not as obvious as with my company.»** [Interview 2].

> **«… ultimately we need to make technological progress in order to have a lower footprint with the same growth projection, by means of closing chains and raw materials. That is why I think we should look much more at how we design, produce and disassemble raw materials. All this with the aim of being able to go back to material type, so that we do not lose material types ... There is a definite narrative that offers leasing opportunities for entrepreneurs, […] producers and consumers. There is less hassle for consumers and more turnover for entrepreneurs »** [Interview 4].

> **«… if you make […] on a small scale, I think it is already a more sustainable principle … if you create a product that really has added value in […] and that is a special product, which is made with attention, then you create a little more sustainability because money then becomes less important.»** [Interview 8].

Within transparency it was often referred to as being actively involved in informing consumers about the exact materials used in the production process and in which circumstance they are produced, to add a 'story' behind each product, as explained by a respondent; *' … because I think the story you tell about your product contributes to the way they handle it and thus how long they last. [Interview 2]*.

Being transparent and being accessible for those interested in the production process even appears to outweigh some of the drawbacks of being located in an urban area; '*The reason I'm in Amsterdam now, which is actually not very logical, is that it is clear to people how the [...] is made and where it comes from, so that it is simply visible to the consumer. That was an important starting point.' [Interview 8]*.

Lastly, besides the CE narrative, only the concept of Cradle-to-Cradle was mentioned a few times, as this is a commonly known and accepted term, a respondent explained; *'... it's a fun term that many people understand.' [Interview 3]*. None of the terms or schools of thought apart from the CE or C2C as shown in figure 2 were cited.

6. CONCLUSIONS & DISCUSSION

However, it is often unclear what adaption towards and the implementation of the CE exactly implies in practice for many different sectors and how they interrelate to each other, and, how already identified barriers in becoming circular may or may not apply to each. It appears that the CE still is an ambiguous and difficult to measure concept for many, whereby not all benefits are always (made) clear or insightful from start. When thoughtfully and consequently is implemented, the CE could benefit society socially, financially and environmentally, where some sectors, such as UM, prove to be very potent for different reasons. A circular UM, however, becomes increasingly difficult to achieve as they increasingly become separated from each other and urban areas, especially in growing cities. This study intended to collect information on which and how barriers when implementing circularity apply to UM, based on a framework of barriers found by Kirchherr et al. (2018) and if and which intermediary activities as described by Patala et al. (2017) and Van Lente & Hekkert (2017) could help to overcome them. Intermediaries elsewhere have proven to be effective at brokering between actors and sectors in many other sustainability-related transitions, hence, specific research on intermediaries promoting and fostering circularity is still lacking. Hence, the central theme of this thesis was sustainable UM, whereby the case of UM in the MRA as a case study was used to better understand if and how they effectively could be supported by intermediary activities and to what extent. In the case of the MRA, UM, especially in the city of Amsterdam, are being pushed out by other developments towards isolated business parks and have become fragmented from each other. Thereby, several aspects of stimulating circular UM become difficult, in which and therefore, intermediaries are included and researched. Thereby, data was collected by interviewing eleven respondents through eleven semi-structured in-depth interviews involved or related to UM and or promoting and fostering the CE. The following research question guided the research; ***What are key barriers that restrict or slow down (sustainable) urban manufacturing in the MRA and how can intermediaries help to overcome them?*** The next paragraph provides a summary of the results by answering the three sub-research that are set up to be able to provide a clear and complete answer to the main research question. Thereafter, some reflections are presented, and recommendations for future research are given.

6.1. Answering the sub-research questions

Which key barriers apply to different UM in the MRA that restrict or slow down their transition towards a sustainable or circular economy?

The results of this research are largely in line with the findings of the study by Kirchherr et al. (2018), however, some minor differences were discovered, two barriers, based on the data of this research, for example, were not identified; 'Lacking standardization' and 'Limited funding for circular business models'. Cultural barriers, similarly, overall scored high as a category in this study, while, contrary, the most mentioned specific barrier was 'High upfront costs'. In the study of Kirchherr et al. (2018) 'High upfront investment costs' was ranked as the fifth most mentioned barrier. 'High upfront investment costs' might come forward as a more pressing barrier in this research in comparison with the study of Kirchherr et al. (2018), as this research also included a few respondents less (visibly) aware of and engaged with circularity, that are more at a starting point where market barriers are valued more pressing. While all respondents in the sampled group of Kirchherr et al. (2018) all were familiar with implementing circularity and are more aware that this could help to save costs, besides from other benefits. Hence, 'High upfront investments costs' as the most mentioned barrier in this research might give a false indication; as they are estimated to be higher in advance due to ignorance caused by poor or incomplete information provision or the complete lack thereof, whereby the many possible ways costs are saved by implementing circularity. Some of the UM included in this research have considered necessary related investments in becoming circular, but, still are doubting the advantages – which they

often cannot value and understand fully – versus the disadvantages repeated by the majority. 'High upfront investment costs', nonetheless, still seem to be a major reason why investments are not made at all, while one could wonder whether that is the foremost aspect to take into account given the social and environmental benefits. Furthermore, the data of this research indicates that the second most mentioned cultural barrier is 'Lacking consumer interest' is, contrary to the findings of Kirchherr et al. (2018). 'Lacking consumer interest' is likely to have multiple causes, for example, the vast majority of consumers still is (being kept) very price-conscious, and, therefore, engage less with businesses selling custom made products that are designed with principles of circularity (Kirchherr et al., 2018), as they cannot value such products correctly. Thus, they do not get familiar and aware of the impact that such products have and the effort that is put in. Furthermore, they are possibly likely to be less familiar at all, and, thus, lack interest, as UM and customers are increasingly being disconnected, as UM become less visible because they increasingly disappear from the streets, let alone end up in preferred visible locations. Instead, they end up in secluded or isolated business parks, which, on the one hand, takes away possible nuisance complaints and are more often less expensive, while on the other hand, these areas do not always make interaction possible or are the most inspirational places to operate. The general audience this way stays less or not informed at all about more sustainable options and products and the ways they are produced, which explicitly has come forward to be the one of reason to be located near the city, by one of the respondents.

How are those key barriers in the MRA between UM and concerned actors as well as among UM themselves addressed?

The four categories of barriers each have different ways they can and possibly should be overcome, how they are or are not overcome will be explained. Based on the results of this research, it should be connoted that some of the barriers are more difficult than others to overcome in comparison, and some are likely to not be overcome in the next years or coming decades. In sum, the results indicate that key barriers for becoming circular are difficult to overcome and also do not reveal any clear direct solutions or attempts. Regulatory barriers, for example, are difficult to overcome by UM and concerned actors themselves, as indicated in paragraph 4.1.2., which subsequently rely on governmental institutions allowing them to change and take action. Nevertheless, they still keep hindering UM in using certain nearby leftover materials and (by)products, as according to the respondents, certificates/quality mark/labels decide what is 'waste' and thereby who is eligible to receive and handle certain resource flows. As a result, as indicated by several respondents, illogical and vague deals ensure that leftover materials and products are still being moved to parties elsewhere and even across national borders, instead of seeking close connections with UM nearby.

Technological barriers according to some scholars are the most pressing ones, while in this research, they are not at all or barely addressed. Several respondents mentioned that they are aware of what others in their sector and nearby are achieving, but, stated their product cannot be changed without affecting functionality or uniqueness. Hence, in general, it appears they are aware of possibilities others are pursuing and are not denying the ongoing trends. It could, therefore, be stated that a 'lack of demonstration projects', while it is not clearly or directly mentioned among the examples of the respondents, is more applicable than as it currently has come forward. Demonstration projects could inspire and influence those UM that state their products cannot change or the ways they are manufacturing.

Cultural barriers are the most pressing category of barrier and are also the most challenging barriers to overcome according to literature, in which it is indicated that it will take several years or maybe decades to overcome, as the main cause, the LE, is still dominating our behaviour and infrastructures are not set up for the CE properly. The way respondents of this research are mostly

overcoming cultural barriers is not by actively advertising their products or ways they produce but through the products themselves that showcase how more can be done with less, for example. Also, by being transparent and unique it was indicated that customers gradually will change their minds, and make more sustainable decisions overall.

One intermediary in the MRA, Amsterdam Made, overall has made progress as the only intermediary related to promoting and fostering a circular UM. It should be connoted that circularity is one of the principles Amsterdam Made is supporting, hence, not explicitly brought forward as the only or foremostly concept to support. While Amsterdam Made seems to be the only and foremost official intermediary actor in the case of promoting and fostering a sustainable UM industry in the MRA, in which several respondents mentioned to be familiar with, it was connoted by a few that their support not always is consistent and often somewhat restricted. The foremost barriers as discussed within the first sub-research question, however, are not of focus directly within Amsterdam Made. Several respondents, as also mentioned by Amsterdam Made themselves, focus rather on exposure and establishing connections and exploring possibilities.

Within the market barriers, high upfront investment costs mostly seem to be a final clincher. Unfortunately, the expected high investment costs to become more sustainable are overall still not overcome in practice among the respondents of this study and this, therefore, remains a barrier for which there is no suitable and consistent solution yet. There is simply too little attention and research to better map and highlight business models that are based on circularity. Ultimately, it is also a matter of valuing the financial loss differently compared to the profit that can be achieved in other areas, however, it should be understood that there is still not an appealing alternative to offer until then. High investment costs also remain a barrier that will never be overcome, simply because UM expects their product to be so specific that it is impossible to make changes that will not make it more sustainable. Demonstration projects, or 'Moonshots' as used and described by a respondent, could contribute as a solution to this problem if they also highlight how high investments costs could be overcome for smaller UM in the MRA.

Through which activities can intermediaries further effective encourage and accelerate different UM in the MRA in their transition in becoming circular?

The dominating and most pressing barriers of this research, the cultural barriers, require changes on different levels. Systemic, transformative, and effectively sustainable, innovation is the prerequisite for genuine sustainability, as some pioneering examples around the world are already demonstrating (De Jesus & Mendonça, 2018). It was expected that intermediary activities would more clearly be identified in practice and thereby would also be seen as beneficial in encouraging and accelerating UM in the MRA in their transition in becoming circular. It was also expected that they would play a key role, however, it appears that UM often take on the role of intermediaries themselves, as also described in the literature. Thereby, within 'Allignment of actors and possibilities'**,** 'Connecting actors' was the most identified activity, possibly due to the fact many UM are fragmented, thus, this is more recognized and identified in practice in this research. In this stage, getting started and mapping out all those who are willing to participate is a logical and essential activity; also a core activity of Amsterdam Made currently. 'Niche intermediaries' can thereby make connections between particular and often isolated local innovation projects and with the wider world (Kivimaa et al., 2019). Other intermediary activities as found in literature, furthermore, that moreover are identified in practice and thus can be seen as effective or necessary are; 'Raising awareness' and 'Support of learning processes'. Thereby, 'Raising awareness' can help to overcome the cultural barriers and 'Support of Learning processes' can support those UM that are firm in their beliefs their products cannot be changed, in other ways to become more circular. Unfortunately the MRA nor the municipality of Amsterdam were

not identified as a key player for promoting and accelerating a circular UM in the MRA, however, they both have put the CE and adhering goals on their agendas.

6.2. Answering the main research question

What are key barriers that restrict or slow down (sustainable) urban manufacturing in the MRA and how can intermediaries help to overcome them?

Based on the results, cultural barriers as a category appear to be slowing down the implementation of the CE the most; this affects UM themselves as they mostly stay unaware of all the benefits for themselves as well as for (long-term) effects society benefits from. It also linked as a cause for the other barriers, especially the most mentioned barrier of this research; 'High upfront investment costs', as a result of which most respondents do not feel inclined and convinced to step over this. Hence, it should be indicated that 'High upfront investment costs, or other market barriers, moreover are based on first experiences and may not be that hindering after all. In addition and at the same time, based on the results, there is the assumption among many UM that their products should not and cannot be adjusted because it is expected that this will be at the expense of their individuality or functionality. Hence, technological barriers are indicated to be pressing as well, while not to a great extent, and many researchers and scientists claim that the techniques, methods and materials already are available to investigate and put into practice sufficient possibilities, whereby the product itself may not be adaptable, but the production process around it may be. finally, regulatory barriers do not appear to be a major cause among respondents at the moment; only a few showed that it is complicated to use materials for certain purposes as a product

Then, how can intermediaries effectively now support UM in the MRA that are restricted and slowed down by the abovementioned barriers? To be able to answer this, it is important to bear in mind several important aspects. It should be connoted that, although UM are well suited to directly contribute to the many different goals and agendas that are set to become circular and thereby also to the different benefits of the CE, there also should be a focus on how the industry physically will take place and develops in the future. It is likely that the struggle UM in the MRA nowadays experience, of being pushed away from each other and from urbanized areas and to continue to exist as a fragmented industry, is likely to continue, as they are expected to densify and increase in population. Hence, a focus on a smaller scale UM industry in the MRA that is well able to adapt to a changing and growing, modern city, is much more realistic and essential. Specifically for those UM, which are part of the Maker Movement as described by Wolf-Powers et al. (2017), intermediaries should less focus on exposing techniques or inspire them, hence, they would most benefit from intermediaries when they actively provide connections and make it possible to obtain nearby (leftover) materials and resources (i.e. to stimulate and promote urban mining). On the other hand, a certain amount of UM in the MRA will likely be persistent in their beliefs of products and production processes that are unchangeable. Intermediaries could reach out to them to explore if they, if not environmentally, could, for example, include the social aspects more or can help them open up and becoming more transparent, to provide workshops to make consumers more aware of how and where things are made to contribute to the essential cultural change. Several respondents indicated that this transparency is an important part in which they believe consumers will be affected to at least rethink where and how they buy products. Placing and maintaining those less willing or suited in urban areas, therefore, will be essential, in which intermediaries can play a role as lobbyists also, to strengthen the UM industry in its entirety and to put it back on the agenda's of policy-makers again. Intermediaries could also play a key role in informing policy-makers how UM is changing or perhaps cannot change, but, also those less 'efficient' in terms of circularity have plenty of other functions to offer that just need to be rightfully exploited, in the right place at the right time. As described in the literature, it appears that in practice policy-makers and

those involved still mostly are focused on improving larger manufacturers, which indeed are needed in terms of absolute efficiency could contribute greatly and achieve goals, but seem to be less aware of the 'Maker Movement' related smaller in scale UM and the often indirect they offer. Distinguishing them from each other properly, as many academics already are describing, can be very useful, intermediary parties can thereby help to identify all makers and maintain contact.

6.3. Research limitations and reflection

6.3.1. Limitations

Simultaneously, there is uncertainty on how and if UM could continue to take place in highly urbanized and densified areas, which recently has been explored and described by Lane & Rappaport (2020). Whereby it has become clear that UM in the MRA on its own have to strive to survive in the first place from a spatial perspective, to be able to fit in among other (new) functions and demands. This discussion has been kept in mind throughout the research, however, it has not thoroughly been investigated in this study. How this exactly will affect UM in becoming circular, thus, remains unclear. The results regarding the barriers are limited at revealing which barriers may or not may apply and not at pointing out the origin of these barriers, for instance, how and which changes in socio-technical regimes are of influence. Lastly, results regarding the intermediary activities are limited at identifying if and to which extent they could contribute in the case of UM in the MRA, and is not aimed at indicating a responsible key actor, or which type of intermediaries is favoured.

6.3.2. Reflections

First, initially, stratified sampling was considered, using four sub-groups, distinguishing UM between circular versus non/less-circular and those situated in the city centre of Amsterdam and those located more at the periphery of urban areas in the MRA. However, the population thereby of all UM was not clear and estimated. Also, thereby categorization of UM based on a degree of circularity appeared to be too complex and was later disregarded, as measuring circularity/sustainability still is complex, which possibly could place them in a wrong group if measured incorrectly, for example. Respondents would thereby also have to be informed in which group they would be categorised and why they would have been approached and sampled. That is why respondents selected on this conditions was disregarded, hence, the common factor for selecting and approaching UM was that they all were located in the MRA, and thereby not selecting those in complete rural areas. One respondent stands out here, being located in a urbanized part The Hague, in which it was decided to include this interview in the results as its situation was comparable and recognizable with the other interviewed UM. Regarding the sampling, furthermore, it should be connoted that governmental organizations/actors are not included which are likely to play a key role in helping to overcome key barriers. While different respondents were approached for this group, it was often indicated that there was no available time to participate, which probably could be since this research was carried out during the already impetuous COVID-19 pandemic.

Second, the scope of the research was the city of Amsterdam first, hence, this appeared to be too narrow (due to the lack of response and willing respondents, and, thereby, being able to explore, understand and highlight the diversity of the UM industry nowadays). Thirdly, digitalization was not included (and also not recognized within the interviews), hence, in literature many researchers are indicating that UM are more digitally engaged and the suggested definition also included digitalization, as it can boost the transformation towards a more sustainable circular economy (Antikainen *et al.*, 2018).

Fourthly, face to face interviewing was not possible due to the COVID-19 pandemic, thus, maybe not all desired respondents are gathered, as some respondents indicated they dislike digital

meetings. Face to face contact with a researcher can motivate respondents to participate who would otherwise not bother with a questionnaire (Gordon 1975) (Barriball & While, 1994), while emotions also could be captured better contributing to the interpretation of given answers.

6.4. *Future and practical research recommendations*

The results of this research can be used by those affiliated and willing to promote and accelerate a circular UM industry, to better understand how key barriers that restrict or slow down them, may or may not apply and to indicate the potential intermediary activities have to overcome them. For policy-makers, the results provide the insights that the UM industry could contribute to all benefits of the CE, may it not be all of them at once, is changing, and, that they should not solely focus on larger manufacturers, and that UM in monotone urbanized areas contribute to the vibrancy and embrace and explore what they could do for a neighbourhood if well managed.

As this study used the MRA as a case study, the foremost recommendation for future research is to expand the research to other areas, especially in regions or cities where UM must compete with other developments associated with growing cities. Here, the potential of UM could be possibly better exploited, for example, to also benefit from urban mining. Furthermore, while it has been briefly discussed within the research as a solution, for example, ICT systems for sharing and providing information on where and which materials are suited for urban mining, digitalization could be explored more in-depth within related future research, as it also is being claimed widely to have a huge impact throughout society and all sectors. Future research should also continue to include more interviewees from different sectors (i.e. actors related to governmental organizations and institutions), expand the sample group in numbers, and a wide variety of UM, based on business size, location, sector and if possible, degree of circularity. In-depth interviews are thereby also suggested as a method to collect data, due to the complexity and sometimes sensitive situations; some UM could feel overstressed or overlooked in some cases. It could thereby be assumed that UM nowadays intrinsically feel they do not belong longer in cities, while as well as for themselves as for the cities they are located in there could be many fruitful possibilities that are worth exploring and exploiting.

6.4.1. Practical recommendations

To achieve a widespread penetration of the CE, it is important to highlight its different benefits whereby a cultural change is mandatory, allowing and stimulating consumers and partners to be able to value and weigh up them in different way in first place. In addition, (public) authorities must continue to be informed about long-term thinking and the difference that can now be made by implementing widespread CE. Financial impulses alone are thereby not sufficient as indicated by Lane & Rappaport (2020), which also provide many ins. Furthermore, commonly the 'Circular Economy' is known, while this might impede the social and environmental benefits, hence, using the term 'Circular Society' in discussions and future research would be more suited.

Also, and most importantly, one should not pursue implementation of the CE everywhere, we are slowly waking up from a long sleep whilst neglecting what needs to be done. In waking up, it is important to not at random or everywhere pursue in all sectors and places to strive for (more) circularity immediately as the CE is still debatable and understood very differently, and a 100% closed-loop seem to be impossible in most cases. Regarding a circular UM industry in the MRA, therefore, an optimised and thought-out infrastructure with prime examples are more effective and inspiring, instead of pushing the CE in this take-off phase, in which most UM in the MRA are situated. However, the current strategy regarding circularity of the MRA, is still for a huge part to many involved and interested too vague and focused on improving larger businesses in rural areas, and does not offer a plan for an efficient infrastructure a fragmented UM industry needs, which are working in a vacuum

whilst there could be many fruitful corporations with the right supervision (i.e. through intermediary activities). Taking this into account, the fact that the CE will and cannot take place throughout the MRA, (still) is a first step and necessary change in the mindset of many (policy-makers). Thereby, one should focus on an "optimal" mix of taxes, rules, infrastructures and educational set-ups promotes the CE (De Jesus & Mendonça, 2018, p. 82) and cities need to be strategic about their industrial land inventory and match the supply of industrial land to the strategic economic goals of the region (Lester *et al.*, 2013).

Also, it is strongly advised for city planners and policymakers, to acknowledge and reconsider UM as an essential asset again as they were in the past for most cities globally, that could contribute greatly to accelerating the CE, so as not to just put them aside and keep in constant conversation. Policy-makers should thereby intend to be collaborative, adaptive, experimental and reflexive as described by Fusco Girard & Nocca (2019).

To achieve a widespread penetration of the CE among UM in the MRA, it is important to continously highlight and weigh up the different benefits, whereby foremostly a cultural change must take place among to value and weigh up the benefits of the CE in a different way. In addition, (public) authorities must continue to be informed about long-term thinking and the difference that can now be made by implementing widespread CE. Thereby, financial impulses alone are not sufficient as indicated by Lane & Rappaport (2020). Furthermore, commonly the 'Circular Economy' is known, while this might impede the social and environmental benefits, hence, using the term 'Circular Society' in discussions and future research would be more suited. Alltogether, this should restrict and prevent the MRA, and within especially the city of Amsterdam, in, to use a common phrase, eating itself, whereby it appears that especially UM seem to be on the menu.

References

Antikainen, M., Uusitalo, T., & Kivikytö-Reponen, P. (2018). Digitalisation as an Enabler of Circular Economy. *Procedia CIRP, 73*, 45-49. doi:https://doi.org/10.1016/j.procir.2018.04.027

Barriball, K. L., & While, A. (1994). Collecting data using a semi-structured interview: a discussion paper. *Journal of Advanced Nursing-Institutional Subscription, 19*(2), 328-335.

Barrie, J., Zawdie, G., & João, E. (2017). Leveraging triple helix and system intermediaries to enhance effectiveness of protected spaces and strategic niche management for transitioning to circular economy. *International Journal of Technology Management & Sustainable Development, 16*(1), 25-47. doi:10.1386/tmsd.16.1.25_1

Bauwens, T., Mees, R., Gerards, M., Van Dune, J., Friedl, H., Von Daniels, C., . . . Hekkert, M. (2020). Disruptors: How Circular Start-ups Can Accelerate the Circular Economy Transition. In.

Blomsma, F., & Brennan, G. (2017). The Emergence of Circular Economy: A New Framing Around Prolonging Resource Productivity. *Journal of Industrial Ecology, 21*(3), 603-614. doi:10.1111/jiec.12603

Bossuyt, D. M., & Savini, F. (2018). Urban sustainability and political parties: Eco-development in Stockholm and Amsterdam. *Environment and Planning C: Politics and Space, 36*(6), 1006-1026. doi:10.1177/2399654417746172

Bryman, A. (2016). *Social research methods*: Oxford university press.

Clark, J. (2014). Manufacturing by design: the rise of regional intermediaries and the re-emergence of collective action. *Cambridge Journal of Regions, Economy and Society, 7*(3), 433-448. doi:10.1093/cjres/rsu017

Couzy, M. (2020, March 23). Alternatief plan voor NDSM: een wijk voor ambachten en vakscholen. *Parool*. Retrieved from https://www.parool.nl/nieuws/alternatief-plan-voor-ndsm-een-wijk-voor-ambachten-en-vakscholen~bd82ffd1/

Cramer, J. M. (2020). The Function of Transition Brokers in the Regional Governance of Implementing Circular Economy—A Comparative Case Study of Six Dutch Regions. *Sustainability, 12*(12), 5015. doi:10.3390/su12125015

Darling, N. (2020). The Potential for the Sustainable Urban Factory. In *The Design of Urban Manufacturing* (pp. 135-150): Routledge.

De Jesus, A., & Mendonça, S. (2018). Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy. *Ecological economics, 145*, 75-89. doi:10.1016/j.ecolecon.2017.08.001

Denzin, N. K. (2017). *The research act: A theoretical introduction to sociological methods*: Transaction publishers.

Doussard, M., Schrock, G., Wolf-Powers, L., Eisenburger, M., & Marotta, S. (2017). Manufacturing without the firm: Challenges for the maker movement in three U.S. cities. *Environment and Planning A*, 0308518X1774970. doi:10.1177/0308518X17749709

Ellen MacArthur Foundation. (2017). Cities in the circular economy: An initial exploration. In: Ellen Macarthur Foundation.

Fratini, C. F., Georg, S., & Jørgensen, M. S. (2019). Exploring circular economy imaginaries in European cities: A research agenda for the governance of urban sustainability transitions. *Journal of cleaner production, 228*, 974-989. doi:10.1016/j.jclepro.2019.04.193

Fusco Girard, L., & Nocca, F. (2019). Moving Towards the Circular Economy/City Model: Which Tools for Operationalizing This Model? *Sustainability, 11*(22), 6253. doi:10.3390/su11226253

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm? *Journal of cleaner production, 143*, 757-768. doi:https://doi.org/10.1016/j.jclepro.2016.12.048

Gemeente Amsterdam. (2016). *Circulair Innovatieprogramma*. Amsterdam: Gemeente Amsterdam Retrieved from https://assets.amsterdam.nl/publish/pages/868668/20161020_circulair_innovatieprogramma_2016-2018_met_een_doorkijk_naar_2025.pdf

Gemeente Amsterdam. (2018). *Woningbouwplan 2018-2025*. Retrieved from https://www.amsterdam.nl/bestuur-organisatie/volg-beleid/ontwikkeling/bouwen/

Gemeente Amsterdam. (2020). *Amsterdam Circulair 2020-2025 Strategie*. Retrieved from https://www.amsterdam.nl/bestuur-organisatie/volg-beleid/ambities/gezonde-duurzame-stad/amsterdam-circulair-2020-2025/

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of cleaner production, 114*, 11-32. doi:https://doi.org/10.1016/j.jclepro.2015.09.007

Grodach, C., & Gibson, C. (2019). Advancing Manufacturing?: Blinkered Visions in U.S. and Australian Urban Policy. *Urban Policy and Research, 37*(3), 279-293. doi:10.1080/08111146.2018.1556633

Hansen, T., & Coenen, L. (2015). The geography of sustainability transitions: Review, synthesis and reflections on an emergent research field. *Environmental Innovation and Societal Transitions, 17*, 92-109. doi:10.1016/j.eist.2014.11.001

Hartley, K., van Santen, R., & Kirchherr, J. (2020). Policies for transitioning towards a circular economy: Expectations from the European Union (EU). *Resources, conservation and recycling, 155*, 104634. doi:https://doi.org/10.1016/j.resconrec.2019.104634

Heebels, B., & ten Kate, J. (2019). *Aan de slag met de nieuwe maakindustrie*. Retrieved from Den Haag: https://www.platform31.nl/publicaties/aan-de-slag-met-de-nieuwe-maakindustrie

Hirsch, P. M., & Levin, D. Z. (1999). Umbrella advocates versus validity police: A life-cycle model. *Organization Science, 10*(2), 199-212.

Homrich, A. S., Galvão, G., Abadia, L. G., & Carvalho, M. M. (2018). The circular economy umbrella: Trends and gaps on integrating pathways. *Journal of cleaner production, 175*, 525-543. doi:10.1016/j.jclepro.2017.11.064

Howells, J. (2006). Intermediation and the role of intermediaries in innovation. *Research Policy, 35*(5), 715-728. doi:10.1016/j.respol.2006.03.005

Jones, P., & Comfort, D. (2018). Winning hearts and minds: A commentary on circular cities. *Journal of Public Affairs, 18*(4), e1726. doi:10.1002/pa.1726

Juraschek, M., Bucherer, M., Schnabel, F., Hoffschröer, H., Vossen, B., Kreuz, F., . . . Herrmann, C. (2018). Urban Factories and Their Potential Contribution to the Sustainable Development of Cities. *Procedia CIRP, 69*, 72-77. doi:10.1016/j.procir.2017.11.067

Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., & Hekkert, M. (2018). Barriers to the Circular Economy: Evidence From the European Union (EU). *Ecological economics, 150*, 264-272. doi:10.1016/j.ecolecon.2018.04.028

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, conservation and recycling, 127*, 221-232.

Kivimaa, P., Boon, W., Hyysalo, S., & Klerkx, L. (2019). Towards a typology of intermediaries in sustainability transitions: A systematic review and a research agenda. *Research Policy, 48*(4), 1062-1075.

Lane, R. N., & Rappaport, N. (2020). *The Design of Urban Manufacturing*: Routledge.

Lester, T. W., Kaza, N., & Kirk, S. (2013). Making Room for Manufacturing: Understanding Industrial Land Conversion in Cities. *79*(4), 295-313. doi:10.1080/01944363.2014.915369

Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry. *Journal of cleaner production, 115*, 36-51. doi:10.1016/j.jclepro.2015.12.042

Masi, D., Day, S., & Godsell, J. (2017). Supply Chain Configurations in the Circular Economy: A Systematic Literature Review. *Sustainability, 9*(9), 1602. doi:10.3390/su9091602

Matschoss, K., & Heiskanen, E. (2017). Making it experimental in several ways: The work of intermediaries in raising the ambition level in local climate initiatives. *Journal of cleaner production, 169*, 85-93. doi:10.1016/j.jclepro.2017.03.037

Metropoolregio Amsterdam. (2018). *Meer dan de delen Programma Kunst, Cultuur & Erfgoed*.

Ministerie van Infrastructuur en Milieu, & Ministerie van Economische Zaken. (2016). Nederland circulair in 2050. *Rijksbreed programma Circulaire Economie, Den Haag: Ministerie van Infrastructuur en Milieu*.

Moos, M., Vinodrai, T., Revington, N., & Seasons, M. (2018). Planning for Mixed Use: Affordable for Whom? *Journal of the American Planning Association, 84*(1), 7-20. doi:10.1080/01944363.2017.1406315

Murray, A., Skene, K., & Haynes, K. (2017). The circular economy: an interdisciplinary exploration of the concept and application in a global context. *Journal of business ethics, 140*(3), 369-380.

Patala, S., Salmi, A., & Bocken, N. (2017). *Organizing open sustainability: the role of intermediaries in circular economy practices.* Paper presented at the Academy of Management Proceedings.

Petit-Boix, A., & Leipold, S. (2018). Circular economy in cities: Reviewing how environmental research aligns with local practices. *Journal of cleaner production, 195*, 1270-1281. doi:https://doi.org/10.1016/j.jclepro.2018.05.281

Pianoo. (2021). Circular procurement explained. Retrieved from https://www.pianoo.nl/en/sustainable-public-procurement/spp-themes/circular-procurement/circular-procurement-explained

Ploos van Amstel, W. (2020). Duurzame steden hebben ruimte voor bedrijven nodig. Retrieved from https://www.binnenlandsbestuur.nl/ruimte-en-milieu/opinie/ingezonden/duurzame-steden-hebben-ruimte-voor-bedrijven.14581371.lynkx

Prendeville, S., Cherim, E., & Bocken, N. (2018). Circular Cities: Mapping Six Cities in Transition. *Environmental Innovation and Societal Transitions, 26*, 171-194. doi:10.1016/j.eist.2017.03.002

Prieto-Sandoval, V., Jaca, C., & Ormazabal, M. (2018). Towards a consensus on the circular economy. *Journal of cleaner production, 179*, 605-615.

Rashid, A., Asif, F. M. A., Krajnik, P., & Nicolescu, C. M. (2013). Resource Conservative Manufacturing: an essential change in business and technology paradigm for sustainable manufacturing. *Journal of cleaner production, 57*, 166-177. doi:https://doi.org/10.1016/j.jclepro.2013.06.012

Remøy, H., Wandl, A., Ceric, D., & Van Timmeren, A. (2019). Facilitating Circular Economy in Urban Planning. *Urban Planning, 4*(3), 1. doi:10.17645/up.v4i3.2484

Rizos, V., Behrens, A., Van Der Gaast, W., Hofman, E., Ioannou, A., Kafyeke, T., . . . Topi, C. (2016). Implementation of Circular Economy Business Models by Small and Medium-Sized Enterprises (SMEs): Barriers and Enablers. *Sustainability, 8*(11), 1212. doi:10.3390/su8111212

Saunders, B., Kitzinger, J., & Kitzinger, C. (2015). Anonymising interview data: challenges and compromise in practice. *Qualitative Research, 15*(5), 616-632. doi:10.1177/1468794114550439

Savini, F. (2017). Wasted experiments: A commentary on Amsterdam policy for a circular society. *The wasted city*, 131-134.

Singh, S., Hertwig, M., & Lentes, J. (2017). Economic Impact of Ultraefficient Urban Manufacturing. In

(pp. 273-293): Springer Singapore.

Turcu, C., & Gillie, H. (2020). Governing the Circular Economy in the City: Local Planning Practice in London. *Planning Practice & Research, 35*(1), 62-85. doi:10.1080/02697459.2019.1703335

Unterfrauner, E., & Voigt, C. (2017). Makers' ambitions to do socially valuable things. *The Design Journal, 20*(sup1), S3317-S3325.

van Lente, H., Hekkert, M., Smits, R., & Van Waveren, B. (2003). Roles of systemic intermediaries in transition processes. *International journal of Innovation management, 7*(03), 247-279.

Wolf-Powers, L., Doussard, M., Schrock, G., Heying, C., Eisenburger, M., & Marotta, S. (2017). The Maker Movement and Urban Economic Development. *Journal of the American Planning Association, 83*(4), 365-376. doi:10.1080/01944363.2017.1360787

Yin, R. K. (2009). *Case study research: Design and methods* (Vol. 5): sage.

Yuan, Z., Bi, J., & Moriguichi, Y. (2008). The Circular Economy: A New Development Strategy in China. *Journal of Industrial Ecology, 10*(1-2), 4-8. doi:10.1162/108819806775545321

Appendix 1 / *Interview guide*

Introduction - General information - Type of business and activities		
	o What position do you have within the company? o Production process: what exactly do you make and how? o From research & design to production, what are you doing? o How many people work in your company? What tasks are they engaged in? o Amount of m2?	
Barriers on becoming (more) sustainable/implementing circularity		*Aimed to link to the following specific barriers*

Cultural barriers	1. Are there any views on sustainability within your/the company? (i.e. goal/focus of sustainability, social/ecological, cradle2cradle/CE/industrial ecology)
	   a. If so, which ones and why?
	   b. If so, have they changed over time?
	   c. If CE applies, what definition does the company use and do you agree?
	   d. If not, why not (anymore)?
	 2. Which sustainability principles are most important to your company?
	 3. Have sustainability related goals been set within your company?
	   a. If so, are these actively communicated internally/outwardly and how and why?
	   b. If not, why not (anymore)?
	 4. How can this principle/these principles be concretely reflected in practice in the products you offer and/or working method?
	   If several employees are employed
	 5. Do you speak internally about (different) sustainability principles? (regarding working method or ambitions/goals)
	 6. Does the surrounding area play a role in applying sustainability within your/the company?
	   a. Do surrounding residents play a role?
	       i. If so, which one?
	   b. Does the region or city of Amsterdam play a role in this?
	       i. If so, which one?
		Q 1-5: Hesitant company culture
		
		 Q 6-10: Limited willingness to collaborate in the value chain
		
		 Q 11: Lacking consumer awareness and interest
		
		 Q 12-13: Operating in a linear system

	c. If not, why not (anymore)?
	7. Do you work with other companies in the city? Or in the region?
	   a. If so, with whom and where are they located?
	   b. If so, how and why?
	   c. If so, do these companies advise you on how to become (more) sustainable and vice versa?
	   d. If not, why not (yet)?
	8. Is there joint procurement of products that you need for your company?
	9. Do you expect to collaborate more with other companies in the future?
	   a. If so, with whom and why?
	   b. If not, why not (more)?
	   c. What role does the direct surrounding area play in this?
	   d. What role does the region or city of Amsterdam play in this?
	10. Do you think there should be more local collaboration? (more in the production chain and/or in the sector, region)
	   a. If so, between whom and why?
	   b. If so, who should take the lead in this?
	   c. If not, why not (more)?
	11. Do your consumers talk about your sustainability principles?
	   a. If so, in which parts or in which phase? (e.g. they participate in the design, marketing or delivery of products/services)
	   b. If not, why not?
	   c. If not, where and/or when could that be possible?
	12. Do your direct partners/suppliers talk with you about your sustainability principles?
	13. Is there direct competition within your sector against companies that operate in a similar way?
	   a. If so, in which areas does this influence your working method/ambitions?
	   b. If not, is there a clear reason why not?	

Regulatory barriers	14. Are you externally stimulated to purchase and apply circular products (recycled materials/raw materials)? (is there pressure from the (local) government, sector or region to become more sustainable) 15. Is it possible to experiment with products/services that you offer?	*Q 14: Limited circular procurement* *Q 15: Obstructing laws and regulations*

		a. If not, which regulations or laws hinder this? 16. Do you expect certain trends to affect your business? a. Is there agreement within the (local) sector/region which trends (will) have the most influence? 17. Are there any preconditions that your product(s) must meet?	*Q 16-17: Lacking global consensus*

Market barriers		18. What kind of sustainability goals do comparable companies have?
		   a. If so, does this influence your ambitions and how? (is that why they are higher/lower?)
		19. Is it possible to jointly purchase materials/raw materials?
		   a. If so, does this include virgin or recycled products/materials?
		   b. If not, why not (more)?
		20. Are there any preconditions that your product must meet?
		21. Do external investments play a role in your/your business operations?
			Q 18-19: Low virgin market prices
			
			Q 20: Limited standardization
			
			Q 21: Limited funding for circular business models

Technological barriers		22. Are there any advantages to your/your business location for applying sustainability
		   a. What are the ideal physical conditions to improve your/your product on the current scale? (such as changes in the business premises or connections with respect to the immediate environment)
		   b. What are the ideal physical conditions to improve your product for expansion/growth? (such as changes in the business premises or connections with respect to the immediate environment)
		   c. Are there also disadvantages associated with your/your business location for applying sustainability?
		23. Do you work with designers/researchers/scientists from the area or region?
		   a. If so, for what purpose and to what extent? (how often and how does communication take place)
		24. Are there many examples that you get inspiration from?
		   a. If yes, what kind of examples?
		   b. How do these affect the developments within the company and products?
		   c. How do you keep your knowledge up-to-date on examples?
		   d. If not, why not (anymore)?
			Q 22: High quality remanufactured products
			
			Q 23: Limited circular design
			
			Q 24-25: Demonstration projects
			
			Q 26-28: Lack of data (e.g. on impacts)

	25. Should there be more examples to be able to continue working on the application of sustainability?
	    i. If yes, via which platform? (online, newsletter, meetings, workshops)
	26. Do you keep track of where materials/residual products come from that are suitable for reuse? (is there a database with an overview of services/machines/products or the like available)
	    a. If so, how?
	    b. If not, why?
	27. Are the products and/or services you offer monitored by external parties?
	    a. If so, by whom and when?
	28. Do you keep track of the impact you have? (if applicable when this is stated on the site or is actively communicated to external parties)	

Intermediary/knowledge organizations, institutions or actors		

	29. Are you affiliated with any knowledge network/knowledge circle?
	    a. If so, which ones and why?
	    b. If so, who sought the contact and in what way?
	    c. If not, why not (more)?
	    d. If not, would you like to be a part of this?	

Appendix 2 / *Coding tree based on theoretical framework*
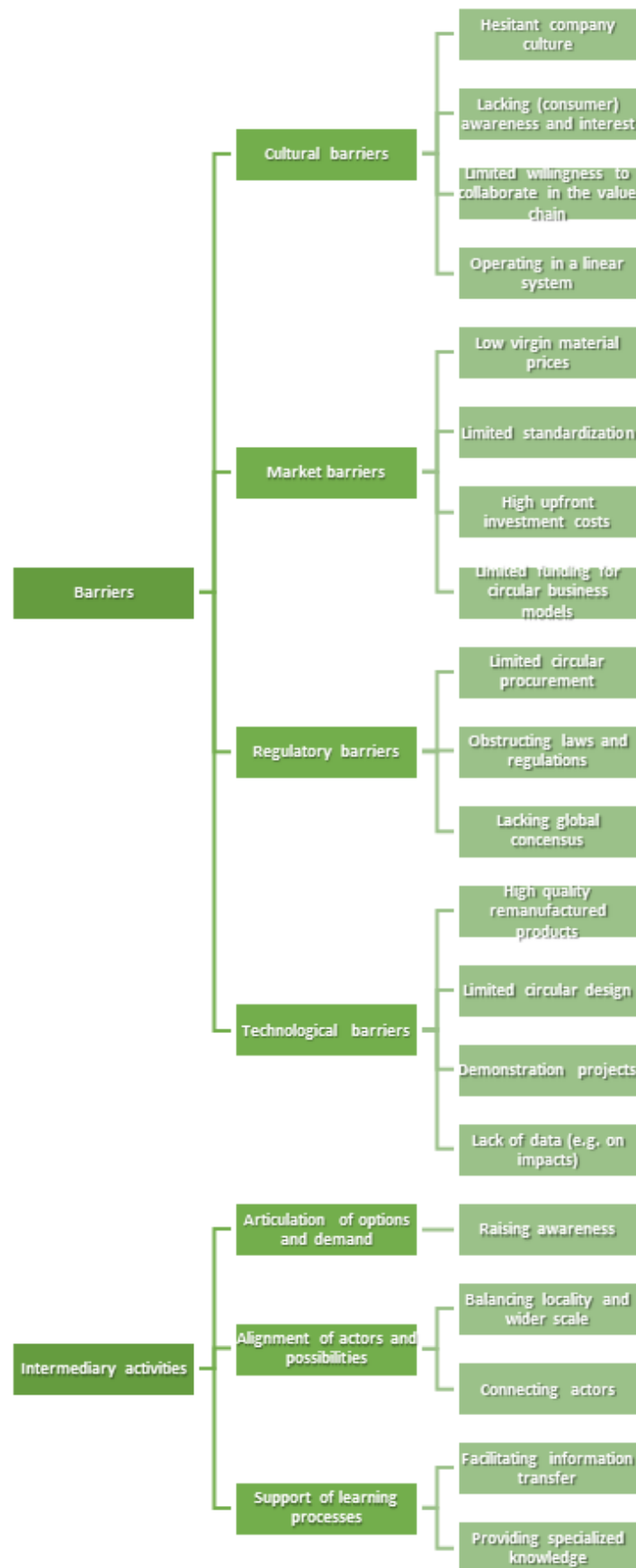
Appendix 3 / *Coding tree based on initial coding*