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Deliverable 1.2

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1 Executive summary

Deliverable 1.2, part of WP1 'Theory and Methodology', outlines the methodologies developed and used for the FABRIX project, which aims to foster the creation of circular and regenerative textile and clothing (T&C) ecosystems in urban environments. This document is a continuation of the theoretical and conceptual framework laid out in Deliverable 1.1, building a bridge from theory to practice. The FABRIX methodology is designed to integrate spatial design, industrial symbiosis, and value chain analysis to support the development of localized, circular manufacturing systems.

At the core of the methodology is the exploration of two interrelated concepts: the "space of network(s)" and the "network of space(s)." These concepts guide FABRIX in addressing the complex relationships between spatial and economic factors in urban manufacturing. The project examines how these systems interact and how they can be optimized to support circular and regenerative production processes, particularly in the cities of Athens and Rotterdam. Through this approach, FABRIX aims to uncover key insights about how networks of actors, resources, and institutions can drive local innovation while responding to global challenges.

The methodology is operationalized through several key stages. These include the mapping and scoping of existing T&C ecosystems, a visualization methodology that combines topological and spatial data, and the development of a relational database to analyse the interaction between various actors and their relationships. Additionally, interviews with stakeholders—government officials, facilitators, and businesses—will provide qualitative insights that inform the development of the MANTEL platform, a digital platform of tools designed to support and guide local value chains by enhancing collaboration and problem-solving capabilities for facilitators and public and private policy makers.

FABRIX's methodological approach emphasizes a co-creation process, with ongoing interaction and feedback loops between the research team and local stakeholders. Through open calls, financial support, and workshops, the project will directly engage facilitators and businesses, empowering them to adopt circular practices and build collaborative networks. This participatory approach ensures that the solutions developed are not only theoretically sound but also practically viable in real-world settings.

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2 Introduction

FABRIX's 2030 vision

Imagine a future in which textiles and clothing (T&C) are manufactured and consumed as locally as possible, in beautiful and sustainable urban environments, close to home and close to where people want to live. Imagine a time, not long from now, in which low quality fabrics and garments are out of fashion, where pre- and post-consumer textile waste is turned into a resource through local processing; a future where one company's low- to high-tech repair expertise is a student's dream job. Where companies share resources, data and innovation, and cooperate in symbiotic ecosystems, towards shared regenerative goals. A time and place that embrace diversity and equity. Where local cultural heritage and traditional textile techniques are preserved, valued and modernized, and where local craft skills are part of a decentralized urban manufacturing ecosystems. What will such a T&C productive system look like when it is beautiful, designed to be circular, innovative, adaptive, just, and regenerative? This is the future of the T&C ecosystem that we need, and FABRIX delivers the methods, frameworks and digital interactive tools to realize this vision.

The transition towards a greener, digital, more resilient, inclusive, and democratic economy and society in Europe strongly depends on the capacity to combine digital and regenerative industrial technologies with a more human-centred approach (COM, 2023). Research done in the past decade demonstrates the deficiencies of techno-centric approaches and restricted focus solely on environmental concerns (Corvellec et al., 2021). While there is an increasing number of tools, practices and studies that support a more human-centred approach to the green and digital transition, these initiatives are often small-scale, fragmented, and isolated. Moreover, they often fail to integrate insights from different disciplines; from urbanism to industrial symbiosis, and develop interconnections across local value chains in support of more regenerative practices across the board. As a result, opportunities for wider system change towards an inclusive technological and social development are often overlooked at the local level within urban areas; innovative practices emerge within businesses, but then fail to scale-up or connect and become part of a local ecosystem (Diemer et al., 2022). Many times, they are hosted in old industrial or office buildings in deprived neighbourhoods that are undergoing rapid processes of gentrification and increased social divide (Ferm et al., 2021). Many of the challenges are related to cross-border and cross-sectoral – or network relational – systems; systems that go beyond the area itself (Van den Berghe et al., 2018). In turn, many of the economic sectoral challenges, such as a more human-centred development of digital technologies in Europe, relate to spatial design as well (COM, 2022b).

The **aim of FABRIX** is to tackle this challenge through an integrated approach to local and regenerative urban manufacturing. This involves blending spatial design with strategies for industrial symbiosis and circular manufacturing, as well as conducting thorough value chain analysis and management. By combining theories and practices that have hitherto remained disconnected, FABRIX develops knowledge in actionable form in support of an ecosystem transition in local and urban manufacturing. It doesn't start out of the blue, but builds on existing yet disconnected digital platforms of tools that currently primarily focus on the business level to integrate the spatial and network dimensions, thus developing an innovative and interactive platform (MANTEL) in support of local value chain management for more circular and regenerative urban manufacturing.

The MANTEL platform targets businesses but also public authorities and other organisations. The interactive information provided by MANTEL in particular aims at detecting and helping facilitators: companies, public authorities or other forms of organisation that enable the coupling of actors and subsequent emergence or transition of ecosystems. In ecosystems, facilitators play a very important role, and their value and knowledge is often very specific and path-dependent. Via the typical 'spreadsheet' perspective, such facilitators are often difficult to detect, as they mostly are not the largest company or the most relevant public authority. Often, their facilitating role is broad and can be on different levels, such as financing or regulative, through coupling, or by spatial planning and design. This leads to the central **research question** of FABRIX: How can we through urban, regional, and (inter)national spatial development and the use of digital platform of tools, facilitate the existing network of actors, institutions, and assets, towards a more localised, innovative, and socially inclusive ecosystem of regenerative manufacturing?

This document, Deliverable 1.2, presents the FABRIX project methodology. Deliverable 1.1 explains the analytical and conceptual frameworks which the methodology is built upon. This document is structured as follow: first, the general project methodology is explained; after this, the different main methodologies relevant for the different steps of FABRIX are presented.

3 Project methodology

The methodological approach in FABRIX is designed to fully grasp the complex interplay between the space of network(s) and the network of space(s). To reach this intended depth and to ensure viable recommendations are produced, the FABRIX project methodology (Figure 1) is built on two principal characteristics that can best be understood as an hour glass: first, FABRIX starts with understanding the broad practical and academic field, lending from a broad range of ideas and experiences, gradually narrowing down to in-depth observation, aiming to improve the observed sub-optimal reality in the selected economic sector and case studies (WP1-> WP2->WP3->WP4). Second, from this in-depth focus and implementation, FABRIX gradually zooms out again and goes beyond the specific context and focus of FABRIX to related challenges in other cities and other sectors (WP3->WP4->WP5). FABRIX's methodological approach allows for deep engagement while avoiding to achieve results that are so specific, cf. surface geography (Yeung, 2023), that they are not relevant for another context or timeframe.

The observed reality is that in many (European) cities the development of deprived former urban industrial areas is not always successful: either industrial (mixed) areas are transformed completely into a mostly high-end (e.g. waterfront) residential area for new upmarket residents, or they are transformed into dedicated, isolated, and often fully automated industrial and/or logistical districts lacking any accessible spatial design and connection to their surroundings, not least in terms of social inclusivity. Artists and creative entrepreneurs have always been attracted to former industrial buildings as part of their need for affordable urban spaces, as discussed by (Zukin, 1989) in her seminal work "Loft Living" in New York. Over time, bottom-up and top-down cultural-led urban regeneration processes have taken place in many derelict industrial areas all around the world (Braun & Lavanga; Evans, 2009; Foord, 2009; Lavanga, 2004; Van der Borg et al., 2005). Arts and culture, or creative industries in general, have been used to start urban regeneration processes in derelict industrial buildings showcasing the potential of culture-led urban development policymaking (Lavanga & Drosner, 2020). Especially top-down creations of cultural districts, quarters or clusters were expected to boost the economy and revitalize urban areas (Lavanga, 2020), with copy and paste solutions circulating worldwide (Lavanga & Drosner, 2020; Pratt, 2008). Many scholars have criticized the instrumentalistic use of culture in urban policies, "in particular for the lack of attention paid to place-specific characteristics and the increase in socio-economic and spatial inequalities" (Lavanga & Drosner, 2020).

A second observation is that many urban economic sectors lack innovation and critical mass to deal with a range of pressures, while, ironically, one of the predominant features of urban environments is a crucial variable for innovation: a diverse population in terms of labour, production, and consumption. In other words, the solution for both space-based development and economic network development lies with a better connection and combination between the two goals. To achieve this, the project's red thread through all WPs is the practice-oriented conceptual and analytical differentiation, but at the same time connection, of (i) space of network(s) and (ii) network of space(s), and the (iii) process of implementation of change and improvement for both.

3.1 The space of network(s)

The space of network(s) focusses on place-based challenges and problems. It relates to the specific spatial challenges and problems many cities experience regarding area development and in particular the (re)development of urban (semi-) industrial areas. Spaces are delimited, in most cases based on administrative definitions, but we can also think of space in broader terms. Nonetheless, spaces in reality are never completely closed

and only exist because of actions and reactions with their surroundings. This poses a challenge for space-based policy makers and practitioners, such as municipalities and architects, that aim to improve spaces and spatial design but at the same time lack full control over the relational networks (e.g. people, goods, knowledge, arts, norms, values, and money) that interact with those spatial elements. In other words, “a space is a social construct that conditions and is conditioned by politics, culture, economics, governance, and power relations” (Paasi, 2010). A space therefore can be seen as first a ‘local buzz, within global pipelines’ (Bathelt et al., 2004), as described in economic geography for clusters, but arguably is comparable with any area and specifically areas within urban environments. This implies that a confined space is the result of the place-based effects of the numerous networks that interact with that specific space.

FABRIX focusses on the Textile and Clothing (T&C) sector, but only as a starting point to analyse what other networks (e.g. finance, logistics, R&D) are relevant to be taken into account to better understand and improve area development. Second, a place can be seen as a system of (sub)systems, and in turn is a subsystem belonging to many systems (Berry, 1964). In other words, a space can be seen as a confined system with a unique identity, linked to for example a specific history, economic activity, or community. Especially for FABRIX, great importance is given to this unique identity and its necessary role for achieving improved area development. In turn, this improved area (seen as a system) development can only be successful if it fully grasps the relations with other systems (Luhmann, 1986) such as ‘economy’, ‘regulations’, ‘communities’, etc. Therefore, while in WP1 the theoretical and conceptual frameworks are developed to steer the project and, at the same time, guarantee its positioning within the broader academic fields, in WP2 this understanding of how space-based aspects are reciprocally related to systems and networks is analysed in depth and mapped in the spatial systems in Rotterdam and Athens using the starting networked system of the T&C sector.

3.2 The network of space(s)

The network of space(s) focusses on relational challenges and problems. Every economic sector is in the first place a network of relations between actors, assets, and institutions (Coe et al., 2004) that cross administrative, regulative, and spatial borders. As with many economic sectors, T&C is characterized by numerous global consumption-production networks (cf. GPNs), that together create many complex value chains. What is often forgotten, though, is that all the involved actors, assets, and institutions have a specific location that in turn is part of numerous systems (culture, regulation, etc.) as explained above. Hence, questions for example related to circular design in the T&C sector, that is predominantly addressed by research in fields such as business organisation or industrial ecology, need a strong link to space if in the end we want to address these issues successfully (Bucci Ancapi, Van Bueren, et al., 2022). FABRIX chooses the networked system of the T&C sector but at the same time perceives the sector as a seed for more complex circular and regenerative community value chains. T&C production, while currently dominated by multinational brands and their global supply chains, is in fact grounded in secular traditions and identities within what is actually a highly fragmented sector characterised by a preponderance of microbusinesses and SMEs (Pratt, 2008). Indeed, as the minimum manufacturing unit is the home sewing machine, the more creative, innovative, and sustainable brands today are independent designer-producers working at the local scale (Brydges et al., 2014; Gwilt et al., 2019). These flexible new production ecosystems are emerging independently of the sector’s traditional industrial districts, drawing more on local creative energies than the infrastructural conditions that normally prevail. WP2 will in depth analyse these complex value chains and networks of the T&C sector in Athens and Rotterdam. Nonetheless, while most research remains at the

level of analysis, FABRIX also intervenes on the ecosystems in Athens and Rotterdam, or in other words do action oriented research as an interventionist methodology (Wittmayer et al., 2021). To do so, WP3 will develop an interactive digital platform - MANTEL - that incorporates tools to assess and manage social, economic, ecological, financial, spatial, and managerial issues, as the most relevant 'systems' through which to change the observed suboptimal situation.

3.3 Overview of the project methodology

The process of improvement influences the existing structures by steering mechanisms. Describing first the space of network(s), second the network of space(s), and third operationalizing these analyses through the interactive MANTEL platform is, however, not the end of the project. FABRIX aims further to effectively change the observed sub-optimal situation of both the spatial area design and the socioeconomic T&C sector in both cities. The insights and recommendations developed in WP2 and WP3 will be implemented in WP4. At this point, FABRIX goes from the analytical 'snapshot' in time t_0 to the changed analytical time t_1 . To go from t_0 to t_1 , FABRIX becomes part of its object of research, as an actor that no longer describes the situation but actively interacts with it. In other words, the observed 'static' structures, spaces, and socioeconomic networks will be actively influenced by mechanisms initiated and steered by FABRIX. These mechanisms are, however, only relevant if they lead to significant effects (Sayer, 2000). To make sure that effects are thus achieved, WP4 aims to actively co-create a more optimal spatial development and socioeconomic T&C sector through, amongst others, the Financial Support for Third Parties (FSTP) calls. Finally, as in reality, time cannot be stopped; FABRIX also looks beyond t_1 to the future t_n . By disseminating its results, lessons learned, guidelines, and (scientific) methods and results, the project aims to ensure that the recommendations and best practices (cf. the mechanisms and their effects) can be transferred to change the suboptimal structures in other cities and/or other sectors.

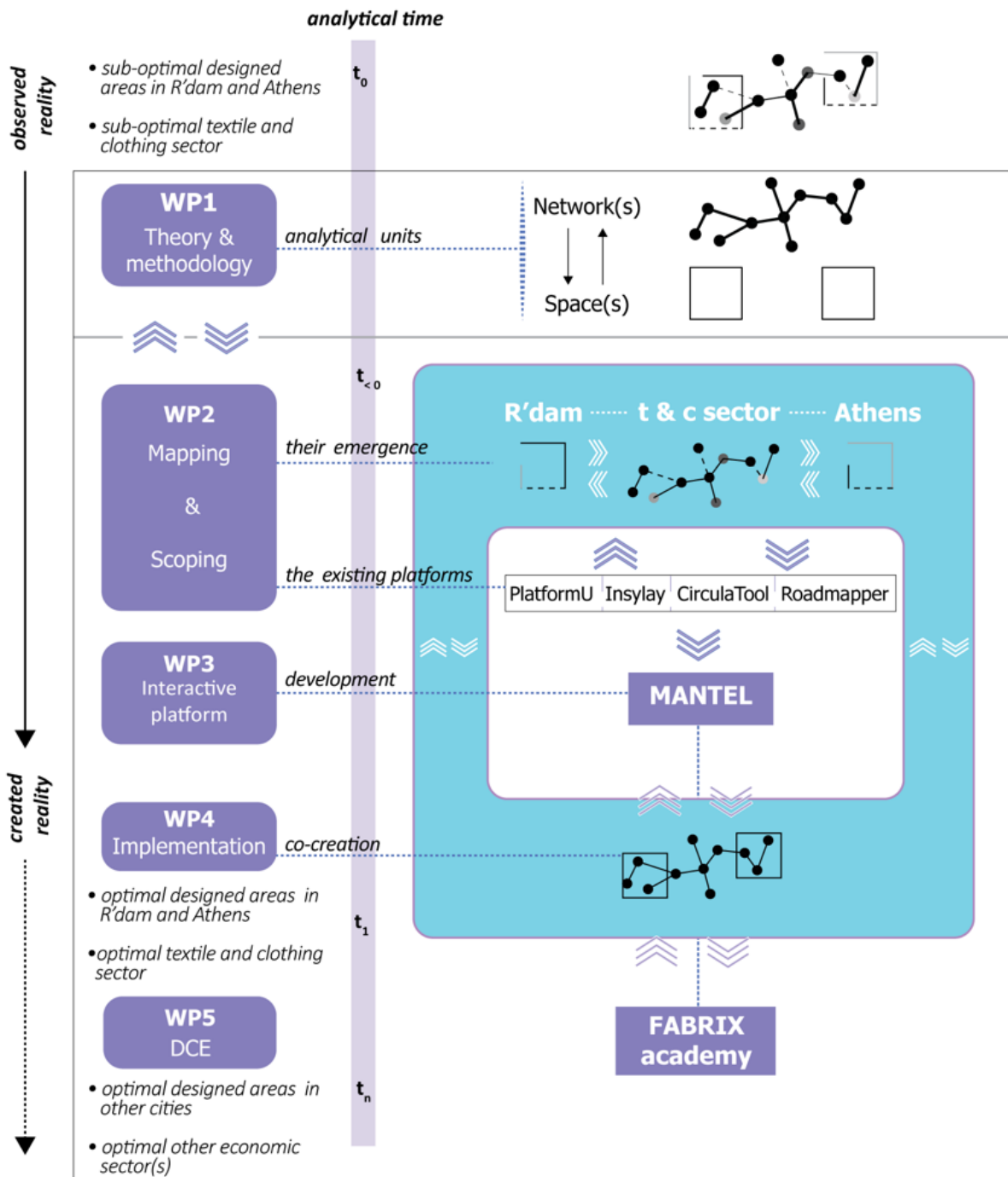


Figure 1: FABRIX project methodology overview

The FABRIX methodology is built upon four principal elements; each exists on its own, but relationally builds on the others:

- **Observation:** Identifying first the challenges and problems of the observed suboptimal spatial design and second the reciprocal related challenges and problems of the economic sector.
- **Analysis:** FABRIX will employ existing and verified platform of tools to scoop and understand the possibilities, in turn to improve the in-depth observation of the specific contexts, but also to simultaneously provide input to the development of MANTEL.
- **Development:** WP3 will develop the interactive MANTEL platform, building on the experience of technological and experiential successes and failures gained in the development of the different platforms and tools that form the basis of MANTEL.

- **Implementation:** by effectively moving actively within the context of the two cities, FABRIX will co-create the needed change and achieve a better spatial design combined with a better structured economic sector.
- **Outreach:** Strategic outreach via different outlets, targeting public and private practitioners (e.g. SMEs), policy makers, organisations, and governments in the focus cities and sectors, but also beyond these cities and beyond the T&C sector: cities and sectors with similar challenges as Rotterdam, Athens, and the T&C sector.

4 Mapping & scoping

As shown in Figure 1, mapping and scoping occurs in WP2. Herein we want to fully grasp the context and particularities of what FABRIX is focusing on: the T&C sector in Rotterdam and Athens; or analytically speaking: understanding both the space of network(s) and the network of spaces. This all to understand the current ecosystem of actors, institutions, and assets. To do this mapping and scoping, we employ a mix method approach, consisting of qualitative and quantitative methods, enabling a pluralistic mapping and scoping. In what follows, we briefly give an overview of these different methods.

4.1 Literature Analysis

In order to develop our analytical framework, see deliverable 1.1, literature analysis is key to learn from past decades, as well as positioning FABRIX in the latest developments in spatial sciences (e.g. the normative turn). Though, the framework is also tailored to the specific research context of FABRIX and enables to split and combine simultaneously the space of networks and the network of spaces. Overall, our analytical framework that leads to our conceptual framework allows to go in-depth and to decontextualise and retheorize.

Literature analysis will be performed in many ways, from snowball technique to a systemic literature analysis. For the latter, PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) will be followed. PRISMA, in itself the result of an analysis about systematic literature searches (Moher et al., 2009), is increasingly being used in social science and qualitative research (Bucci Ancapi, Van den Berghe, et al., 2022). PRISMA guidelines make use of a checklist and a flow diagram to summarize the process of study selection in terms of identification, screening, eligibility, and inclusion. Both the checklist and flow diagram enable a rigorous review that can be checked and replicated by others.

4.2 Visualisation methodology

The mapping and visualisation of the T&C network in Rotterdam and Athens builds upon an earlier developed visualisation methodology (Van den Berghe, 2018; Van den Berghe & Daamen, 2020; Van den Berghe et al., 2018; Van den Berghe, Louw, et al., 2022; Van den Berghe, Peris, et al., 2022; Van den Berghe et al., 2024; Van den Berghe & Verhagen, 2021) that is able to combine topology and topography, cf. in order to understand for example centrality or in-betweenness (e.g. who is currently the central facilitator connecting different parts of the networked system of actors, assets, and institutions), and structure and agency (Jessop, 2008).

4.2.1 Networks

Before we go into the specific methodology, first we explain how we interpret networks and its three aspects: (i) boundaries, (ii) structure and hierarchy, and (iii) pluralistic.

Networks are by definition open and endless, both in time and space. From an analytical standpoint, this presents a challenge because it implies that a network is difficult to fully examine, as it is unclear where to draw the boundaries or when to stop. Typically, the decision to halt the analysis at a particular point in time depends heavily on the availability of data. Even when data is relatively recent, the outcomes are always somewhat outdated, as reality continuously evolves. To define the relevant extent of networks analytically,

Menzel and Fornahl (2009) suggest combining thematic and spatial boundaries. In other words, the network's spatial and relational characteristics are used to establish its "horizon" (Van Der Haegen & van Weesep, 1974), beyond which the influence and relevance diminish rapidly. The thematic boundary distinguishes a network based on a shared characteristic, such as a financial network, a logistical network, or a social network. This allows a network to be isolated from the environment in which it exists and interacts (e.g., a society). The spatial boundary, in contrast, geographically isolates the network from similar networks located elsewhere.

Next, a network has a structure and hierarchy. Both are interconnected and provide insights into the differences in importance among the nodes within the network (Denicolai et al., 2010). For example, in a hub-and-spoke network, the central node is typically more important than the others. To assess this, various network analysis techniques can be applied, such as calculating centrality or connectivity scores (Yeung, 2000).

The third key aspect is the pluralistic or multi-dimensional nature of networks. This characteristic is often overlooked, especially in studies that tend to focus on one specific type of network. For instance, researchers may focus on the flow of goods in a supply chain to understand global distribution patterns or analyse corporate relationships to reveal hierarchical structures within multinational firms (Sassen, 2000; Taylor et al., 2008). However, there is limited research on the overall network, which encompasses multiple types of networks operating simultaneously. The difficulty in disentangling correlated networks (Boggs & Rantisi, 2003) contributes to this gap in research. Nevertheless, understanding the convergence of different networks, along with their structures and hierarchies, can provide a clearer understanding of how locations function and differ from one another. For example, Giuliani (2007) examined the business and knowledge networks within three wine clusters in Italy. These networks exhibited very different structures and hierarchies. While the business network was fairly homogeneous, connecting all economic actors in the region, the knowledge network was more selective, less dense, and had a hierarchical structure. In this case, the business network was focused on information distribution, while the knowledge network centered on trust (Boschma, 2005; Malmberg, 2003). Understanding how these networks interact and influence each other helps to shed light on the complex relationships between flows and spaces.

4.2.2 Database Construction

The first step in the methodology is the construction of a relational database that organizes data in a structured and coherent manner, enabling the identification and analysis of relationships between entities. The database is designed around a two-table structure—referred to as a "From-To" structure—where individual entities (or nodes) are linked via different types of relationships (or edges). The nodes represent actors such as organizations, companies, or institutions, while the edges represent the various relationships between them.

The nodal data, which represents the entities, is derived from a combination of national and international socio-economic databases. This includes data from business directories and firm-level registries that provide detailed information on attributes such as location, size (measured in number of employees), industry sector, and financial performance. Examples of data sources are the LISA database for the Netherlands. Additionally, international datasets like "Orbis" will be utilized to include transnational firms and cross-regional relationships, ensuring a robust dataset with wide coverage.

The relationships between the entities are multi-dimensional and encompass a variety of interactions. Although subject of ongoing research, we aim to map six types of relationships:

- **Input/Output Relationships:** These represent the movement of goods, materials, and services between entities, such as supply chain connections.

- **Energetic Relationships:** These connections reflect the flow of energy resources like electricity, gas, or other inputs required for production processes.
- **R&D Relationships:** These describe knowledge exchange, collaboration, or joint research and development activities between firms and research institutions.
- **Advanced Producer Services:** This category includes specialized support services, such as legal, financial, or engineering services that entities may use to enhance their operations.
- **Membership/Association:** Firms often belong to industry associations, chambers of commerce, or labor unions that facilitate interactions and collaborations.
- **Shareholder Relationships:** This captures ownership structures and investment links between parent and subsidiary companies.

By organizing the data into these categories, the database allows for a nuanced analysis of different types of networks, from supply chains to research collaborations, offering a comprehensive understanding of the interplay between entities.

Table 1: The different networks taken into consideration (Van den Berghe, 2018; Van den Berghe & Daamen, 2020; Van den Berghe et al., 2018)

	Relational type	Explanation	Examples
1	Input/Output	For the production of goods	grains, diesel, organic waste
2	Energetic	Used as input for support of production of goods	electricity, diesel, heat
3	R&D	The (fundamental) research and development of production of goods or production processes	processes in (lab-) environments
4	Advanced producer services	Services in support of (maritime) production/transport activities	engineering, IT services, insurance, legal advice
5	Membership/ Association	Organisation in which companies/institutions meet each other (de Langen, 2002)	association, labour union, chamber of commerce
6	Shareholder	Full or partial ownership of shares	mother/daughter companies

Sources: Kuipers and Manshanden (2015); Vandermeulen et al. (2010); annual company reports; company websites; Orbis; LISA database

The database model links the nodal and relational table on a one-to-many relational (e.g. one company can have relations with more than one company).

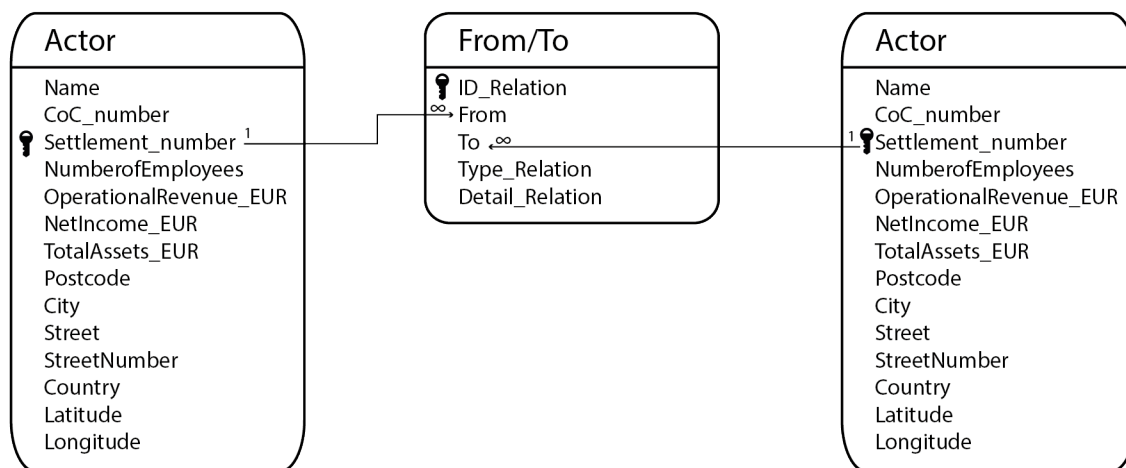


Figure 2: The database model design linking the nodal company socio-economic table (left and right) with the relational From/To table (middle) using a one-to-many relation. (cf. key symbols are the primary keys) (Van den Berghe, 2018; Van den Berghe & Daamen, 2020; Van den Berghe et al., 2018)

4.2.3 Visualisation

The visualisation methodology that FABRIX will develop further, used ArcGIS ArcMAP 10.3. At the moment, FABRIX' researchers are exploring other, more developed ways to achieve the same visualization. In what follows, the main reasoning is thus of more importance than the used program or extensions. These two shapefiles are subsequently transformed to a geographical network (GN). Within ArcMap, this GN can eventually be combined with

an institutional-administrative layer to locate the network in space. However, the 'regular' Euclidian visualisation results in an analytical problem (Adams, 2014). Some nodes in the network are located at the same location (cf. high rise office building) or closely together, especially within linear (e.g. port) areas. Hence, once the relations are plotted, many of these overlaps and become blurred or covered, making important information lost in the visualisation (Figure 3).

Therefore, one needs to make abstraction of the geographical Euclidian distances, without losing its information. To achieve this, we used ArcMAP extension Schematics¹. Frequently used within engineering-electrical analyses, schematics visualises networks by topological spreading the nodes and relations. However, it does not lose the coordinates attached to the nodes, enabling it to group the nodes based on their administrative location. Hence, we can present our visualisation method (Figure 4).

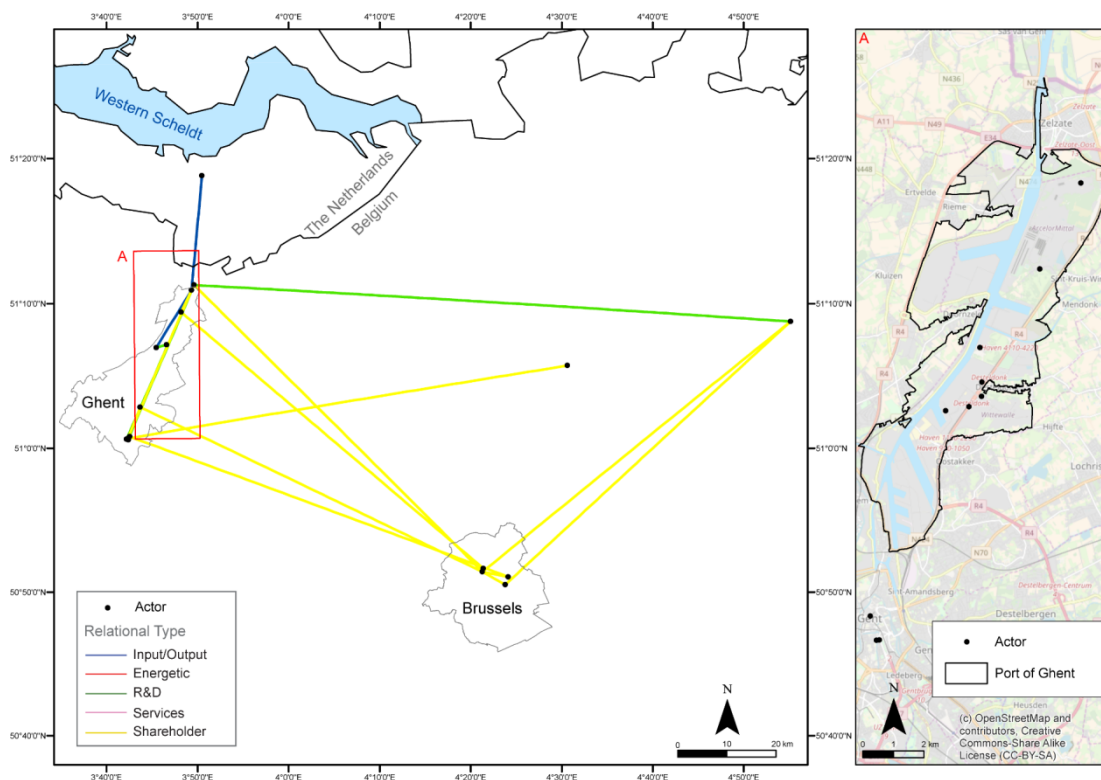


Figure 3: Euclidian visualisation of the steel manufacturing sector in Ghent, total network and zoom in on the Port of Ghent where involved nodes are closely located to each other, overall visualisation unsuitable for further analysis (Van den Berghe, 2018; Van den Berghe & Daamen, 2020; Van den Berghe et al., 2018)

¹ <https://desktop.arcgis.com/en/arcmap/latest/extensions/schematics/what-is-schematics-htm>

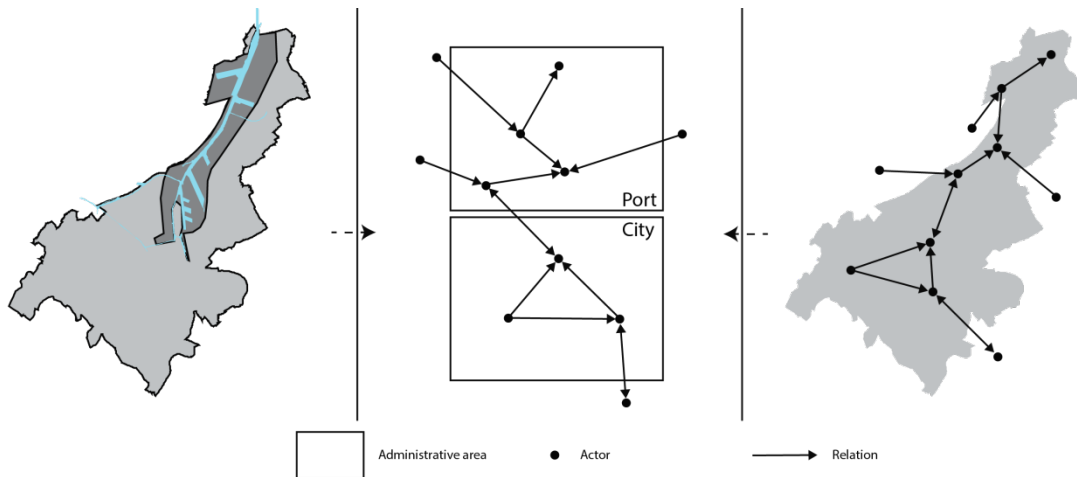


Figure 4: Visualisation method combining institutional-administrative information (left) and the structure, hierarchy and direction (From/To) of the involved economic network(s) data (right), example Ghent (Van den Berghe, 2018; Van den Berghe & Daamen, 2020; Van den Berghe et al., 2018)

4.2.4 R-studio

At the moment, FABRIX' researchers are using R-studio to both process the available data, and analyse and visualise these. This is currently subject of the research and still in development.

R is a powerful, open-source programming language widely used for data analysis, statistical computing, and creating visualizations. It offers a vast library of packages designed to perform a variety of data science tasks.

RStudio is an integrated development environment (IDE) designed specifically for working with R. It provides an intuitive interface for users to write, run, and debug R code efficiently. RStudio simplifies data analysis by offering tools to import, explore, transform, and visualize data, making it a valuable tool for both beginners and experienced users. It's also commonly used in machine learning for building predictive models.

4.2.5 Pattern language

Within FABRIX, we will try to also include and further develop the pattern language, developed within the Cities of Making project². The pattern language serves as a framework to integrate manufacturing into urban environments by addressing common challenges and opportunities. It presents a set of recurring patterns to guide the development of sustainable urban manufacturing. These patterns cover themes like material flows, logistics, governance, spatial integration, and stakeholder collaboration. The framework encourages cities to develop flexible and adaptable strategies that consider the local context, aiming to balance manufacturing with urban life and sustainability goals. This structured approach offers solutions for revitalizing urban production while enhancing environmental and social benefits

4.3 Interviews

In the FABRIX project, interviews will serve as a key method for gathering insights from three distinct target groups: government officials, facilitators, and businesses. The interviews are structured to explore specific topics relevant to each group while aiming to identify challenges, opportunities, and potential synergies in promoting circular practices and local manufacturing.

² <https://citiesofmaking.com/>

For **government officials**, the interviews will focus on understanding their initiatives to promote local manufacturing and circular economy practices. We will explore their data collection methods, policy objectives, and the challenges they face in supporting these practices. This helps us identify the types of data and features necessary for MANTEL, the digital tool being developed in the project, to enhance their operations.

For **facilitators**, the interviews will examine how they support businesses in adopting circular practices, the sectors they engage with, and the collaborations they facilitate between different stakeholders. This allows us to understand the types of support they provide, the challenges they encounter, and how digital tools could further improve their facilitation efforts.

For **businesses**, the interviews will delve into their supply chain partners, the barriers they face in implementing circular practices, and the drivers behind their efforts to minimize waste and reuse materials. Additionally, we will assess their openness to adopting new digital platforms like MANTEL and identify the types of support they need to scale their circular activities.

Across all groups, the interviews will also provide critical qualitative data that informs the development of MANTEL, in turn MANTEL can then later on help guiding facilitators and other public and private policy makers to advance progress within their ecosystems and places.

4.4 Multiple case study analysis and pilot

FABRIX focuses on the analysis of the T&C sector in two case study cities: Athens (Greece) and Rotterdam (The Netherlands). The in-depth study of these two cases helps to shed light on the transition to circular, just, and regenerative practices in urban manufacturing that results in considerable environmental damage, energy consumption and social injustice. Specifically, we zoom in on spatial planning and land use issues, identifying barriers and opportunities for urban manufacturing. For this purpose, we build on the collaboration of a technical university (TUD), an economics faculty (AUEB), and a Humanities and the Social Sciences research university (EUR), a non-profit organisation (SOFFA), and with public organisation and private companies. Both cities are actively rethinking their approach to urban manufacturing, particularly in the T&C sectors, yet with different challenges and opportunities. These settings offer a promising avenue for an in-depth analysis of real-world challenges with circular and just transitions, as well as decentralised urban manufacturing. In WP2, the FABRIX team will engage in a thorough analysis of local and inter-local T&C supply chains and mapping the bottlenecks and opportunities to the uptake of more circular, regenerative, and socially just practices (Bucci Ancapi, Van Bueren, et al., 2022; Bucci Ancapi et al., 2024; Pugh et al., 2024). We will also map resource flows and interconnectivity within local and inter-local ecosystems. By identifying specific challenges and opportunities for transition, we can gain insights into what frameworks, tools and functionalities might benefit the emergence of circular and just manufacturing ecosystems (Buchel et al., 2022).

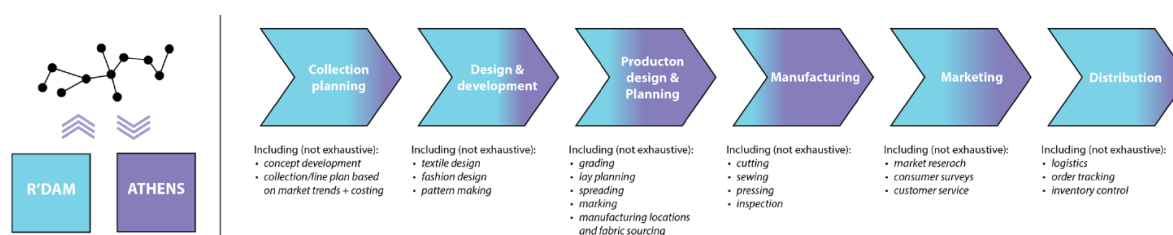


Figure 5: The T&C (re)manufacturing chain, with the areas of expertise of the ecosystems in Rotterdam and Athens

The selection of the the City of Athens and the City of Rotterdam for the demonstrating of the project's methodologies and platform of tools has been based on the areas of expertise of the two regions in the T&C (re)manufacturing chain (Figure 5). Rotterdam is a port-city that has increasingly shifted focus to services and technology, hosting research organisations and new start-ups involved in fundamental research, applied research and development, and prototyping particularly in terms of textile technology. Athens has a strong foundation at the intersection of fashion and artisanal production. Both cities have a growing interest in the circular economy and in art. These two cities together offer a fruitful overview of the T&C (re)manufacturing chain to fully understand how networks intersect with space, and while not outliers of either textile or clothing, they represent opportunities to create knowledge how to scale up the knowledge that can be replicated in other European cities and regions. The cases represent two distinct regions of Europe and offer several complementary learning and standardisation benefits that stem from both their similarities (a new generation of like-minded circular and sustainable fashion designers and entrepreneurs are active in both cities) and differences: Athens has a deeper manufacturing and bio-based thread making tradition, it has a strong culture of craftsmanship linked to textile. Rotterdam has a stronger co-creation, collaboration and resource sharing ecosystem and a more advanced waste collection system. Rotterdam has also a strong fundamental research tradition and sophisticated R&D and automation technology centres. Both cities, as port cities, take an important role in (global) logistics. Both cities are among the 100 cities which were selected for the EU Mission for Climate-Neutral and Smart Cities. This project therefore directly supports ongoing and future endeavours in Athens and Rotterdam to become climate neutral.

4.4.1 Athens

Over the last ten years, during the big financial recession, Greece had the largest youth unemployment rate in Europe (today is still the second highest 34.2%, Jan 2021), which drove young people the creation of innovative start-ups, many of which are in the T&C sector using new circular and regenerative business models. 30% of early-stage start-ups in Greece are from founders aged 18-24, and the average early startupper's age is 36 years; the primary sector doubled to 8% and 25% are in manufacturing (Bosma & Kelley, 2019). These sustainable ventures operate in silos with very high marginal costs, and they are unable to source many sustainable materials due to the minimum order quantities (MOQs) in place. Besides, they are locally oriented, face barriers to enter other geographic markets and fierce competition from the non-sustainable and fast fashion brands. There is no access to funding or other incentives for these (micro-)businesses in place, which often leaves them isolated on the market and prevents sound circular business models. On the contrary, mainstream fashion designers and producers face the challenges of dealing with their waste and are widely unaware of the new EU legislation, measures, and frameworks. This situation spurred the need for the development of a Sustainable and Circular Textile and Fashion HUB in Athens, an initiative taken by AUER and SOFFA to bring together different industry players the majority of which are based in Athens. Initiatives of the Sustainable and Circular Textile and Fashion HUB in Athens have developed circular business models that include the upcycling of house awnings waste to produce bags and accessories (3Quarters), the upcycling of plastic to create sandals and clothing (Eating the Goober), or the recycling of fishnets from the Aegean Sea (Healthy Seas) among others. The Hub also initiates and promotes projects related to regenerative farming, swap platforms, or cultural heritages.

4.4.2 Rotterdam

Rotterdam is increasingly seen as an attractive place for the T&C sector. The city has an open creative climate and an atmosphere where T&C professionals feel free to

experiment and deviate from the beaten path. A new generation of designers in Rotterdam focuses not only on aesthetics, but also on how fashion can contribute to societal and sustainable issues (e.g. fashion hub De Wasserij and BlueCity). There is a growth of innovations with residual streams from forestry and agriculture that are used to produce sustainable and renewable fibres for fabrics. Examples include tomato stems, cane yarns, pine needles, and reintroducing a national chain for products made from local wool. However, there is lack of coordination and networking that make the sector rather fragmented (COM, 2022a). Education in T&C is not well connected to the industry, most students aspire to launch their own brand but have little knowledge businesswise on top of lacking interest and skills on the production side. At the same time, Rotterdam is a major importer and exporter of post-consumer textiles following it is the largest European port. A significant part of the sorters who process this textile are located around the Port of Rotterdam. Although the textile sorters in the region collect approximately 126,000 tons of textile annually, 31% of it is no longer re-wearable, and 10% ends up in the incinerator. More generally, Rotterdam has a very young and diverse population, posing interesting questions in relation to (re)skilling. Meanwhile, the national government sets targets and new regulations such as the Extended Producer Responsibility (EPR). The EPR is seen as an important tool to help making the T&C chain more sustainable. Yet developments like these bring many uncertainties for T&C businesses who are less versed in these regulations. This creates a greater need for knowledge sharing and cooperation. For a complete transition - and not just an adaptation of existing practice - it is necessary that all parties involved in the T&C chain change along with it. Thanks to the high concentration of second-hand textiles in the Rotterdam region, it is possible to scale up innovative recycling techniques for no longer re-wearable textiles. Collaboration between different levels of education can also be strengthened. For this, however, it is important that there is more connection and visibility within the T&C chain. The city's circular and creative industry are not yet sufficiently connected in the field of fashion. There is still a clear division noticeable between the front and back of the T&C chain.

5 MANTEL development

The development of the MANTEL platform is central to the FABRIX project. It serves as a key platform of tools to support local production chains and enhance circular and regenerative manufacturing practices. MANTEL aims to integrate data, analysis, and decision-support to help various stakeholders manage and optimize local and sustainable production systems and built environments. The development process is structured into several phases to ensure that the platform meets the needs of its diverse users while remaining flexible and adaptable to changing requirements.

5.1 Links to other WPs

The development of MANTEL, in WP3, is closely interlinked with other work packages to ensure that the development of MANTEL aligns with the project's overall goals. The mapping and analysis conducted in WP2 feeds directly into WP3 by providing crucial data for tailoring the platform's features. Additionally, the platform's implementation and the enhancement of local ecosystems, supported through WP4, provide real-world testing and application of MANTEL. Facilitators and businesses selected through WP4 will play an essential role in testing the platform and providing feedback, thus improving its functionality. Furthermore, WP5, which is dedicated to dissemination, communication, and exploitation, ensures that the results of MANTEL are widely shared, both within the FABRIX consortium and beyond.

5.2 Platform Design and Architecture

The first step in the MANTEL platform development involves the creation of its digital architecture and user interface. This process starts with mapping out the different user

journeys and defining the necessary functionality for each stakeholder group. For instance, businesses may need access to tools that help them assess their supply chain's circularity, while facilitators might focus on collaborative tools that enhance communication between various actors in the production ecosystem. The interface design is carried out with a focus on simplicity and accessibility, ensuring that even users with limited technical expertise can effectively engage with the platform.

5.3 Backend Development and Integration

In parallel with the front-end design, the platform's backend is developed to support complex functionalities and data management. The backend infrastructure is built to handle various datasets and modules, enabling seamless integration of tools like data analytics, mapping systems, and decision-support features. The architecture allows for modular development, meaning that different functionalities can be added incrementally based on project needs and user feedback. The backend also incorporates systems for data security, ensuring that sensitive information—such as proprietary business data or governmental datasets—is protected in accordance with legal and ethical standards (see DMP below).

5.4 Tool Optimization and Iteration

MANTEL builds upon tools and systems developed by project partners in previous initiatives, such as PlatformU, Insylay, and CirculaTool. These tools are refined and adapted within the platform to ensure that they align with the specific needs of FABRIX stakeholders. This iterative approach involves continuous testing and feedback loops. For example, low- and high-fidelity prototypes are tested with different user groups, including businesses, government agencies, and facilitators, to gather insights on usability and functionality. This feedback is crucial for refining the tools, ensuring that they are both user-friendly and highly effective in supporting local manufacturing and circular economy initiatives.

5.5 Prototyping and Testing:

A significant component of the MANTEL development process is the creation of prototypes, both in low-fidelity and high-fidelity forms. The low-fidelity prototypes, which may include simple wireframes or basic functional models, allow early testing of the platform's core features. Feedback from this stage is used to refine the interface and improve user experience. High-fidelity prototypes are more advanced versions of the platform, incorporating more complex functionalities such as data analytics, GIS integration, and decision-support tools. These advanced prototypes are subjected to rigorous testing by a wider audience, including key stakeholders such as industrial partners and local governments, ensuring the platform's practical applicability in real-world scenarios.

5.6 Training and User Engagement

Once the platform's core functionalities are developed and tested, FABRIX focuses on creating a comprehensive toolkit to support the adoption and effective use of MANTEL. This includes developing training materials such as video tutorials, user manuals, and workshops. The aim is to ensure that end-users—whether they are local manufacturers, facilitators, or policymakers—can fully leverage the platform's capabilities to enhance their operations and contribute to the circular economy. By empowering stakeholders with the knowledge and tools they need, the project ensures that the platform is not only accessible but also widely adopted across various sectors.

6 Implementation and co-creation

The implementation and co-creation of actions (WP4) to enhance circular and regenerative practices in the textile and clothing (T&C) sector focus in particular on the local ecosystems of Rotterdam and Athens. The core goal of WP4 is to integrate insights gained

from earlier work packages into practical, on-the-ground actions that foster sustainable production and strengthen local value chains. This is achieved by using the MANTEL platform to bring together facilitators, businesses, and other stakeholders to collaboratively address bottlenecks and exploit opportunities for local manufacturing transitions.

6.1 Financial support through third-party (FSTP) calls

A key mechanism to foster collaboration in the T&C ecosystems of Athens and Rotterdam is the use of financial support through third-party (FSTP) calls, which identify and fund facilitators and businesses within the T&C sector. Facilitators are first selected through open calls based on their capacity to engage with the local ecosystem and address specific challenges identified in WP2, such as bottlenecks in production or spatial limitations. Once facilitators are in place, a second open call targets local businesses involved in the production chain to partner with facilitators in implementing circular initiatives. These open calls are designed not only to provide financial support but also to promote engagement across various stages of the supply chain, from product design to manufacturing processes.

6.2 Capacity building

FABRIX will organise workshops, training sessions, and open-day events to engage stakeholders and enable them to test the tools developed within FABRIX, particularly MANTEL. These activities are designed to build a community of practice around circular and regenerative manufacturing, with a focus on collaboration and knowledge exchange. By encouraging peer-to-peer learning and providing expert mentoring, FABRIX helps facilitators and businesses improve their practices and adopt innovative circular solutions. Regular meetings and workshops in both cities ensure ongoing dialogue between participants, while also allowing for adjustments to the co-creation process based on feedback and real-time results.

6.3 Urban planning and design

FABRIX does not just focus on the operational aspects of manufacturing but also addresses how urban spaces can be optimized to support local production. The co-creation process in WP4 includes collaboration with local stakeholders to tackle issues related to the spatial design and development of the manufacturing areas in both cities. WP4 offers solutions for improving the use of space in a way that supports circularity and regeneration. This dual focus on relational (network) and spatial (planning and design) perspectives ensures that the project addresses both the physical and organizational dimensions of the ecosystems in which these businesses operate.

6.4 Community building

Finally, partnership building is another critical outcome of WP4. By connecting local facilitators with businesses and providing them with the tools and support to collaborate, the project strengthens the local T&C ecosystems. The goal is to create a self-sustaining model where facilitators and businesses can continue to collaborate and innovate even after the project ends. WP4 also links closely with WP5, which focuses on the dissemination and scaling of these practices. By providing training and capacity building beyond the initial stakeholders, FABRIX ensures that the knowledge and tools developed in WP4 can be shared widely, fostering broader ecosystem transitions.

7 Dissemination, open science, and data management

7.1 Dissemination

The dissemination strategy for the FABRIX project is designed to ensure that its results reach a wide and diverse audience, spanning multiple stakeholder groups and the broader public. The plan covers various channels and stages, ensuring that the project's outputs, findings, and innovations are communicated effectively throughout its duration. Central to this strategy is the dedicated FABRIX project website (<https://www.fabrixproject.eu/>), which will serve as a hub of information for anyone interested in the project, ranging from local stakeholders to international audiences. The website will host key details about the project, its goals, its partners, and its technical results, including access to deliverables and scientific papers.

Additionally, the project leverages social media to enhance its visibility and engagement. Dedicated FABRIX accounts on platforms like LinkedIn and Instagram will help reach both professionals and the general public. Social media campaigns will focus on growing a follower base first within the pilot cities of Rotterdam and Athens, before expanding to other areas with potential interest in replicating the project's findings. Newsletters sent twice a year will update subscribers on project progress, events, and findings.

FABRIX aims to publish at least nine open-access scientific papers in peer-reviewed journals (four have been published so far (Pugh et al., 2024; Van den Berghe, 2024; Van den Berghe et al., 2024), see FABRIX website for more information), ensuring that academic and professional audiences benefit from its findings. The project also plans to present its results at high-profile international conferences, such as the annual Regional Sciences Association (RSA) conference (FABRIX presentation were part of the RSA 2024 annual conference, Firenze) and the Association of Cultural Economics International (ACEI) conference at Erasmus University Rotterdam in June 2025.

A final conference will highlight the project's overall achievements, with presentations and discussions focusing on the practical impacts of FABRIX in the T&C sector and beyond. This will ensure that the project's outcomes continue to inspire and influence beyond its official duration.

7.2 Open Source

To achieve success in the project, we maintain an open, cooperative work environment and use tools to share knowledge between consortium partners and the wider community. FABRIX opens access to all parts of the research process, including methods, results, publications, data, and software, aiming to enhance collaboration, knowledge dissemination, transparency, and research reproducibility, while supporting research integrity.

Key actions include:

- Publishing all outputs in trustworthy repositories under Creative Commons and Open Source licenses, ensuring open access to publications to maximize reuse and impact.
- Early sharing of research through preprint archives and open access platforms like Zenodo, ArXiv, and PURE. Research datasets follow FAIR principles, ensuring they are findable, accessible, interoperable, and reusable. Negative results and orphan data are also shared in appropriate repositories.
- Peer-reviewed publications will have open access under the latest CC BY license, with assistance from the TUD library to retain intellectual property rights. Open access journals or platforms like Open Research Europe will be used for publishing. Datasets will be linked to publications through DOI links.

- Open peer-review processes engage relevant stakeholders in assessing results, and all non-sensitive data is stored in the 4TU repository for others to use.
- Engagement with society is facilitated through open workshops, outreach, and dissemination activities. Workshops will be open to all researchers, encouraging knowledge exchange and incorporating participant feedback to shape project methodologies.
- Data supporting findings is made public as early as possible, balancing openness with necessary confidentiality due to industrial partnerships. The principle of "as open as possible, as closed as necessary" is followed.

Given the variety of consortium partners, FABRIX manages a large volume of data, ensuring interoperability across processes and methodologies. Knowledge is freely exchanged among partner institutions, including input from key actors, citizens, and others in co-creating research and innovation agendas.

7.3 Data Management Plan

The Data Management Plan (DMP for the FABRIX project), agreed upon in September 2024, outlines the key strategies for handling data throughout the project lifecycle. The plan focuses on ensuring that all data is collected, stored, protected, and shared according to best practices and legal standards. Data integrity, confidentiality, and accessibility are core principles. The DMP emphasizes the use of open repositories for public datasets, while sensitive or confidential data is securely stored and shared under controlled access conditions.

The plan also ensures that all data is documented and accompanied by metadata, making it findable, accessible, interoperable, and reusable (FAIR principles). Throughout the project, various methods, including desk research, surveys, and interviews, are used to collect data. Ethical considerations, such as GDPR compliance and informed consent, are central to the management of personal and sensitive data. The DMP further supports transparency and reproducibility by making data available to the broader research community whenever possible.

This strategy ensures that the project's outputs are useful both during the project and for future research.

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