MASTERTHESIS

FOOD FOR THOUGHT: RETHINKING SUSTAINABILITY IN URBAN FOOD WITH BLOCKCHAIN

Exploring the role of blockchain technology in reshaping urban food systems through degrowth and the pursuit of strong sustainability

ABSTRACT

This thesis explores how blockchain technology can support the transition of urban food systems from growth-oriented sustainable development toward strong sustainability, guided by degrowth and commons principles. It critically examines the limitations of current sustainability frameworks, highlighting how weak sustainability and sustainable development fail to address ecological and social challenges. Through a philosophical and conceptual lens, the study investigates blockchain's potential to enhance transparency, traceability, and community governance. While not a standalone solution, blockchain can contribute to more just, localized, and ecologically sound urban food systems—provided it is integrated into broader, post-growth frameworks centred on equity, resilience, and the preservation of natural capital.

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1 Introduction

1.1 Background

In recent decades, the food sector has encountered many crises, including environmental degradation, unequal food distribution, food waste, and unsustainable agricultural practices. Addressing these challenges requires a shift toward more resilient and sustainable food systems, which implement ecological balance, social equity, and economic resilience. The urgency of these issues is rising due to global population growth and intensifying urbanization. Most people now live in urban areas, which requires cities to play a critical role in shaping, supporting and standardizing food practices. Unfortunately, food related problems are also increasing due to urbanization, such as food insecurity, unsafe food supply chains, and unequal access to nutritious food. Cities are pivotal locations for food consumption, and the challenges and opportunities within urban food networks are central to achieving sustainability in the food sector. This study therefore focuses on cities and urban food systems, aiming to explore how they can evolve to address these pressing challenges.

Looking for balance seems an almost impossible challenge in the 21st century, we are both failing short and overshooting at the same time. But balance is exactly what we need. While millions or even billions of people are falling short on their most basic needs, the richest are only getting richer. Furthermore, we have passed over six of the nine planetary boundaries, risking irreversible impact of climate breakdown and the collapse of our ecosystem (Richardson et al., 2023). These include climate change, where the levels of greenhouse gases, particularly CO2, have surpassed safe thresholds, and biosphere integrity, marked by widespread biodiversity loss and species extinction (Foley et al., 2011). The biogeochemical flows of nitrogen and phosphorus have been messed up by excessive industrial practices and fertilizer use and ocean acidification threatens marine ecosystems. Lastly, the over-extraction of freshwater resources has reached a point that jeopardizes their long-term availability. These interconnected boundaries highlight the urgent need for global efforts to restore and preserve the planet's resilience and sustainability.

Sustainability has become a prominent term in global discourse, both publicly and academically, across environmental, philosophical, economic, and technological fields, yet its precise definition remains a subject of ongoing debate (Bourban, 2021). There are two distinctions crucial for understanding the concept of sustainability. Firstly, the distinction between sustainability and sustainable development. Over the past decades, these concepts have become increasingly intertwined. Historically, sustainability was rooted in resource management and the principle of intergenerational justice, focusing on the responsible use and conservation of resources for future generations (Muraca & Döring, 2018). Recently, the concept of sustainability has been tainted by putting it into development frameworks, and in so doing, made sustainability commonly associated with a greener version of growth, overshadowing the original focus on ecological limits and justice. This shift has led to the emergence of sustainable development policies that often fail to address the intrinsic contradictions and compromises between environmental, social, and economic objectives. Such policies typically align with neoliberal, top-down, industrial strategies that continue to prioritize unlimited economic growth. These policies are therefore sustainable development, which differs from environmental sustainability. Two main paradigms associated with sustainable development are the growth paradigm (Dale, 2012), and Ecological Modernization Theory (EMT) (Bergendahl et al., 2018; Brey, 1997; Spaargaren & Mol, 1992), The growth paradigm refers to the belief that economic growth is essential, limitless, and the solution to many societal issues (Dale, 2012) and EMT focusses on technological innovation for solving sustainability (and other) issues (Spaargaren & Mol, 1992). Sustainable development operates under the assumption that technological advancements can decouple economic growth from environmental degradation, allowing both to coexist (Fletcher & Rammelt, 2018; Parrique et al., 2019). Critics argue that these ideas fail to achieve the necessary depth of ecological protection and social equity required for sustainability.

These limitations of sustainable development are especially evident in the food sector. Food is treated as just another commodity which fails to recognize the unique nature of food. Unlike products such as software or plastic, food is directly and fundamentally tied to the health and well-being of individuals and the planet. While food undeniably exists within a business context, it cannot be reduced to a simple market good because of its fundamental role in sustaining life and its direct impact on ecological systems. Technological innovation has shaped the food sector, driving developments across various stages of the supply chain—from the industrialization of agriculture to use of genetically modified organisms (GMOs), and from food delivery platforms like Thuisbezorgd.nl to vertical farming. These innovations are often framed within the ideas of sustainable development, the growth paradigm and especially EMT, these prioritize economic growth, placing it above environmental preservation and social well-being. These policies are increasingly critiqued by scholars, activists, and practitioners who argue that it fails to provide long-term sustainability, safety, and well-being needed for future generations, in other words it fails to provide "strong sustainability". This leads us to the second important distinction in sustainability.

The distinction between strong and weak sustainability (Neumayer, 2013). Weak sustainability assumes that natural capital can be substituted by man-made capital, such as technology and human ingenuity. It suggests that as long as the total stock of capital (natural and human-made) remains the same or increases, future generations can be just as well off as the present one. In contrast, strong sustainability argues that natural capital is irreplaceable, particularly key ecosystems, biodiversity, and ecological processes. It suggests that some natural resources cannot be substituted by human-made capital, and their depletion could harm future generations (Neumayer, 2013). A lot of current efforts and policies dedicated to sustainability can be distinguished as weak sustainability, which according to critics is insufficient. They emphasize that achieving strong sustainability requires not just technological innovation (or even not at all), but a fundamental transformation of the systems driving ecological and economic crises. This thesis aligns with the concept of strong sustainability, underscoring the imperative to safeguard Earth's critical natural capital and to challenging growth-centric economic models. Given the complexity of the sustainability debate, this thesis will first provide a comprehensive examination of the historical and conceptual evolution of sustainability and sustainable development, before linking these ideas to contemporary challenges in food and technology.

Recent discussions around sustainability and degrowth present an alternative vision that challenges the dominance of growth-centred economic systems. This alternative framework, grounded in the principles of strong sustainability, emphasizes the importance of maintaining natural capital and ecological integrity while rethinking development and consumption patterns (Daly, 1996; Kallis et al., 2015). Degrowth, as a critical response to the conventional growth paradigm, advocates for a transition towards community-centred, equitable, and ecologically balanced systems. It repositions sustainability within a broader normative and political context, highlighting the need for more localized and just approaches to resource management. Furthermore, The Greifswalder Approach (Ott, 2003) contributes to this discourse by offering a comprehensive, multilevel theory of sustainability that integrates justice and ecological limits, guiding societal decision-making to meet the needs of both current and future generations. This approach critiques the historical shift from a balance between environmental and economic concerns to a narrow emphasis on economic expansion. Next to degrowth also a “return to the commons” forms part of the base of shaping this sustainable urban food network. By shifting from privatized ownership to shared responsibility, the commons framework supports cooperative and community-driven food networks.

A key area of debate within these alternative paradigms is the role of technology. While technological developments have historically contributed to ecological and economic crises, some proponents of degrowth argue that technology, when aligned with their, can play a constructive role. Particularly in contexts like urban food systems, technology holds potential for innovative, sustainable solutions—provided it supports ecological integrity and social equity rather than perpetuating the logic of endless growth (Brey, 2017).

One promising technological innovation is Blockchain Technology (BCT), which has gained attention for its potential to enhance transparency and traceability in food supply chains. Using a decentralized distributed ledger, blockchain can improve the accountability of food systems, allowing both producers and consumers to make more informed and sustainable choices. In urban contexts, BCT can help localize food systems, fostering sustainability. However, blockchain should not be viewed as a technological fix or a standalone solution; it must be integrated into a broader strong sustainability framework that prioritizes environmental preservation and social equity over economic growth.

This thesis explores the potential of blockchain technology to support more localized, transparent, and equitable urban food systems. It examines how blockchain can contribute to the development of urban food networks that align with post-growth and commons-oriented ideals, advancing sustainability through collective action, equity, and ecological integrity. Ultimately, the aim is to shift the conversation from technological fixes to a more holistic, socially responsible approach to the challenges of sustainability, demonstrating that technological innovation can play a role within the framework of strong sustainability.

1.2 Research Question

The central research question guiding this thesis is:

How can blockchain technology support a shift in urban food governance from sustainable development towards strong sustainability, guided by degrowth and commons principles, and create sustainable urban food systems?

The following research questions guide this inquiry:

1. What is sustainability, the difference between weak and strong sustainability, and why are these important when analysing contemporary urban food systems in this global world?
2. What are the key features and limitations of growth-oriented paradigms of sustainable development – e.g. the growth paradigm and EMT and how do these frameworks impact urban food systems?
3. How can blockchain technology enhance transparency and traceability in urban food systems and how might this support the transition to strong sustainability?
4. What are the core principles of alternative frameworks such as degrowth and the commons and how can they form a basis for the integration of blockchain technology to transition to strong sustainability?
5. What are the practical and technological challenges when implementing blockchain in urban food systems for sustainability purposes and what ethical and social justice concerns might arise, particularly regarding data privacy, accessibility and inclusivity for marginalized communities?

1.3 Objectives of the Study

This thesis aims to explore the potential of blockchain technology to transform urban food systems into more resilient and sustainable structures. To correctly do so, the concepts of sustainability and sustainable development will need to be studied. There will be a deep dive into the origins of sustainability and how it has evolved into sustainable development. Furthermore, the difference between weak and strong sustainability is analysed. After laying that groundwork, a key objective is to critically review the dominant neoliberal, growth-driven paradigms of sustainable development—growth paradigm and ecological modernization— and its limitations, and why these are examples of weak sustainability, keeping food systems from becoming resilient and sustainable. Furthermore, this study explores alternatives to these growth-oriented paradigms by turning to degrowth and commons, as they focus on reducing consumption and restructuring economies for well-being and ecological balance. Both challenge the logic of perpetual growth and offer a vision that is both technologically advanced and ecologically sustainable. All these perspectives shape a framework for the development of sustainable urban food systems and its governance. Technology plays a crucial part in this. Therefore, central to the research is the examination of the capacity of blockchain (BCT) to enhance sustainability and transparency in food systems by enabling secure tracking of food from production to consumption. This would reduce fraud, ensure ethical sourcing, and promote sustainable practices, all while fostering greater accountability. However, the research also argues that the successful integration of blockchain requires a fundamental shift away from growth-oriented models towards governance frameworks operating from the premises of strong sustainability and focused on community control, sustainability, and ecological limits. Although blockchain is now often used as a technological fix, its decentralized nature aligns with the models of the commons and degrowth, offering tools to facilitate transparent, traceable, and community-managed food systems. Finally, the study addresses the technological limitations and ethical implications of blockchain in urban food systems, particularly regarding data privacy, accessibility, and potential inequalities. It examines how blockchain applications can prioritize social justice, ensuring inclusivity for marginalized communities and avoiding the strengthening of existing social and economic gaps. Ultimately, this research aims to demonstrate how blockchain can serve as a tool to disrupt traditional market-driven urban food systems and promote more just and sustainable alternatives.

1.4 Philosophical and technical justification and significance

This thesis explores the intersection of blockchain technology and sustainable urban food systems, a timely and critical topic given growing concern around food security, environmental destruction, and social inequality. By focusing on how blockchain can challenge traditional, growth-driven models of sustainability, this study addresses key gaps in academic scholarship, policy-making, and practical applications in urban food systems.

For academic scholarship, this study contributes to a relatively underexplored area: the integration of blockchain with alternative sustainability frameworks, in this case degrowth and the commons. While much of the recent literature focused on blockchain's potential to improve supply chain transparency for food safety and for profit, few studies have critically examined its capacity to support systemic shifts towards more sustainable food systems, principally in urban areas. By studying how blockchain can add to strong sustainability with its characteristics of traceability and decentralization, this thesis offers new insights into how digital technologies can contribute to transformative changes in –urban food– governance and practices. It highlights the importance of rethinking the role of technology within broader societal values, promoting for a move away from sustainable development and the growth-centric models.

Furthermore, this thesis offers valuable recommendations for policymakers seeking to create resilient, sustainable urban food systems. Food systems are under pressure due to climate change, urbanization, and rising inequality. Thus, policymakers need innovative solutions. This thesis demonstrates how blockchain can play a very important role in enhancing transparency, accountability, and trust in food systems, which is crucial for fostering more sustainable and inclusive urban environments. Moreover, the study shows the potential of blockchain to support commons-based approaches to food governance, which potentially gives policymakers ideas about promoting shared responsibility and community control over food resources.

This research could also have important implications for food system specialists and urban planners. As cities continue to grow and food systems become more complex, adopting decentralized technologies like blockchain could improve efficiency, reduce waste, and empower local communities. The study examines real-world applications and challenges in using blockchain, ensuring that its implementation is both practical and ethically sound, particularly for marginalized communities.

Overall, this thesis contributes to the broader discourse on sustainability and technology by showing how blockchain, when applied within a post-growth, equity-focused framework, can drive the transformation of urban food systems into more transparent, just, and ecologically responsible networks.

1.5 Research Methodology

This thesis used various methods, such as a qualitative research approach, drawing on literature review, conceptual analysis, and philosophical methods—both normative and dialectical approaches—to critically explore the potential role of blockchain technology in transforming urban food systems. The study involved both contemporary and historical academic literature on sustainability, blockchain, and urban food systems to establish a strong theoretical foundation.

1. **Literature Review**: At the basis of the study is broad review of theoretical and empirical literature, focusing on key themes such as blockchain technology, sustainability (including weak and strong sustainability, as well as sustainable development), urban food systems, EMT, and the commons. The review will critically examine various perspectives on technological interventions and sustainability in food systems.
2. **Conceptual Analysis**: Central concepts like "sustainability," "degrowth," and "blockchain" will be analysed to explain their meanings and relation to urban food systems. This analysis will strengthen the claims about how technology interacts with sustainability goals.
3. **Hermeneutic Methods**: Hermeneutic methods are used to dig into key texts on sustainability and technology, looking at them through the lens of their historical, social, and cultural backgrounds. This will help us uncover the hidden assumptions and values in both academic and policy discussions, giving us a better understanding of how blockchain could play a role in creating more sustainable food systems.
4. **Future Studies**: This thesis will use future studies methods to explore different scenarios for urban food systems. We'll look at possible tech advances, environmental shifts, and social changes, imagining how blockchain and similar innovations might fit with ideas of sustainability, postgrowth, and the commons.
5. **Philosophical Approaches**: The methodology combines two philosophical approaches: normative and dialectical. The normative approach will look at the ethical side of using blockchain in food systems, focusing on fairness, justice, and sustainability. Building on Ott et al. (2011), practical philosophy will be used to develop a theory of sustainability, navigating the debate between weak and strong sustainability. The dialectical approach will critically examine the contradictions and tensions in sustainability discussions, especially around tech, environmental limits, and social fairness. Together, these methods will help us critically assess what sustainability should be and how contradictions in the current system affect blockchain's role in urban food systems.

1.6 Structure of the Thesis

This thesis is organized into five key chapters, accompanied by an introduction and conclusion. Each chapter addresses an essential aspect of the research and builds upon the conceptual foundations made in earlier sections. The first chapter is the current chapter, involving the instruction, the objectives, the research question and sub-questions, the methodology and in this section; providing the reader with the significance of this study as well as the structure of the thesis. The second chapter gives a sort of conceptual framework, it zooms in on the modern city, and on the concept of sustainability, the difference between strong and weak sustainability and its relations to the urban food system. This chapter set the stage for the further discussion. The third chapter is devoted to exploring sustainable development and in particular the dominant growth paradigm and ecological modernization as start for exploring sustainability in the urban food system by framing and criticizing the key theories underlining current sustainable development. To build a sustainable food system for todays and future generations, we must address the paradox between unending growth, modernization and capitalism versus ecological sustainability. This chapter will argue that sustainability cannot be achieved while unbounded growth and capitalist logics remain central to economic systems. The fourth chapter will cover blockchain technology (BCT). It presents an introduction to the basics of BCT and its main principles but will also cover BCT's relationship to sustainability and the importance of transparency and traceability in that relation. Furthermore, it will demonstrate how BCT has been applied in current food systems as well as examining how BCT's transparency features can further contribute to more sustainable practices in the food sector. The fifth chapter will present the alternative frameworks for sustainability, mainly aligned with degrowth and the commons. It also studies the evolving relationship between local and global dynamics as it is crucial for understanding the complexities of sustainability in urban contexts, to make the local urban food system globally more sustainable. The sixth chapter will present the challenges of the plan to use blockchain to support the transition from privatized food production to commons-based, community-controlled urban food systems. The focus will be twofold: on the philosophical and ethical challenges involved, as well as on the practical issues and technological limitations that need to be addressed. It will be concluded by addressing these challenges for the future. The final chapter is the conclusion, synthesizing the insights from the previous chapters. It will summarize the problems with the current focus on growth and ecological modernization and exemplify the potential for post-growth and commons ideas, particularly in conjunction with blockchain, to reshape urban food systems. The chapter will conclude with recommendations for future research and policy directions, emphasizing the need for a more holistic and inclusive approach to sustainability in urban food systems.

2 Sustainability of the urban food system

2.1 Urban food system

We live in a globalized technological world, marked by modernism and consumerism. Modernity and technology thoroughly transform every aspect of the world, in temporal, spatial, and material terms (Edgerton, 2007; Law & Hetherington, 2001; Leyshon & Lee, 2003). These transformations are particularly visible in the global food system. Food and agriculture are fundamental aspects of modern industrialized society yet often excluded from public and academic discussions about the benefits and harms of industrialization and technological advancement. Food is commonly perceived as something that is pretty straightforward, while the fact that the majority of people in industrialized societies get to eat three times a day could be considered the "greatest triumph of industrialization" (Steel, 2013, p. 1) . This triumph, however, comes at a substantial cost: climate change, biodiversity loss, slavery, water depletion, soil erosion, and diet-related diseases are just some of the consequences of our current food systems. Food and agriculture thus raise fundamental questions concerning both cultural practices and environmental sustainability.

Today's economy centres around consumerism, expanding markets and especially unlimited growth. Most of this growth is attributed to urban areas. About 56 percent of the world's population currently lives in urban areas (WorldBank, 2023) and by 2050 this is estimated to be at least 70 percent[1] (IRP, 2018; Viljoen & Wiskerke, 2012). Cities are places of mass consumptions and pollution, responsible for 70 percent of the global energy use, 60 percent of the use of natural resources and over 65 percent of the world's CO2 emissions (IRP, 2018; Steel, 2013). While governance is still, and has been since the years after World War II, mostly national-focussed, globalization reorganizes the world, and cities serve as the beating heart of our global society (Khanna, 2016; Steger & James, 2013). It is in these global cities where humanity is creating the largest environmental threats to biodiversity and to the very ecosystem humanity depends on.

An important factor that drives these changes is fast expansion and development of both physical and digital infrastructures, especially in urban areas (Borrelli et al., 2018; Clark et al., 2021; Cohen & Ilieva, 2015; Khanna, 2016; Marsden et al., 2018; Steel, 2013). This expansion is not just something that happens locally, it is a global phenomenon. While we are more interconnected than ever before, the systems that enable and sustain these global connections are growing in complexity (Khanna, 2016). A common phrase to describe the effects of globalisation is "the world is getting smaller." Technological advances—such as the internet, global supply chains, and digital communication—have lowered difficulties with communication and information exchange, which makes it easier to allow people, goods, energy, and data to move across borders. All this has increased complexity. Digital connections rely not only on massive networks of data centres, satellites, and fibre-optic cables but also on the physical infrastructure of roads, ports, and bridges to sustain today's digital economy. In reality, as the world becomes more connected, it also becomes more intricate and harder to manage (Sassen, 2000). Disruptions—data breaches, supply chain issues, cyberattacks, or port closures—can occur through our food systems and climate governance. While global connectivity has

[1] There exist numerous estimations of this percentage, studies talk about 70%, 75%, 80% or even higher. For accuracy I have chosen the lowest predicted percentile, but it is relevant to know that this is in fact one of many estimations.

restructured our world into a tightly linked network (Borrelli et al., 2016, 2018; Deakin et al., 2019; Khanna, 2016), it has also created systems that are becoming more and more vulnerable and obscure.

In this context, cities play a central role. As centres of physical and digital infrastructures, urban areas represent the dual nature of modern connectivity, the globality of the world in local form. They are “global cities” (Sassen, 2003, 2007) where the consequences of these developments are most felt. Today’s global city is a paradox: on one hand, it is seen as a beacon of progress, innovation, and resilience. On the other, it is also a site of concentrated challenges—climate change, pollution, resource scarcity, waste, and food insecurity—all exacerbated by reliance on fossil fuels. Many of these issues are closely connected to urban food systems, making infrastructure a central concern in building more sustainable urban futures (Clark et al., 2021; Marsden et al., 2018). The COVID-19 pandemic exposed the vulnerability of large cities to unforeseen, complex global risks and crises (Meuwissen et al., 2021; Pulighe & Lupia, 2020). Lockdowns led to increasing awareness of the critical importance of food availability for urban citizens. The combined impact of border closures and movement restrictions resulted in higher food losses and export costs, particularly for vegetables and perishable goods, putting non-self-sufficient countries at greater risk (Pulighe & Lupia, 2020). Cities around the world are reaffirming the crucial role of food, not just in feeding the growing urban population, but also in driving economic growth, tackling social and health disparities, and promoting environmental sustainability (Moragues-Faus, 2021). The importance of cities in developing more sustainable food systems is increasingly acknowledged on the global stage, including in initiatives like the United Nations' New Urban Agenda and the Sustainable Development Goals (UN-Habitat, 2015 ; UN, 2012, 2015). Ensuring food security in cities is getting harder yet remains largely under-researched because of a lack of knowledge and data about the origin of food in cities and the food flows (Marsden et al., 2018). Cities play a central role in the shaping, supporting, and standardizing food practices, locally and globally and should therefore be positioned as key actors in any transition towards sustainability. For that reason, This is why this thesis is focussing on urban food systems, as urban centres serve as critical points in the global food supply chain, influencing not only local food but also broader environmental and social outcomes.

The idea of a supply chain is often used, but it’s no longer a simple linear process. Today’s food supply chains have evolved from independent, local actors to a globally interconnected web full of complexity and a huge range of stakeholders (Astill et al., 2019). Instead of thinking of it as a chain, we are now looking at urban food networks (Moragues-Faus, 2021) and urban food systems (Bricas, 2019; Kasper et al., 2017). This shift has major consequences for the production, processing, transportation, and delivery of food. While the new system gives us more variety, convenience, and cost-effective ways to trace food, it also comes with a lot of waste, pollution, rising inequality, and growing food safety concerns. The complexity and number of players involved make it harder—if not impossible—

to track a product’s origins or the full extent of its journey. Studies show that consumers are pushing for more transparency and traceability in the food they buy, especially when it comes to sustainability, security, and safety (Aung & Chang, 2014; Govindan, 2018). This has led to more people moving away from unsustainable production processes, which reflects a global shift towards greater consumer awareness of ecological impact of food productions, processing and distribution worldwide (Matzembacher et al., 2018; Sagoff, 2017). Ethical concerns are also rising because people are more aware of food crises, such as the awareness around animal killings due to BSE (Ling & Wahab, 2020; Trienekens et al., 2012). On top of that, fraudulent practices in agri-food supply chains and food safety outbreaks are on the rise, causing economic losses, waste, sustainability issues, and most importantly, a loss of consumer trust (Menon & Jain, 2024).

In recent years, there has been a growing focus on the development of technologies aimed at making the urban food system more sustainable and community resilient. Examples are smart city technology, Internet of Things (IoT) for precision agriculture, vertical farming, blockchain technology, urban greenhouses, Community-Supported Agriculture (CSA) platforms, and food delivery apps with sustainable sourcing. These are great developments. The problem, though, is that many of these developments are tied to ideas like sustainable development, weak sustainability, and ecological modernization. These concepts suggest that we can reduce ecological impact by boosting prosperity, which supposedly leads to better care for the planet (Kirwan et al., 2017; Maye, 2019). Why this is problematic will be discussed later in this thesis, but studies have shown that while most of these technologies can support sustainability goals without growth as part of its main aim, but fundamental change is needed to achieve this (da Cruz & Cruz, 2020; Howson, 2021; Manski, 2017; Maye, 2019). Blockchain is one of those promising technologies that could play a big role in creating more sustainable urban food systems. But before delving into how this tech could help, we need to understand how local and urban systems fit into the bigger global picture, as well as lay the groundwork for the concepts of sustainability and sustainable development.

2.2 Balancing geographic connectivity in the urban food system

The relationship between global and local is essential when discussing the sustainable urban food system for the future. We live in a global world, better connected than ever, and most of daily life is lived in the city. Our future us shaped less by national borders than by global supply chains, argues Khanna (2016). The nation-state is not dead (not yet, if we believe Khanna (2016)), they still have socio-political value and significance. The focus is shifting to a globally oriented imaginary (Khanna, 2016; Steger & James, 2013), even wars between nations are less about territory and more engaged in tugs-of-wars over pipelines, railways and internet cables. Supply chains, communication, trading and people's relationships and engagement are all largely global, all made possible through technological innovation. It compressed the world into a single place and makes the global the frame of action, while the city is the place where most of life happens.

Creating new urban food systems and networks requires more than just a local focus within a city—they need to be supported by a global network between cities. To make this happen, there are several factors at play, and studying social movements can help us understand how global networks and social actions play a role. For example, food networks and city governments around the world need to collaborate, sharing knowledge and practices across different locations and scales. Urban food networks need to have both local and global dimensions, taking into account the socio-spatial dynamics in a world made up of networked places (Moragues-Faus, 2021). Additionally, we need to expand our understanding of how cities connect and build networks that work together toward common goals. During the Covid-19 pandemic, the importance of these networks became even more apparent, as city networks quickly shared best practices to tackle rising urban food insecurity (Ivanov & Dolgui, 2020; Meuwissen et al., 2021; Pulighe & Lupia, 2020). There already great examples of how cities, while working globally on issues like climate change, can have different local actions, such as promoting shorter food supply chains or reducing meat consumption. Many cities balance their local efforts with broader goals, with many urban food policies shaped by local networks like food councils. The idea is to focus on the infrastructure that connects cities, helping us understand how different networks different abilities have to act, whether that involves pushing policies or taking local action. The politics of creating these networks must be transparent, including how decisions are made and who gets to participate. It emphasizes the need to understand the roles of different actors—like local governments and civil organizations—and how their capacities to act vary (Deakin et al., 2019). This raises the need for a deeper look into how the rules for participation are set and the role the state plays in shaping these networks, especially when it comes to the democratic aspects of these more flexible, multi-actor governance structures. In conclusion, a key element of sustainable urban food policy is creating city food networks that function at national, regional, and global levels. A great example is the Milan Urban Food Policy Pact, launched in 2015, which encourages cities to develop sustainable food systems and has been signed by over 200 mayors worldwide (Deakin et al., 2019). The principles of the Milan Pact are widely backed by various initiatives that promote knowledge-sharing and collaboration to speed up the transformation of urban food systems. These include working groups within networks like C40 and Euro-cities, as well as new platforms like the UK's Sustainable Food Cities network (now called Sustainable Food Places). These *trans local* efforts are helping strengthen a global system of sustainable food by building local capacities and encouraging collective action across different levels. From the Milan initiative came ideas like the Smart Food City (Deakin et al., 2019; Maye, 2019), where smart technologies like blockchain are used to make urban food systems more sustainable, grounded in grassroots, degrowth, and commons-based principles. This highlights how important it is to have a global network connecting food policies within urban food networks. Next, the crucial concept of sustainability will be considered and analysed.

2.3 Sustainability

2.3.1 The concept of sustainability

The term sustainability has gained widespread popularity, but this has led to an "overextension of its meaning to the point of trivialization" (Ott et al., 2011). The meaning of sustainability is contested however, which is not surprising as there are over 300 definitions, according to Dobson (1996). Sustainability is an interdisciplinary topic, and scholars interpret it through the terminological and methodological perspectives of their respective fields (Bourban, 2021). Still, there's often disagreement over a single definition, even within the same field. Sustainability is a complex idea shaped by history, social movements, research, and politics. After the Rio Summit, which sparked a global conversation on sustainable development, the term sustainability often gets tossed around as a buzzword with little clear meaning. While its broadness makes room for a lot of different groups to get involved, it also allows powerful players to co-opt it and push their own agendas under the label of being "sustainable."

To get a clearer idea of sustainability, there are two important distinctions to make. First, the difference between" sustainable development" and "sustainability". These terms are often used interchangeably, but that's partly because there are so many definitions of sustainability, some of which overlap with the concept of sustainable (Bourban, 2021). Zaccai (2012) remarks that both terms are flexible and adaptable to various contexts, which has led to ambiguity in their meaning. Adding to this, Ott and Döring (2011) claim sustainability has become a "plastic concept," adaptable to various political and institutional agendas, often obscuring the status quo.

Muraca and Döring (2018) provide some historical context: the idea of sustainable development actually has two main roots—sustainability and development. Sustainability goes back to the 17th century, particularly in German forestry, thanks to Hans Carl von Carlowitz. On the other hand, the concept of development emerged after WWII, focusing on industrialization, modernization, and economic growth, mainly in the global North. Carlowitz's idea of sustainability considered not only managing resources—it also included a concern for intergenerational justice, as he feared that future generations would be deprived of vital resources (Muraca & Döring, 2018). There are a lot of different ways to interpret sustainable development, but a good starting point for debating this distinction is the Brundtland report (WCED, 1987), which had a big impact on shaping the modern idea of sustainable development. They defined sustainable development as "*development that meets the* *needs of the present generation without compromising the ability for future generations to meet their own needs*." (WCED, 1987, p. 43) Initially, sustainability focused on connecting environmental concerns with development. By the late 1990s, the "three pillars" approach emerged, which emphasized balancing economic, social, and environmental goals (Zaccai, 2012, p. 80). As Bourban (2021, p. 293) notes, "since then, sustainable development has been aiming to conciliate economic growth, human development, and environmental protection." The environmental pillar focuses on things like conserving biodiversity, cutting down waste and pollution, tackling climate change, and supporting sustainable practices in areas like energy and agriculture. The social pillar aims to build fairer societies by ensuring access to basic needs like food, clean water, shelter, healthcare, and education, while also promoting social justice, reducing inequality, and empowering marginalized groups. The economic pillar encourages sustainable and inclusive growth, supporting green technologies, responsible consumption, and long-term economic stability. These three pillars are all connected, meaning that achieving sustainable development requires bringing them together to ensure well-being for both todays and future generations. That said, some critics argue that the Brundtland Report's definition of sustainable development is a weak compromise between environmental protection and economic growth (Ott et al., 2011). After the 1992 Earth Summit, sustainable development became synonymous with sustainability, reinforcing a belief that ecological and social problems could be resolved through a "greener" form of economic growth. As (Muraca & Döring, 2018, p. 339) put it, growth is seen not only as central to sustainability efforts but as the mechanism enabling environmental and social policies.

Sustainability and sustainable development are often used interchangeably, yet they emphasize different things. Sustainable development is tied to the growth paradigm—the idea that economic growth is essential and limitless (Dale, 2012). It supports progress—economic, social, and technological—within an environmentally respectful framework. In contrast, environmental sustainability prioritizes protecting natural systems and ensuring ecological balance, arguing that social and economic goals need to stay within environmental limits. While sustainable development tries to balance its three pillars, environmental sustainability sees preserving the environment as the key to long-term societal well-being. Both ideas support intergenerational equity—the belief that future generations should have the same opportunities for a good life as we do today.

2.3.2 Weak and Strong Sustainability

The second important distinction to discuss is between strong and weak sustainability (Neumayer, 2013; Ott, 2003). Weak sustainability argues that natural and man-made capital can be substituted for each other, so natural capital can be reduced if artificial capital is created at an equal pace. This means that if natural resources like forests, minerals, or clean air are depleted, they can be replaced by increases in other forms of capital, such as technological or human innovation. Supporters of weak sustainability believe that technology can compensate for any depletion of natural resources, ensuring that future generations are no worse off in terms of welfare. In contrast, strong sustainability argues that this substitution is limited, and that some natural capital cannot be replaced. Critics of weak sustainability see it as overly optimistic, arguing that it overlooks the irreversible nature of some environmental losses. Most current sustainability policies, however, are based on weak sustainability, and we will explore both perspectives further to argue why the focus might need to shift toward strong sustainability to better address ecological impacts.

As stated above, weak sustainability allows for the substitution of natural capital with man-made, such as physical, human and financial capital, under the assumption that future generations will enjoy at least the same welfare as the current one Bourban (2021, p. 294) describes this as “weak” because it allows “virtually unlimited substitution between types of capital, as long as welfare is maintained across generations.” A well-known proponent of weak sustainability, Robert Solow (1993) argues that as long as total capital (both natural and man-made) does not decrease, future generations can be just as well off or better off. This view suggests that technological progress and growth can make up for any depletion of natural resources. Weak sustainability prioritizes maintaining or increasing physical and human capital for future generations, assuming that growth will eventually solve any resource limitations. This perspective aligns with traditional neoclassical economics (Neumayer, 2013), which views economic growth as essential and believes technological innovation and market-driven solutions can replace declining resources. It also supports the practice of discounting, where future environmental preservation is considered less urgent because future generations are expected to be wealthier and better equipped to handle environmental challenges (Muraca & Döring, 2018). Solow (1993) argues that intergenerational justice only requires leaving future generations with the capacity to achieve similar economic well-being, with depleting resources replaced by assets of equal value (Bourban, 2021). This idea is further reinforced by the Environmental Kuznets Curve (EKC), which suggests that while economic growth may initially lead to environmental degradation, it eventually results in improved environmental protection as income levels rise (Kuznets, 1955). However, applying discounting at the macro level can be problematic, especially in situations where future prosperity is uncertain, as it may conflict with basic justice principles (Muraca & Döring, 2018).

Strong sustainability argues that certain elements of natural capital—such as the Earth’s ecosystems, biodiversity, and ecological processes—cannot be replaced by human-made capital (Neumayer, 2013). The assumption of near-perfect substitutability between natural and human-made capital is seen as fundamentally flawed. For instance, once a species goes extinct or a vital ecosystem is destroyed, it cannot be replaced by a financial investment or technological innovation. Economists like Herman Daly (1996) emphasize that once these resources are damaged or exhausted—whether through species extinction or ecosystem destruction—they cannot be recreated or replaced. This challenges the idea of endless economic growth, suggesting that the economy operates within a finite ecological system. So, expecting indefinite growth without environmental collapse is unrealistic. Instead, strong sustainability calls for a steady-state economy, where human activities stay within the Earth's ecological boundaries. It also highlights the precautionary principle, which urges careful decision-making when there is uncertainty about the environmental impacts of certain actions. Neumayer (2013, p. 110) explains that the precautionary principle can be seen as "an insurance scheme against uncertain future environmental catastrophes." In simpler terms, this means that we should take preventive action to protect the environment now, even if we are not completely sure about the risks of future environmental disasters. Strong sustainability also rejects the practice of discounting, which assumes that future generations will be wealthier or more technologically advanced, and therefore can "afford" to deal with environmental damage (Muraca & Döring, 2018). instead, it emphasizes the importance of preserving irreplaceable natural capital—things like ecosystems and clean air—for future generations. One of the key normative rules for strong sustainability, proposed by Daly (1996), is the Constant Natural Capital Rule. This rule states that "natural capital should not decline over time" (Ott et al., 2011). In other words, we should aim to keep the total amount of natural resources steady, so that future generations can enjoy a similar quality of life to the one we have today. This principal emphasizes that we cannot simply assume technology or financial investments will replace things like biodiversity and ecosystems. Strong sustainability also focuses on protecting essential natural services, like clean water, food production, and climate regulation, which are necessary for human survival. It promotes social equity by advocating for a fair distribution of environmental benefits and burdens, especially for vulnerable populations. One important concept in this approach is reflexive equilibrium, which involves constantly reflecting on your own values while considering rational arguments and the views of others (Ott et al., 2011, p. 24). This process encourages continuous reflection and dialogue, helping people make more informed decisions to change their behaviours and contribute to socially and environmentally responsible practices that support sustainability. Ultimately, strong sustainability is a holistic approach that puts the environment at the core of economic and social decision-making, recognizing the inherent value of natural systems and the need to protect them for the long-term well-being of both the planet and its people.

2.4 Sustainability in the urban food system

Food supply systems need to become more sustainable in order to rebuild and maintain consumer trust after several food-related incidents and scandals (Wognum et al., 2011; Yiannas, 2018). Food has always played a major role in shaping technology, infrastructure, and urban systems, but its importance as a daily necessity has often been overlooked in sustainability discussions. In recent years, however, food and its supply systems have been recognized as central to sustainability. This has made it clear that we need to focus on how food production, processing, distribution, and consumption impact our ability to achieve ecological sustainability goals.

The significance of sustainability in the global food chain is particularly evident in urban areas, which act as key hubs in the food supply chain. Cities affect not only local food security—they also influence broader global environmental and social outcomes (Armanda et al., 2019; Marsden et al., 2018). The ethical aspects of food production and consumption highlight the moral economy of food, which becomes even more significant during times of crisis (Morgan, 2015), such as in war zones like Gaza and the Ukraine or during global events like the COVID-19 pandemic (Ivanov & Dolgui, 2020; Meuwissen et al., 2021; Pulighe & Lupia, 2020). During these periods, certain foods became scarcer, leading to higher food waste, and the costs of food imports and exports increased—both financially and ecologically. This made countries that depend on food imports, especially those that aren't self-sufficient, more vulnerable.

The environmental impact of growth-focused policies is particularly clear in food systems. The push for higher agricultural output often leads to overuse of natural resources like soil, water, and biodiversity. Profit-driven, intensive farming practices contribute to soil degradation, deforestation, and the depletion of aquatic ecosystems (Armanda et al., 2019; Wilson & Clarke, 1998). Food production and distribution companies are increasingly under pressure to balance economic, environmental, and social concerns, especially as agricultural land degrades and water scarcity grows (Liu et al., 2021). By adopting more sustainable practices, urban food systems can address issues like food waste, greenhouse gas emissions, and unequal access to nutritious food. This shift benefits consumers while also pushing producers to embrace more sustainable approaches in response to market demands(Antonucci et al., 2019; Bastian & Zentes, 2013; Caro et al., 2018). The literature on supply chains highlights that consumer demand plays a key role in driving competitive advantage (Rogerson & Parry, 2020). While consumer preferences are a major influence on corporate sustainability efforts, other stakeholders—such as governments, environmental organizations, financial institutions, and academia—also have a significant impact on shaping sustainable practices (Colapinto & Porlezza, 2012). By shifting away from resource-heavy agricultural methods and reducing waste, cities can cut overall food costs and encourage healthier eating habits. These cost reductions may become more apparent over time as emissions decrease and supply chain transparency improves (Hamilton, 2010). As urban areas continue to expand, the urgency of creating sustainable food systems becomes more pressing. In the end, building sustainable urban food systems is not just an ethical obligation; it is essential for ensuring long-term food security and resilience as cities grow.

2.5 What to sustain in the urban food system

The concept of sustainability has been introduced, as has its relation to urban food systems. When considering sustainability, the question arises what needs to be sustained. When considering sustainability, it's important to think beyond merely maintaining current systems of food production, consumption, and governance. The main goal is to preserve and improve ecological health, social equity, and community well-being, particularly within urban food systems. The argument calls for a shift toward strong sustainability, which challenges the idea of endless economic growth, instead prioritizing ecological limits and societal well-being.

First and foremost, the sustainability of ecological systems is top priority. The natural environment, including resources, ecosystems, and biodiversity, must be protected. This thesis addresses how urban food systems contribute to environmental harm, such as climate change, resource depletion, and biodiversity loss. By incorporating tools like blockchain and alternative approaches such as degrowth and the commons, we can explore ways to make urban food systems more transparent and better aligned with ecological limits, ensuring they do not further damage the planet.

Second, social equity is a core element of sustainability. Food systems need to be fair for everyone, especially marginalized groups. This includes tackling food insecurity and ensuring equal access to healthy, nutritious food. Blockchain technology can enhance transparency and accountability in food sourcing, potentially helping to create a more equitable distribution of resources.

Third, community well-being and resilience are vital. Urban food systems should empower communities to be more resilient, allowing them to recover from challenges like climate change or economic crises. Blockchain can play a role here, supporting local, community-driven food networks that strengthen these systems and improve their self-sufficiency.

Finally, it's crucial to recognize ecological limits and criticize growth-centred sustainability models. Strong sustainability is the way to go here, as it focuses on preserving natural resources and curbing economic growth to ensure long-term ecological and social stability. Ultimately, the goal is to sustain a balanced, integrated system that supports environmental health, social equity, and community resilience—shifting away from unsustainable practices and toward a transformative sustainability model that doesn't depend on constant economic growth.

3 Addressing Sustainable Development

3.1 Underlying frameworks

Most sustainability and ecological policies today still operate within the framework of sustainable development, rather than focussing on environmental sustainability. While sustainable development seeks to balance economic growth with environmental and social improvements, strong sustainability argues that continuous economic growth is incompatible with ecological preservation and prioritizes maintaining natural capital. To understand how urban food systems can shift from growth-driven models to true sustainability, it's crucial to look at the growth paradigm and ecological modernization theory (EMT). These frameworks guide current thinking and highlight the challenges of integrating technologies like blockchain in ways that truly support strong sustainability.

3.1.1 The Growth paradigm

For decades, sustainable development has been pursued within the growth paradigm, the belief that economic growth is essential, limitless, and the answer to many societal issues (Dale, 2012). Though often associated with sustainability today, this paradigm has broader historical roots. Economic growth—defined as the increasing production and consumption of goods and services, typically measured by GDP—has dominated both capitalist and socialist economic policies (Dale, 2012; Schmelzer, 2015). Historically, societies like ancient Mesopotamia and Rome focused on expanding wealth and territory, but growth was not their central aim (Dale, 2012). Growth became a key focus with the rise of capitalism in the 16th and 17th centuries. Mercantilism, for example, aimed to increase national wealth through trade, while industrialization later fuelled growth through technological innovation and expanding global trade. Over time, growth became closely tied to market expansion, increased production, and consumer demand. This shift was driven by new ideas about personal success, material wealth, and the belief that maximizing wealth was essential. The Industrial Revolution marked a major turning point, where economic growth became self-sustaining, powered by technological advances, specialization in labour, and global trade networks. (Borowy & Schmelzer, 2017; Schmelzer, 2015). Thinkers like Smith, Ricardo, and Malthus reinforced the benefits of growth, despite early concerns over inequality and resource scarcity (Kallis, 2019; Schermer, 2016). By the 20th century, growth was embraced across ideologies. GDP became the standard for measuring progress during the 1930s. The post-WWII "Golden Age" of growth (1950–1973) saw it as a means to reduce poverty, ease class tensions, and fund welfare programs (Sassen, 2000). Both capitalist and socialist countries aligned economic development with political power and societal advancement. Growth was seen as key to maintaining geopolitical and military power and as a solution to social issues such as class tensions and inequality (Dale, 2012; Sassen, 2000), particularly in Europe, where social democrats viewed it as a means to fund welfare programs and raise living standards. This short history shows that the growth paradigm is capitalism in its core. However, growth has become more than an economic metric—it now shapes values, identities, and political goals. Everything from human well-being to environmental stability is interpreted through its impact on GDP (Manski, 2020). In this system, happiness, meaning, goals, identity and stability are all measured in the economic terms, making us increasingly dependent on GDP (Brey, 2017). Kate Raworth (2017) argues that modern societies have become "addicted to growth"—financially, politically, and socially. Financial systems rely on returns and debt, governments depend on rising GDP to increase tax revenues, and consumer culture connects identity, status, and happiness to the idea of endless consumption. Raworth suggests that while these addictions are not impossible to overcome, they need urgent attention due to their significant impact. This obsession with growth is deeply embedded in our economic and political structures, despite growing evidence of its ecological limits. As Raworth points out, in the 1960s, economist Walt Rostow[2] famously compared growth to an airplane taking off and cruising forever, but Raworth critiques this analogy, arguing that real planes must eventually land (Raworth, 2017, p. 212). Our positive view of growth comes from how we observe it in nature. However, nature shows that growth is temporary, organisms grow, mature, and then stabilize. Continuous growth is neither natural nor sustainable (Raworth, 2018). his is especially problematic since economies depend heavily on natural resources. Economic growth often ignores the finite nature of these resources, and the environmental costs of unchecked growth are rarely factored into mainstream economic planning (Sagoff, 2017). The global GDP has grown tenfold since 1950, bringing prosperity to many, but also increasing inequality and causing environmental harm. Humanity's ecological footprint now exceeds the Earth's capacity to regenerate, destabilizing ecosystems and accelerating climate change.

The food system clearly highlights this disconnect. From traditional farming to mechanization and global supply chains, food has become just another product of economic growth. Modern urban food systems focus on ensuring availability, high standards, and constant supply, often at the expense of the environment. This globalized model, driven by growth, tends to ignore both ecological limits and social equity. In response, governments, corporations, and policymakers have tried to reshape growth, introducing ideas like green growth, inclusive growth, smart growth, and resilient growth—attempts to marry sustainability with economic expansion. While politically attractive, these ideas often rest on the assumption that growth can be decoupled from environmental harm. Scholars, however, argue that this is a fundamental contradiction: true sustainability and endless growth cannot coexist. Rather than confronting the ecological limits of growth, mainstream approaches try to fit sustainability into

[2] Read more about this in Rostow's 1960 classic "The Stages of Economic Growth: A Non-Communist Manifesto" Rostow, W. W. (1991). *The Stages of Economic Growth: A Non-Communist Manifesto* (3 ed.). Cambridge University Press. https://doi.org/DOI: 10.1017/CBO9780511625824

the existing growth framework. This often leads to treating environmental problems as technical issues that can be solved with innovation, a view grounded in ecological modernization theory (EMT). According to EMT, environmental degradation can be reduced through market solutions, technological advancements, and institutional changes, without challenging the underlying economic system.

3.1.2 Ecological Modernization

Apart from the growth paradigm, sustainable development policy has largely emphasized technological innovation as a primary solution to ecological challenges. This emphasis is rooted in Ecological Modernization Theory (EMT), which promotes the idea that a more sustainable world can be achieved through innovation and efficiency, without fundamentally altering the structures of post-industrial capitalist society (Mol & Spaargaren, 2000; Spaargaren & Mol, 1992). EMT views environmental degradation not as a systemic flaw, but as a challenge to be addressed through "systematic eco-innovation and its diffusion" (Jänicke, 2008, p. 557). It supports voluntary policy instruments, market incentives, and stakeholder engagement to foster sustainability (Hajer, 1995), with global examples such as the Kyoto Protocol and Copenhagen Accord embodying its principles.

Since the emergence of EMT in the postmodern era, technology has been positioned at the centre of global and local sustainability efforts (IPCC, 2014; UN, 2012). EMT argues that industrial societies can reduce their environmental impact while maintaining economic growth by making production processes and products more efficient—this includes using fewer non-renewable resources, lowering emissions, and minimizing waste. As Philip Brey points out, this means focusing on efficiency in production and consumption, aiming to reduce harmful environmental impacts (Brey, 2017). EMT suggests that modest reforms—such as incorporating ecological principles into industries—are enough to support sustainable growth.

Crucially, EMT aligns with the concept of weak sustainability, which holds that human-made capital (e.g. technology, infrastructure) can substitute for natural capital (e.g. ecosystems, biodiversity). As long as the total capital stock remains stable or increases, economic development is viewed as sustainable. This logic supports the notion that technological efficiency can decouple growth from environmental harm, allowing for progress without fundamentally altering the economic system. EMT presents modernization as the solution to sustainability, advocating for cleaner technologies, market incentives, and gradual institutional reforms to align economic and ecological goals. However, while EMT promotes cleaner production and more efficient resource use, it does not challenge the foundational assumptions of capitalist modernity. It retains the ideals of free markets, individual autonomy, and technological progress—values integral to the modernization project. EMT is an extension of this project, grounded in an "*an ideal of progress through increases in productivity and technological complexity, rationalization of production, the employment of scientific principle and* *method, and professionalization within the economic context of free-market capitalism*" (Brey, 2017, p. 141). To address environmental issues, EMT proposes strategies like emission control, resource management, and "cradle-to-grave" life-cycle approaches, aiming to minimize harm without reducing production or consumption. These strategies focus on enhancing efficiency through technology and innovation. While EMT encourages industries to integrate ecological principles, such as mimicking natural cycles, it assumes these changes can happen without disrupting economic growth or consumer lifestyles. Yet, in natural systems, growth is always temporary and constrained by ecological limits. By contrast, EMT posits that economic growth can be sustained indefinitely through technological advances. This assumption overlooks the finite nature of Earth's resources and the biophysical boundaries that govern all life systems. While EMT provides tools for reducing environmental impact, it ultimately fails to address the deeper issue: long-term sustainability may require shifting away from growth as the central goal of policy and planning.

3.2 The paradox of sustainable development

3.2.1 Limits to growth

Criticism of contemporary sustainable development and its underlying paradigms has been around for a long time. A key area of concern has always been the tension between growth and sustainability. One of the most significant critiques came from the *Limits to Growth* report (Meadows et al., 1972), published over 50 years ago. The report argued that continuous economic growth was unsustainable, warning that unchecked growth would deplete and damage the natural systems upon which the economy depends, leading to both environmental and economic collapse. This was part of a broader wave of environmental critiques in the 1970s, which raised alarms about industrialism and modernity. Figures like Ivan Illich and E.F. Schumacher went even further, suggesting that society should dismantle industrial systems and return to small-scale, more sustainable technologies (Illich, 1973; Schumacher, 1970). Unfortunately, these ideas were for the most part abandoned during the neoliberal surge of the 1980s, which embraced modern industrial society and prioritized economic growth. The concept of sustainable development started to gain popularity in that time alongside the introduction of EMT. These new views and policies were accompanied by ideas like the "triple bottom line," (Elkington & Rowlands, 1999) which aimed at balancing "people", "planet" and "profit". This suggested *decoupling*, the possibility for the economy to grow without harming the environment. Since then, and currently still, the dominant understanding is that economic growth can be 'decoupled' from environmental impact (Büscher, 2020; Howson, 2021). This decoupling might be global or local, based on production or consumption and happening over short or long periods of time (Parrique et al., 2019). It suggests that growth can continue without escalating environmental degradation, through mechanisms like "dematerialization"—reducing resource consumption per unit of economic output (Smil, 2013). While this decoupling rests on the assumption that growth is essential for achieving sustainability, which is in line with the definition of sustainable development as the ability to meet the needs of the present without compromising future generations' ability to meet their own, as defined in the Brundtland Report (WCED, 1987).In contrast to sustainability, sustainable development is understood as being primarily economic in nature. According to sustainable development, sustainability is "*a situation in which the needs of the present generation are met, without impeding on the satisfaction of needs of future generations*" (Elkington & Rowlands, 1999; Wognum et al., 2011, p. 65). Information about sustainability encompasses, at least, *human health, equity and safety* (People) and *environmental impact* and resource demand (Planet), all situated within an *economic framework* concerned with profit, GDP growth and work (Profit) (da Cruz & Cruz, 2020; Wognum et al., 2011, p. 65). As mentioned, the critique of unlimited economic growth states that growth cannot continue indefinitely without dire ecological consequences. The economic leaders at that time dismissed these concerns though. In fact, many scholars agree that, despite decades of efforts toward "sustainable development," no country has successfully achieved a permanent, large-scale, and rapid decoupling of economic growth from environmental impact (Fletcher & Rammelt, 2018; Jackson & Senker, 2011; Parrique et al., 2019).

Over the decades, frameworks such as the Millennium Development Goals (MDGs) & more recently, the United Nations' Sustainable Development Goals (SDGs) (UN, 2015), adopted in 2015, have sought to guide global progress (Hickel, 2019). These goals align with the general agreement between the nations of the world idea that economic development must be environmentally sustainable (Brey, 2017). However, these goals reveal contradictions, as pointed out by scholars like Hickel (2019). The SDGs, on one hand, aim for "harmony with nature" and urgent action on climate change (goals 6, 12, 13, 14, 15). On the other hand, they call for continued global economic growth (goal 8), based on the assumption that "*growth is necessary for human development and the eradication of poverty and hunger"* (Hickel, 2019, p. 874). Gupta and Vegelin (2016, p. 433) argue that the SDGs demonstrate "*trade-offs in favour of economic growth over social well-being and ecological viability*". This dual focus undermines the very sustainability they seek to achieve. Hajer et al. (2015) argue that the SDGs fall short if they rely solely on top-down steering by governments and intergovernmental organizations, a phenomenon they call "*cockpit-ism*" (Hajer et al., 2015, p. 1651). Given the limited effectiveness of such efforts, the SDGs must engage businesses, cities, and civil society, requiring diverse perspectives on sustainable development to address the various motivations and logics of these actors. They state that governments must recognize the interconnectedness of social, environmental, and economic concerns and follow a model that ensures both ecological viability and social justice. The SDGs exemplify the core issue of reconciling growth with sustainability, showing that, despite well-meaning frameworks, the goal of endless economic growth remains at odds with the imperatives of sustainability.

Continuous economic growth and strong sustainability cannot coexist. The growth paradigm assumes that economic expansion can continue indefinitely, but this conflicts with the reality that Earth's resources are finite. Strong sustainability, in contrast, prioritizes long-term environmental health over short-term economic gain, arguing that certain ecosystems cannot be replaced by human-made capital and that human activities must stay within ecological limits to avoid depletion and environmental harm. (Ayres, 1996; Dale, 2012). When it comes to intergenerational equity, strong sustainability advocates for ensuring the well-being of both current and future generations. It stresses that future generations deserve to inherit a healthy, life-supporting planet. In contrast, the growth model often prioritizes immediate economic success, which can compromise the ability of future generations to meet their needs (Davies, 2013; Ott, 2003). Another key point of tension is the idea of decoupling growth from environmental harm. While proponents of the growth paradigm argue that technological innovations can decouple economic growth from environmental degradation, strong sustainability challenges this idea. The evidence suggests that achieving complete decoupling is incredibly difficult. In fact, economic growth often leads to higher resource consumption, making it harder to reduce environmental impacts (Fletcher & Rammelt, 2018; Parrique et al., 2019).

In conclusion, strong sustainability calls for a fundamental shift in how we think about economics—one that focuses on preserving the environment, ensuring social equity, and prioritizing long-term well-being rather than continuous economic growth. Without this shift, endless growth, driven by unlimited consumption, threatens the principles that are crucial for a liveable future for all.

3.2.2 Criticism on Ecological Modernization Theory (EMT)

Ecological Modernization Theory (EMT) has received significant criticism for its assumptions and implications. Critiques are often concerned with its proposed 'reforms' in technology, production, and consumption. Critics argue that the limited scope of these reforms is far too insufficient. The two key weaknesses in the theory are the challenge of unlimited economic growth and the problem of technological neutrality. EMT assumes that technological advancements can lead to environmental improvements without challenging the growth paradigm. However, this assumption is problematic. Technological innovations often lead to increased efficiency, but they can also result in increased consumption—a phenomenon known as the rebound effect. This paradox suggests that technological solutions alone may not suffice to achieve sustainability (Bergendahl et al., 2018; Carolan, 2004). The ever-increasing population and expanding economies exhaust natural resources, which raises the burden and nature and humanity – in particular today's poor and future generations – continue to suffer (Sagoff, 2017, pp. 173-174). Many environmentalists believe that we are approaching the realisation of the Malthusian theory that resources inevitably diminish and become exhausted as population and consumption increase (Ehrlich & Ehrlich, 2004; Kallis, 2019). Contrary, many EMT scholars proclaim that although there are unquestionably limits to our earth and resources, Malthus did not consider the effects of technological developments and the possibilities of food innovation and food delivery all over the world (Kallis, 2019; Schermer, 2016). Proponents of EMT often argue that technological innovation can overcome ecological limits, leading to sustainable growth. However, this perspective is increasingly questioned. The assumption that technological advancements can indefinitely decouple economic growth from environmental harm is not supported by empirical evidence, and the pursuit of limitless growth may exacerbate ecological and social crises (Jackson & Senker, 2011). Proponents of EMT argue that greening the economy, rather than just reforming industry, will lead to sustainable development. However, this vision faces a critical flaw: it assumes that efficiency improvements will outpace growth in consumption (Fletcher & Rammelt, 2018). Numerous studies have demonstrated that this decoupling is not feasible, and that economic reforms have not led to the widespread adoption of environmentally friendly products, nor made them more affordable or accessible (Büscher, 2020; Fletcher & Rammelt, 2018; Howson, 2021).

Then to technological neutrality. EMT often treats technology as a neutral tool capable of solving environmental problems. This instrumental view treats technology as a simple solution to complex social and environmental issues. Critics argue that this perspective overlooks the complex social, political, and economic contexts in which technologies are developed and implemented. Technologies can have unintended consequences and may reinforce existing power structures, rather than leading to equitable and sustainable outcomes (Brey, 2017; Carolan, 2004; Hobson & Lynch, 2018). EMT advocates for technological reforms in production systems, such as improving material efficiency and reducing waste. While this sounds promising, it creates a paradox: economic growth typically leads to an increase in natural resource consumption. Historically, the belief in technological innovation as a way to overcome this paradox led to the idea that "*innovation will find ways to squeeze more 'value added' to the research bundle*" (Goodland & Ledec, 1987). While this ideal has inspired optimism, it has not been fully realized. A more modern response to this issue is the concept of dematerialization, or reducing physical substance use—illustrated, for example, by the shift from paper-based records to digital systems (Smil, 2013). While digital records reduce paper waste, they often mask the increased energy consumption of data centres and internet infrastructure, leading to more ecological harm. Shifting to digital has not always resulted in material savings; instead, it has created new demands for energy and resources, driving higher consumption. This shows a wider trend, where technological advances, like in the food industry, may improve efficiency but also result in more waste, packaging, and resource use, without significant sustainability benefits. Critics of EMT argue that this way of sustainable development is inadequate for achieving sustainability. They argue for a profound shift in societal values, particularly concerning the quality of life and how it is measured (Asara et al., 2015; Brey, 2017). While acknowledging the importance of technology in advancing sustainability, they emphasize that a fundamental change in our understanding of progress is necessary. They reject the idea that progress should be defined solely by economic growth, typically measured in GDP, and instead advocate for a broader set of indicators that assess well-being, happiness, and life satisfaction (De Castro Mazarro et al., 2023). This critique challenges the Enlightenment-era ideal of progress, which was originally not a belief in economic growth but a belief that science, technology and reason could improve the human condition and quality of life. Critics advocate for alternative frameworks that challenge the growth paradigm and emphasize the need for systemic change. Approaches such as degrowth, steady-state economics, and regenerative economics prioritize ecological sustainability, social equity, and well-being over continuous economic expansion. These perspectives argue for redefining progress and success beyond GDP growth, focusing instead on quality of life and ecological health.

While EMT offers insights into the potential role of technology in achieving sustainability, its limitations highlight the need for broader societal transformations. Addressing the root causes of environmental degradation requires challenging the growth paradigm and adopting alternative economic models that prioritize ecological and social well-being.

3.3 The Growth paradigm and EMT in the urban food system

One of the most visible places to see the concrete trouble with the EMT and the unending growth model is the food sector. These models typically rely on the premise that increasing production, consumption, and technological innovation lead to higher economic output, with little regard for the finite nature of natural resources or the environmental and social costs associated with this growth (Daly, 1996). In the context of food systems, these models promote large-scale industrial agriculture and food production that mainly prioritize maximizing profit – no surprises here – at the expense of ecological health and social equity (Foley et al., 2011; Govindan, 2018). Furthermore, the unequal distribution of the benefits and burdens of growth contributes to widening social inequalities, particularly in terms of access to land, fair wages, and food sovereignty (Jeff & Celia, 2020; Marsden et al., 2018). Other problems that are encountered are monocultures, intensive pesticide use, and overexploitation of water resources can lead to soil depletion, biodiversity loss, and pollution, undermining long-term food security (Armanda et al., 2019; Hoehn et al., 2021; Kayikci et al., 2022; Pretty, 2008).

Growth-focused policies drive up inequality in urban food systems. As big corporations chase profits, small farmers and local producers get squeezed out, leaving power in the hands of a few agribusinesses. This makes it harder for people in urban food deserts to access healthy, affordable food. High production and distribution costs prioritize efficiency over fairness. At the same time, labour conditions in the food supply chain reflect these problems, with workers facing low wages, poor conditions, and limited rights, keeping them trapped in poverty. Strong sustainability might make use of technology, but not only as a fix for a problem. Technology needs to be employed in changing the fundamentals of society, the lifestyles of people and the way they consume. Future food products should be designed for recyclability and constructed from durable, non-toxic materials, produced under socially responsible conditions where workers share in profits and participate in decision-making (Wognum et al., 2011).

It will be a hard job to remove the line of thought concentrated on growth and EMT out of sustainable practices and policies as it is so intertwined with our whole culture, language and even our desires – i.e. our addictions, financially, politically, and socially to growth (Raworth, 2017). It is interwoven in most sustainable policies, as seen with the SDGs. Another example is last year's policy agreement *(regeerakkoord)* of the Dutch government. For almost all the problems there are in the world and in the Netherlands, the proposed solution seems to be technological innovation. They believe so strongly in the solution of technological fixes for complex societal issues, they have used the word innovation 85(!) times (Rijksoverheid, 2024). At the same time, they propose to cut serious amounts of academic funding. Furthermore, this interwovenness is also apparent in sustainable development policies and technological innovation concerned with the urban food systems. To give you a few examples. In the article of Wognum et al. (2011) about systems for sustainability and transparency of food supply chains though they state that "Managers in the food industry and agribusiness will have to respond to these changing consumer demands by increasing sustainability of processes and products" (p. 65). They focus mainly on the financial challenges, costs and uncertainties sustainability and traceability measure might cause than focussing on sustainability, people and change. The definition of sustainability and its focus on "people", "planet" and "profit", is directly followed by: "The economic effects ('Profit') of sustainable business management can be harvested by cost reductions and/or by means of increased revenues. To boost revenues, companies need to respond to public pressure by information processing and increased transparency for consumers to positively change the firms' image" (p. 65). Two paragraphs later it reads: "improving sustainability in the food production system usually leads to higher costs in the short term, while the revenues are uncertain. Creating added value by improved sustainability implies creating transparency, since consumers have to be convinced (and thus shown) that the often higher prices involved are justified by the measures to improve sustainability" (p. 65). It paints a rather bleak picture for raising traceability and transparency in the food supply chain. It shows that costs and benefits are often unclear for the industry and agribusiness. In fact, it uses the word costs approximately 40 times. Reading the whole article, though accurate, it marks the focus on economic growth in sustainable innovation and development in food systems.

Another example is found in the field of urban planning, which is crucial for improving the city. "Sustainable urban planning" is subscribed as reducing the environmental impact of cities while improving or maintaining social welfare. The goals of this field are generating healthy living and working environments today, developing future proof urban environments and guaranteeing wise and responsible use of natural resources (Meijer et al., 2011; Scott, 2019; Viljoen & Wiskerke, 2012). In this field however, the idea of decoupling economic growth from ecological and social impact is dominant, and as it does not consider that growth is limited, it is sabotaging its own ambitions (Fletcher & Rammelt, 2018; Howson et al., 2021). This social welfare seems great, but it is prioritized underneath economic welfare. The whole idea of social welfare is increasingly becoming problematic as humanitarian concern for the meeting of social needs coexisted with the fear of social problems, threatening the wider order (Manning, 2022). Furthermore, social welfare is still measured in GDP (Schmelzer, 2015).

Overall, traditional economic growth models and Ecological Modernization Theory (EMT) present serious obstacles to building sustainable food systems. GDP, used to measure success and well-being, fails to account for the environmental and social costs of growth, showing the need for new approaches. Alternative measures like the Human Development Index (HDI) or the Genuine Progress Indicator (GPI) provide a more holistic view of well-being. Additionally, economic growth in wealthy nations has been linked to increasing inequality and social unrest, with researchers like Richard Wilkinson and Kate Pickett suggesting that inequality, rather than growth, drives social problems. They demonstrate that once a nation reaches a certain level of prosperity, further growth does not improve happiness or health, and worsening inequality undermines societal well-being (Schmelzer, 2015). Growth-driven urban food systems worsen environmental damage and social inequality, highlighting the need for frameworks that prioritize ecological health and social justice over endless economic growth. While technologies like blockchain can improve efficiency and transparency, they must be part of a larger shift that challenges growth and redefines prosperity. Exploring alternatives like degrowth and commons-based models is crucial for sustainability. Economic growth, once seen as a solution, now fails to deliver better social outcomes, and with ecological limits, endless growth is unsustainable. The future lies in balancing well-being, sustainability, and equality.

4 Blockchain technology for sustainable urban food systems

4.1 The technology of Blockchain technology (BCT)

Blockchain is a distributed ledger technology that operates on a decentralized peer-to-peer (P2P) network. The distributed ledger is set up into chains of blocks, and each block is connected to the next one through a cryptographic hash. All blocks contain their own unique block number and a timestamp. There are multiple transactions arranged within each block, and each transaction cryptographically signed using asymmetric digital keys. The governance of the distributed ledger is maintained through a consensus mechanism known as the consensus algorithm, such as Proof of Work (PoW) or Proof of Stake (PoS), which are discussed in more detail later.

Blockchain technology was first introduced in a 2008 white paper by Satoshi Nakamoto (Nakamoto, 2008). The first programmable public permissionless blockchain was launched by Vitalik Buterin in 2013 (Buterin, 2014). Public permissionless blockchains are largely characterized into Bitcoin and Ethereum networks, because of their participation in consensus processes as well as their read-write access. There are a couple of variations in blockchains: i.e. public, private, permissioned and permissionless and consortium. You could say public and permissionless blockchains are the same, accessible to everyone, anyone can view the ledger and is allowed to conduct transactions and participate in the consensus. You also have private blockchains, which – as private already presumes – are only visible to select members and owned and controlled by a single entity or organizations, typically used for internal purposes. In permissioned blockchains only participants who got authorization can access the network, but the control is centralized. Finally, the odd one in the bunch are consortium blockchains. They can be understood as a mix between permissioned and private blockchains. Consortium blockchains are controlled by a group rather than a single entity. That is why it is often used for enterprise collaboration, big groups of multiple entities to manage the blockchain. In consortium blockchains, only a predefined set of members is permitted to transact and participate in consensus (Friedman & Ormiston, 2022).

As append-only distributed databases, blockchains provide the infrastructure for a variety of applications, such as distributed energy microgrids, environmental asset marketplaces, fish supply chain traceability systems, and digital community currencies (Kamilaris et al., 2019; Kouhizadeh et al., 2019; Rejeb et al., 2019; Saberi et al., 2019). Blockchains are typically implemented in situations where trust in institutions or among individuals is lacking. The use of "trust-less" systems to facilitate transactions among users who may be indifferent to fostering strong, collaborative communities may ultimately produce outcomes that are not only unsustainable but also socially divisive. Rather than relying on blockchain as a remedy for business-as-usual practices, the technology should be employed only when it can genuinely contribute to ecologically sustainable, redistributive local economies while addressing issues of power imbalances and social fragmentation. Ultimately, for the realization of sustainable futures, the foundation of trust must precede the adoption of blockchain. Without trust and community-building, blockchain's promise of ecological or social benefits is likely to remain unfulfilled.

4.2 Blockchain technology in the food system

In 1998, a paper titled "Food Safety and Traceability in the Agricultural Supply Chain: Using the Internet to Deliver Traceability" explored how the internet could be leveraged for food supply chain traceability, offering a system accessible to all involved stakeholders (Wilson & Clarke, 1998). Six years later, Gunasekaran and Ngaia reviewed over a hundred studies on information technology in supply chain management, highlighting the growing integration of digital tools into food supply chains (2004). Twenty years later, by 2018, blockchain technology emerged as a transformative solution for ensuring food safety, traceability, and transparency in supply chains (Caro et al., 2018; Teng, 2022). Over the past decade, BCT has emerged as one of the most transformative digital innovations, gaining prominence across a range of sectors, including environmental sustainability (Lockl et al., 2020).

The decentralized digital record-keeping system in BCT used to document the history of transactions is principally different from traditional transactional frameworks, where multiple stakeholders participate in the exchanges within a supply chain, each often maintaining their own independent records of the transactions (Mazzù et al., 2022; Mulligan et al., 2024; Tribis et al., 2018). This fragmented approach frequently leads to discrepancies, duplication, and redundancies, resulting in inefficiencies throughout the supply chain (Antonucci et al., 2019; Caro et al., 2018; Jiang & Zhang, 2022). This issue is particularly pronounced in the food industry, where many small to medium-sized enterprises still rely on paper-based documentation (Burgess et al., 2024). By implementing a single, tamper-evident shared ledger, blockchain significantly alleviates these inefficiencies, providing all parties involved in the transactions with a unified version of all available information. This record can be accessed by all participants in the transaction chain, thereby ensuring that everyone operates from the same, reliable version of the data (Sanchez et al., 2023). In food systems, the choice of blockchain consensus mechanism affects both sustainability and accessibility. Proof of Work (PoW), used by Bitcoin, requires high energy consumption, raising concerns about environmental impacts in already resource-intensive food supply chains. In contrast, Proof of Stake (PoS), adopted by newer networks like Ethereum 2.0 (Bajra et al., 2024; Omar et al., 2024), offers a more energy-efficient alternative. For applications such as farm-to-fork traceability or certification of organic produce, PoS-based blockchains are better aligned with ecological goals. Selecting the right mechanism is crucial to ensuring that blockchain use in food systems supports—not undermines—efforts toward environmental sustainability and ethical sourcing.

The application of blockchain technology to food traceability has been explored in numerous studies. For instance, a blockchain-based solution using the Ethereum platform was proposed to trace fish and fishery products from source to consume (Cruz & da Cruz, 2020). Similarly, Hyperledger Fabric has been employed in tracing products with Protected Designation of Origin (PDO) and Traditional Specialty Guaranteed (TSG) designations (Alves et al., 2021) as well as in tracking Colombian coffee beans (Miatton & Amado, 2020). Blockchain solutions have also been tested in the olive oil sector, with platforms like Devoleum and BRUSCHETTA providing decentralized traceability systems (Arena et al., 2019; Mercuri et al., 2021). Fernandes et al. discusses in the traceability in the olive oil production sector in detail, with special attention to sustainability indicators, business processes and how blockchain solutions enable traceability (Fernandes et al., 2023).[3]

Despite the increasing use of digital tools in many sectors, food traceability systems remain underdeveloped and fragmented. Foodborne illness outbreaks, often linked to a single ingredient highlight the inefficiencies of current traceability systems. Outbreaks in the U.S. have caused numerous hospitalizations and fatalities, linked to various foods, such as chocolate, basil leaves, mangoes, peanut butter, eggs, ice cream and lettuce leaves (FDA, 2024).These incidents underscore the need for better monitoring and response mechanisms. Issues such as delayed responses, underdiagnosis, and food adulteration (e.g., fake honey) highlight the need for improved traceability (Behnke & Janssen, 2020; Friedman & Ormiston, 2022; Lin et al., 2021). Many food companies still rely on paper documentation, complicating traceability efforts and delaying responses. This results in inefficient, fragmented systems, where assembling traceability data during an outbreak is labour-intensive and slow (Astill et al., 2019; Yiannas, 2018). Blockchain's ability to provide real-time, accurate, and tamper-proof data significantly improves traceability, enabling faster responses to food safety issues and supporting the prevention of future outbreaks.

Blockchain's ability to improve transparency, efficiency, and data quality offers several benefits for food supply chains, such as fewer disputes, reduced intermediaries, better product quality, and improved lifecycle management (Burgess et al., 2024; Feng, 2017) While blockchain has traditionally been used to ensure food safety and address issues like foodborne illnesses (Rogerson & Parry, 2020), it is increasingly being used for sustainability purposes in the food sector. In these instances, however, its use is often for the purpose of sustainable development framed within the context of weak sustainability and sustainable development by means of Ecological Modernization Theory (EMT). As a

[3] To better understand how blockchain technology is used to enable traceability throughout a whole chain, this article of Fernandes et al. from 2023 concerning olive oil is highly recommended.

result, while blockchain can improve transparency and efficiency, it may not be sufficient on its own to address the deeper sustainability challenges facing urban food systems. To move closer to strong sustainability, alternative frameworks need to be considered that challenge the assumptions of continuous growth and prioritize ecological and social justice.

4.3 Transparency, Blockchain Technology and Strong Sustainability

Achieving strong sustainability in urban food systems requires not only ecological responsibility but also systemic transparency. In the food literature, sustainability is closely linked to transparency, particularly because transparency fosters trust, informs responsible decision-making, and enables accountability (Beulens et al., 2005; Duffy et al., 2005). Blockchain technology (BCT) is increasingly recognized for its role in enhancing transparency across food supply chains. (Kamilaris et al., 2019; Yiannas, 2018). Its features—immutability, auditability, and decentralized data management—allow for secure and real-time access to information (Caro et al., 2018; Galvez et al., 2018) making it a powerful tool for advancing sustainability claims and consumer confidence. But what exactly does transparency mean in this context?

Defining transparency is challenging, as the term is closely linked to broader concepts like openness, communication, and information (Gupta & Mason, 2014). In food systems, transparency takes on different forms depending on who is seeking it and for what purpose. For example, it may serve consumers by informing them about animal welfare (Hoogland et al., 2005) , or serve regulatory goals by holding industries accountable (Iles, 2007). Transparency is closely tied to the actors seeking it. Transparency can include consumers, governments, and companies (Trienekens et al., 2012). Wognum et al. (2011, p. 65) offer a practical definition: transparency is *"the degree of shared understanding of and access to product-related information as requested by a supply chain's stakeholders without loss, noise, delay, or distortion"*. This means providing relevant, accurate, reliable, and timely data in the right amount, ensuring that information is understandable and well-organized. This encompasses four critical elements: product relevance, data accuracy, stakeholder inclusion, and accessibility. These elements of transparency are often broken into key dimensions of transparency: traceability, accessibility, visibility and accountability of information.

Traceability refers to the ability to track food products throughout the entire supply chain, both backward and forward (Aung & Chang, 2014). The ability to trace food from farm to table supports the swift identification of contamination sources and verification of sustainability claims. The European Community Regulation (178/2002) defines traceability as "*the ability to trace and follow a food, feed, food producing animal, or substance through all stages of production, processing, and distribution*"

(Kehagia et al., 2007, p. 400). The globalisation of food systems and incidents like the 1990s food scandals have intensified demand for robust traceability systems (Karlsen et al., 2013; Liu et al., 2019). Visibility refers to the ability of real-time tracking of goods, to observe the movement of food products across all stages of the supply chain, which helps to identify inefficiencies, enhancing operational performance and boosts consumer confidence (da Cruz & Cruz, 2020; Feng, 2017; Rogerson & Parry, 2020). Accessibility ensures that relevant data—such as sourcing, production methods, and environmental impact—is available in a comprehensible and timely manner (Bastian & Zentes, 2013; Jiang & Zhang, 2022). This empowers all stakeholders, including consumers, to make informed decisions. Accessibility is also a condition for inclusivity, allowing smaller producers and marginalised actors to participate more equally in food governance systems. Accountability is facilitated when information is transparent and verifiable. It holds actors responsible for sustainability claims and ethical conduct. Transparency systems supported by BCT make it harder to obscure harmful practices and easier for regulators, NGOs, and consumers to demand corrective action (Miatton & Amado, 2020; Mol, 2015; Trienekens et al., 2012).

Blockchain technology (BCT) enables transparency by securely recording and sharing product-specific information—such as origin, handling, sustainability certifications, and carbon emissions (Behnke & Janssen, 2020; Galvez et al., 2018)—and sustainability metrics (Astill et al., 2019). This transparency supports strong sustainability by illuminating the environmental and social impacts of production and allowing stakeholders to act on this information. In particular, BCT can be used to expose unsustainable practices—such as deforestation, excessive emissions, or labour exploitation—that would otherwise remain hidden in complex, globalised supply chains (Roberto et al., 2018). Projects using BCT in sectors such as seafood, coffee, and cocoa have already demonstrated its potential for tracing sourcing practices and empowering producers through verified, accessible data.

Consumer expectations for ethical and sustainable food have driven demand for more visible supply chains. Research shows that transparency influences consumer willingness to pay for sustainable products (Napolitano et al., 2010). Transparency stimulates accountability and helps stakeholders understand the impacts of food production on human health and the environment (Gupta & Mason, 2014; Mol, 2014). However, for transparency to be meaningful, it must be very clear and direct. Information overload or inaccessible formats can obscure rather than illuminate sustainability performance (Miatton & Amado, 2020; Mol, 2015; Trienekens et al., 2012). As food systems become more data-driven, efforts to provide transparency must also ensure the usability of information. BCT facilitates this by offering structured and reliable data that can be tailored to different stakeholders—whether regulatory bodies verifying compliance, or consumers looking for carbon footprints or fair-trade indicators (Galvez et al., 2018). Public and regulatory demand for transparency continues to grow. The European Commission’s recent directives on green claims aim to prevent misleading sustainability claims by requiring more evidence and clearer communication (Burgess et al., 2024). Firms are now under pressure not only to improve their actual sustainability performance but also to transparently report it. Transparency, therefore, acts as both a market signal and a regulatory tool, shaping how companies design their sustainability strategies and how consumers navigate ethical food choices.

These traceability systems enhance visibility across the supply chain, ensuring that relevant actors can access reliable information to support ethical and environmentally responsible practices. Overall, transparency includes several key elements: openness of information, where stakeholders can access detailed data about each step in the supply chain; trust and accountability, facilitated by verifiable and immutable data (e.g., through BCT); and ethical practices, where information on sustainability, food safety, and fair labour is disclosed, enabling informed decisions These principles enable consumers to evaluate the sourcing, production, and environmental impacts of food, enhancing trust in food systems (Astill et al., 2019; Miatton & Amado, 2020; Sanchez et al., 2023).

Despite these benefits, most applications of BCT in food systems have been oriented toward weak sustainability—seeking to improve efficiency and reduce risks without challenging underlying growth models (Behnke & Janssen, 2020). Efficiency gains alone are insufficient for strong sustainability, which requires fundamental shifts in consumption, production, and values. BCT can do more than enhance traceability and audit trails—it can act as a catalyst for systemic change if deployed within frameworks that prioritize ecological limits and social justice. For example, initiatives like FairChain use BCT to rebalance value distribution and promote ethical sourcing beyond profit motives.

When integrated into a strong sustainability framework, BCT becomes an infrastructure for transformation. It supports transparency that goes beyond compliance—revealing how food is produced, who benefits, and at what ecological cost. It enables better governance by giving all stakeholders—especially those historically marginalized—equal access to trustworthy data. In complex urban food systems, this capacity is crucial. Cities often rely on distant, opaque supply chains that obscure environmental and social impacts. BCT can close this distance, providing visibility into food's journey from farm to fork and empowering urban actors to demand more sustainable options.

Transparency, supported by BCT, is central to advancing strong sustainability in urban food systems. It encompasses traceability, accessibility, and accountability—each critical for ethical, informed, and environmentally responsible decision-making. While current implementations often reflect efficiency-focused models, BCT's real potential lies in supporting deeper structural transformation. By making sustainability impacts visible and verifiable, and by redistributing informational power, BCT blockchain can help foster resilient, equitable, and regenerative food systems that prioritize ecological integrity and intergenerational justice.

5 Sustainability without growth

As discussed, sustainability consists of three dimensions: While all three dimensions of sustainability - The environmental dimension (planet), the social dimension (people) and the economic dimension (profit)- are essential, they are often weighted differently in practice. The normative prioritization of these dimensions may vary depending on the specific goals policies, or challenges at hand. Strong sustainability puts the emphasis on the environmental dimension. A lot of studies have specifically focused on either the first two, people and planet (Dion, 2017; Trienekens et al., 2012; Wognum et al., 2011; Wünsche & Fernqvist, 2022), or the latter, profit (Kallis et al., 2012; Leyshon & Lee, 2003; Schmelzer, 2015). However, in the last decade or so, there has been a substantial part of research dedicated to the idea that they do not exist without each other, and though planet and people should be prioritized, the economic dimension has an integral part in the world and should therefore have a substantial part in the public and academic debate. To establish a framework sufficient for this task, the main options that think beyond growth are introduced.

Sustainability, originally focused on resource management and fairness for future generations, has often been absorbed into "sustainable development" models that equate it with a greener form of economic growth, as was considered elaborately earlier in this study. This shift has led to policies and metrics that fail to address the trade-offs between environmental, social, and economic goals. While efforts to decouple growth from environmental harm stay, the belief in continuous growth remains strong. On the other side there are the so-called 'growth sceptics' (Morgan, 2020), the people who rejects the assumption that economic growth—whether "green" or otherwise—is compatible with a sustainable future. The popularity of these ideas is rising, which is evident across various systems globally, suggesting a growing recognition of the potential for more sustainable practices beyond growth. This is defended – amongst others – by the degrowth movement. Recent discussions on sustainability and degrowth challenge growth-centred economic systems (Muraca & Döring, 2018; Muraca & Neuber, 2018). Grounded in strong sustainability, this framework emphasizes preserving natural resources and ecological health while rethinking development and consumption patterns (Muraca & Döring, 2018). The Greifswalder Approach (Ott, 2003) further integrates justice and ecological limits, guiding decisions to balance environmental and economic concerns, promoting localized, just approaches to resource management for current and future generations. The concept of degrowth is a critical evolution of the broader sustainability debate, emerging as a direct challenge to the dominant paradigms of sustainable development and economic growth. The roots of degrowth lie in critiques of weak sustainability—the version of sustainability that assumes economic growth can continue with technological fixes and environmental management. In contrast, strong sustainability advocates for a fundamental rethinking of economic structures and societal values, recognizing the finite nature of natural resources and emphasizing that growth is inherently incompatible with true environmental and social sustainability.

All these ideas founded in the idea that the level of sustainability required to take care of the world, its current inhabitants as well as future generations takes more profound changes in people's lifestyles, consumer-behaviour but also and mainly the basic institutions of our systems and in the way we view quality of life, well-being and happiness. This shift reflects a broader transformation in societal values, moving away from modern principles that prioritize economic growth and social status toward postmodern values emphasizing freedom, self-expression, and quality of life (Brey, 2017; Harrison et al., 2005; Inglehart, 1997). Well-being and a good life involve more than just a growing GDP and this change is significantly more recognized in both academic as popular debates. Some of the most well-known counter-narratives of weak sustainability, EMT and the growth paradigm are Planetary Boundaries framework (Steffen et al., 2015) , the Doughnut economy (Raworth, 2017) where growth is replaced by thrive, voluntary simplicity (Etzioni, 1999; Shaw & Newholm, 2002), the return of the commons (Barnes, 2006; Fritsch et al., 2021) and postgrowth and degrowth movements (Asara et al., 2015; Demaria et al., 2013; Sekulova et al., 2013). These authors all use the concept of sustainability in a broader, more critical sense, challenging the traditional emphasis on growth and economic expansion. While the term sustainability may not always appear explicitly in their approaches, their frameworks—such as Planetary Boundaries, Doughnut Economics—imply a vision of sustainability that prioritizes ecological limits, social equity, and well-being over perpetual economic growth. They aim to redefine what it means to live within the planet's ecological and social boundaries, promoting systems that are ecologically resilient and socially just. Degrowth-advocates have been particularly vocal arguing that a growth-based system is inherently unsustainable, and any real solutions lie in reducing consumption, rethinking prosperity, and restructuring economies to prioritize social and ecological well-being overgrowth. Furthermore, a return to the idea of the commons could be relevant for a sustainable urban food system.

5.1 Degrowth frameworks

Degrowth is the literal translation of the French 'décroissance', meaning reduction. Activists launched the concept of degrowth in 2001 as a challenge for growth (Kallis, 2018) as a project of voluntary societal shrinking of production and consumption to achieve social and ecological sustainability. Degrowth as a concept can be traced back to Georgescu-Roegen's bioeconomic theories, particularly his emphasis on the declining state of resources, and the Club of Rome's 1972 "Limits to Growth" report. These early critiques highlighted the unsustainable nature of continuous economic growth (Georgescu-Roegen, 2011). Intellectuals and activists, particularly in Europe, began to question the possibility of reconciling growth with environmental preservation.

Georgescu-Roegen's critique of continuous economic growth, rooted in his bioeconomic theory, significantly influenced the degrowth movement (Muraca & Döring, 2018). His flow-fund model distinguished between "funds" (natural capital, like land and resources) and "flows" (inputs like energy), emphasizing that natural capital cannot be consumed in the same way as other resources due to its slow regeneration. This insight laid the foundation for the degrowth movement, which challenges the growth paradigm by advocating for societal transformation within ecological limits and emphasizing social justice and equity. Herman Daly, a key figure in both sustainability discourses as degrowth ideas, who adapted Georgescu-Roegen's ideas, focused on the concept of a steady-state economy (Daly, 1996). Daly argued for controlling population growth, technological innovation, and maintaining economic stability within ecological constraints. However, Daly's vision of sustainable development still adhered to the idea of balancing economic growth with environmental protection. He viewed different types of capital—natural, human, and manufactured—as complementary but not interchangeable. In contrast, Georgescu-Roegen was critical of sustainable development, seeing it as a way to perpetuate industrial growth and ignore the limitations of finite resources. His work – like this thesis – aligns more closely with strong sustainability, which prioritizes the preservation of natural capital and ecological integrity over economic expansion, natural capital (ecosystems, biodiversity, climate stability) cannot be replaced by human-made capital. Strong sustainability calls for qualitative over quantitative growth—prioritizing well-being, equity, and ecological preservation over mere economic expansion. In this sense, strong sustainability offers a more radical alternative to the conventional growth-based model, advocating for a fundamental shift in how society views economic activity—one that rejects the assumption that growth can continue indefinitely and instead prioritizes long-term ecological and social well-being.

Thus, degrowth is not only about reducing consumption or cutting material production; it is about fundamentally rethinking development (Lianos, 2024; Vicdan et al., 2024). Rather than focusing on GDP or material wealth, it calls for a societal transformation grounded in solidarity, equity, and sustainability within ecological limits (Escobar, 2015). Degrowth advocates for the downscaling of production and consumption, as well as a reorientation of societal values (Lianos, 2024; Savini, 2023).

Degrowth has evolved into a central topic in debates about the future of society, becoming both a social movement and an area of academic research. At its core, degrowth seeks to reframe discussions on necessary social and environmental changes, offering a critique of prevailing economic models and proposing alternative approaches (D'Alisa et al., 2014). In rejecting technocratic solutions like green growth and eco-efficiency, degrowth scholars argue that weak sustainability fails to address deeper political and cultural issues of power, consumption, and production (Heikkurinen, 2018;

Kerschner et al., 2018). By framing environmental and social conflicts as technical issues, mainstream sustainability discourse overlooks the need for structural change. Degrowth, by contrast, sees these conflicts as deeply political and argues for transformative shifts in economic systems and social relations.

Although degrowth challenges existing paradigms like EMT, it has not yet established a fully defined scientific framework. Instead, it offers a diverse and evolving set of ideas, strategies, and actions, representing a critical point where various political movements intersect. Central to degrowth is the recognition that modern capitalist economies, which rely on growth to stabilize social systems, are unsustainable. Ecological limits, such as resource depletion and climate change, reveal the contradictions of the growth-dependent model, especially as growth in wealthy societies stagnates, exposing its failure to deliver promised social benefits.

Opponents often misunderstand degrowth as synonymous with negative growth or scarcity. Kallis (2018) clarifies that degrowth does not seek to shrink the economy or reduce GDP. Rather, it advocates for a decline in market-driven dynamics, emphasizing the decommodification of labour and nature and the reduction of work in general. This shift is seen as an inevitable outcome of improving social and environmental conditions. Hickel (2021) goes even further by arguing that degrowth is not about scarcity but about abundance—abundance for all, rather than for the elite. Contrary to popular belief, capitalist, growth-oriented economies tend to foster scarcity, benefiting a select few at the expense of the many (Hickel, 2020). Abundance in degrowth terms is a much richer and broader concept, as it is not only measured in GDP and welfare, but in wellness, quality of life and happiness as well. Degrowth promotes a fairer distribution of resources and the expansion of public goods (D'Alisa et al., 2014; Latouche, 2009). Additionally, following this abundance concept, degrowth scholars are reluctant to frame the Global South in terms of scarcity, acknowledging that Western dominance contributes significantly to global inequality (Latouche, 2009; Sassen, 2007).

There is also criticism towards degrowth (Drews & Antal, 2016). For instance, critique on the name, which suggests diminishing of the economy. As mentioned, this was debunked by degrowth scholars by their explanation of abundance. But there are also concerns for social feasibility, claiming degrowth presents unrealistic views of social metabolism, a focus on local rather than global issues, and that it focusses too much on the long-run, diminishing it ability to respond to urgent problems (Kallis, 2018). As Romano (2019) argues, a meaningful shift toward degrowth is improbable unless there is a radical rethinking of the formal-institutional dimensions of this transformation, emphasizing the need to move from vertical to horizontal governance structures. While directly implementing degrowth into our society may seem like a step too far for many, the sustainability scholarship of recent decades has increasingly focused on individual behaviour change and sustainable consumption as pivotal to creating more sustainable societies. This marks a significant departure from the focus on industrial and technological changes to (March, 2018).

In summary, while the degrowth movement may be viewed as an inadequate response to the challenges posed by growth-oriented paradigms, it is essential to acknowledge the need to move beyond growth and to recognize the broader shift in sustainability scholarship toward individual and community action. The inclusion of food systems in these discussions represents a significant step forward, offering opportunities to rethink how societal values, technology, and governance structures can converge to create more sustainable futures. This integrated approach can pave the way for meaningful transformation, reflecting the necessity of a holistic understanding of sustainability that encompasses food as a central element.

5.2 The Return of the Commons

Commons-based modes of production, where resources and needs are collectively managed by communities, existed long before capitalism and continue to thrive in many parts of the world. During times of crisis, communities often come together to find collective ways of meeting their basic needs and addressing challenges (Fritsch et al., 2021; Moreira & Fuster Morell, 2020). In recent years, the wave of anti-austerity movements evolved into networks providing people with hope, and leading to the rise of cooperatives, local currencies, and grassroots initiatives aimed at providing essential services like food, education, housing, and healthcare (Castells, 2017). These initiatives are inherently political, as they focus on issues like ownership, participation, and social change. By emphasizing collective resource management and shared responsibility, the commons offer a compelling alternative to market-driven, privatized models of food production and distribution. Integrating the principles of the commons with degrowth and blockchain provides a robust foundation for reimagining urban food systems as more equitable, sustainable, and resilient.

The fact that we need new ways of commons today is described by the concept of the tragedy. The Tragedy of the Commons refers to a concept in environmental and social sciences that describes a situation where individuals, acting in their own self-interest, overuse and exhaust a shared resource, despite understanding that this behaviour is ultimately harmful to everyone. The term was popularized by the ecologist Garrett Hardin in his 1968 paper (Hardin, 1968), where he used the example of a common grazing pasture. Each herder, motivated by personal gain, adds more cattle to the pasture, leading to overgrazing. If every herder acts in this way, the pasture becomes degraded, reducing the resource for all. Hardin's analysis pointed to the need for external regulation or privatization to prevent the depletion of shared resources. Elinor Ostrom's work (Ostrom, 2015) on the commons challenges the idea of the "Tragedy of the Commons," offering a comprehensive framework for effective governance of shared resources. She identified key design principles that support sustainable commons management, including clear group boundaries, locally tailored rules, active member participation, monitoring and sanctions, low-cost dispute resolution, recognition by higher authorities, and multi-layered governance systems. These principles help explain how communities have successfully managed commons throughout history. Beyond Ostrom's institutional perspective, some scholars view the commons as an arena for political struggle, collective action, and social emancipation. The rise of digital technologies has further expanded commons practices by lowering the costs of collective action and fostering collaboration, particularly in urban areas through digital platforms and social movements. These technological shifts have enhanced the ability of communities to organize and engage in collaborative, commons-based initiatives.

5.3 How BCT can support commons and degrowth in urban food networks

In urban food systems, the concepts of the commons and degrowth have been employed in response to contemporary issues like food insecurity, sustainability, and urbanization. Blockchain Technology (BCT) offers a transformative opportunity to integrate the principles of degrowth and the commons into urban food systems. The concept of the commons—characterized by shared ownership, collective management, and mutual responsibility—stands in direct opposition to privatized, market-driven models that dominate today's food networks. In urban contexts, integrating blockchain enables decentralized management of food resources, empowering local communities to oversee production, distribution, and consumption. By doing so, BCT helps foster collaboration, solidarity, and greater sustainability, while also promoting social equity and resilience.

Lately, there's been a growing focus on managing shared global resources, driven by technological advancements and a need for increased international cooperation (Espelt & Edwards, 2020; Nelson & Edwards, 2020). Blockchain's potential in supporting cooperative practices and commons governance is increasingly recognized, especially in digital spaces like free/libre open-source software and platforms like Wikipedia. (Rozas et al., 2021). This technology, already being applied in several degrowth-related projects, offers significant promise in urban food systems by enabling digital infrastructure that supports ecological sustainability and equitable resource management (Howson, 2021).

Bringing degrowth principes and the commons into the urban food system involves reimagining urban spaces as areas where food production, distribution, and consumption shifts from being controlled by private companies or government regulations to being managed by local communities (Barnes, 2006). In traditional food systems, large corporations and state-run agencies centralize control, focusing on profit and growth rather than sustainability and equity. Blockchain's decentralized nature—through its distributed ledger technology (DLT)—facilitates peer-to-peer interactions, eliminating the need for intermediaries like agribusinesses and corporations. This decentralization supports a commons-based approach where food resources are managed collectively by local communities rather than external actors. By reintroducing commons-based practices—like community gardens, urban farms, and food co-ops—the goal is to build food systems that are more sustainable, fair, and resilient (Fritsch et al., 2021; Manski, 2017). The idea is that when people collectively manage food resources in urban environments, they can address issues such as food waste, unequal access to healthy food, and the environmental impact of industrial agriculture. In turn, this reduces the reliance on global supply chains and allows communities to prioritize local needs and ecological sustainability rather than growth-driven imperatives. Additionally, bringing back the commons is seen as a way to reconnect people to the land and each other. BCT's ability to decentralize food systems is particularly powerful in fostering food sovereignty. By enabling communities to directly control food production, distribution, and consumption, blockchain moves food systems away from top-down, corporate-dominated structures toward more inclusive and sustainable models. For example, communities can implement blockchain-powered solutions to track food from farm to table, ensuring transparency and promoting local sourcing that supports smaller-scale producers. This approach counters the dominance of industrial agriculture, which often exploits both human and environmental resources in the name of profit. This is exactly what the degrowth movement fights for, encouraging societies to rethink progress and economic structures. Degrowth is not about smaller economies, but about transformation of how we produce, consume, and distribute resources, emphasizing community well-being, autonomy, and equity. It advocates for collective models that respect ecological limits while maintaining quality of life. Degrowth challenges mainstream sustainability and economic growth, prioritizing long-term ecological health and justice over short-term profits. It redefines success by focusing on solidarity, cooperation, and ecological care, aiming to reclaim sustainability and build a world based on equity and resilience.

One of the strongest ways blockchain can support commons-based practices is by making urban food systems more transparent and accountable. Its tamper-proof ledger tracks transactions and resource flows, making it easier to verify where food comes from and how sustainably it was produced. This is super useful for tackling issues like food waste, unequal access to healthy food, and the environmental damage caused by industrial agriculture. Blockchain's transparency makes these initiatives more credible by allowing everyone to see and verify actions, which helps reduce waste and prevent overusing shared resources. It is also providing digital infrastructure for a wide range of projects and applications focused on sustainability. Plus, blockchain boosts the ability to self-regulate food commons by turning rules and agreements into its code, ensuring things run smoothly and fairly. This self-governance model aligns with Elinor Ostrom's principles of commons governance (Ostrom, 2015; Rozas et al., 2021), particularly in relation to shared global commons. Blockchain's features, such as tokenization, rule formalization, transparency, and trust codification, can support effective governance. Blockchain can address global commons challenges, including power distribution, coordination, scaling governance, tracking compliance, and enabling cooperation across communities (Fritsch et al., 2021). This is essential in creating a resilient and equitable food system that remains adaptable and accountable without relying on external market pressures or state regulation. Blockchain is progressively perceived as possibly playing a key role in supporting regenerative and redistributive post-capitalist economies. Raworth (2017, p. 192) for example sees blockchain as '*game-changing*' technology, specifically with regards to facilitating distributed renewable energy microgrids.

Blockchain can help shift food production back to local systems, reducing reliance on global supply chains. At the heart of degrowth is the call for less material consumption and the pursuit of growth, which encourages sustainable, localized food networks that stay within ecological limits. Blockchain plays a key role in this transition by supporting decentralized food systems, where urban communities can reclaim control over food sovereignty. Several case studies show how decentralized ledger technologies (DLTs) support degrowth and commons principles in urban food networks. (Armanda et al., 2019; Fritsch et al., 2021). By empowering local communities to take control of their food systems, blockchain supports collaborative practices such as community-supported agriculture (CSA) and cooperative models (Antonucci et al., 2019). For instance, Moyee Coffee in the Netherlands uses blockchain to provide consumers with transparent information about the journey of their coffee beans, fostering local sourcing and cutting down on resource-heavy supply chains[4] use BCT to provide consumers with verifiable information about the origin and journey of their coffee beans. This transparency encourages local sourcing and reduces reliance on long, resource-intensive supply chains Likewise, initiatives like Urban Farming in Detroit leverage blockchain to connect urban farmers with local markets, improving direct sales and reducing food waste through better inventory management (Fritsch et al., 2021). These projects allow consumers to invest directly in local farms, creating a sense of shared responsibility while promoting sustainable practices.

Blockchain also enhances efficiency by streamlining processes such as payments and contracts, cutting transaction costs and lowering barriers for local producers (Antonucci et al., 2019). This makes it easier for small-scale farmers to compete with larger, profit-driven agribusinesses while encouraging sustainable and equitable food systems. Blockchain can also enhance resource efficiency and promote social cooperation within food systems. By tokenizing food resources, blockchain enables communities to track and trade goods such as produce, labour, and land use more effectively. Tokenization allows participants to monitor and exchange resources, ensuring optimal usage, minimizing waste, and

[4] https://www.moyeecoffee.com/

enhancing equitable distribution. For example, tokenized systems could be used to reward sustainable practices, such as eco-friendly farming or reducing food waste, while also promoting collaboration between food producers and consumers. Smart contracts—automated agreements executed when predefined conditions are met—a key feature of blockchain, can be used to automate transactions, facilitate surplus food sharing or ensure fair compensation to local farmers (Lin et al., 2018).

Blockchain also fosters social cooperation by facilitating cooperative models of governance. For example, through community-driven projects, blockchain enables equitable participation in decision-making. This encourages consumers and producers to share in the benefits and responsibilities of food systems, thereby strengthening solidarity and cooperation. Blockchain also ensures that local producers are fairly compensated, supporting the principles of economic democracy and social justice at the heart of degrowth. This makes it easier for marginalized communities to enter the food production market and reduces their dependence on large corporations.

Importantly, blockchain supports cultural shifts that are integral to both degrowth and the commons. By enabling participatory governance, blockchain provides a platform for communities to engage in democratic decision-making processes, ensuring that food systems reflect local values and needs. These processes encourage a collaborative mindset over a consumerist one, moving towards collective action and shared responsibility. As blockchain enables transparency and bottom-up decision-making, it supports the transition from consumer-driven food models to those that emphasize sustainability, social equity, and ecological care—key tenets of the degrowth movement.

In conclusion, BCT offers a real chance to reshape urban food systems by aligning with commons and degrowth principles. By decentralizing governance, blockchain reduces reliance on profit-driven, global supply chains and boosts local economies, making food systems more efficient and sustainable. Its transparency and accountability allow communities to take control of their own food networks, creating more resilient and equitable systems. Beyond just improving food supply chains, blockchain represents a broader shift in how we approach sustainability (Friedman & Ormiston, 2022). By encouraging collaboration and local food sovereignty, it helps build systems that prioritize well-being, ecological health, and fairness instead of growth. Blockchain's ability to cut down on waste, improve traceability, and ensure fair compensation makes it a powerful tool for fostering a more sustainable relationship between producers and consumers. This technology offers a way to rethink food systems not only respond to problems like food insecurity and environmental decline but also create long-term sustainability grounded in equity and community-driven values. Therefore, embracing blockchain's potential can be useful for building a food future that balances ecological limits with social justice.

6 Challenges and risks

While BCT, degrowth and the commons have great potential benefits for sustainability of the urban food system, implementation of them could also present a range of challenges and risks that must be carefully considered. These issues not only hinder effective application but also bear significant obstacles for achieving long-term success.

6.1 Environmental impact of Blockchain Technology (BCT)

Primarily, there is a lot of general critique towards BCT. Many scholars who want to take the growth paradigm out of sustainability efforts are very much against technologies such as BCT and other DLTs, they understand these innovations as over-hyped, discriminatory and driven by 'green economy' logic – the illusion that a system of global perpetual economic growth can be decoupled from environmental decline (Büscher, 2020; Howson, 2021; Lohmann, 2020; Morrison & Dunlap, 1986). Some scholars completely reject all blockchain projects on the grounds that they are all extremely wasteful (Sullivan, 2018). This forms the first critical challenge in the development and deployment of blockchain technology: its significant environmental impact, particularly stemming from energy-intensive consensus mechanisms like Proof-of-Work (PoW). The energy consumption associated with blockchain networks—most notably Bitcoin—has raised serious concerns regarding the sustainability of such systems. Studies indicate that Bitcoin's annual energy usage rivals that of entire nations, contributing substantially to global carbon emissions. This concern is especially pressing given the increasing urgency of climate change mitigation. Measuring BCT's environmental footprint is complex due to the variability in mining operations, electricity sources, and technological configurations. However, accurate and nuanced assessments are essential to understanding BCT's real-world impact and shaping policy responses. Others believe that these projects being elitist (Maye, 2019). Furthermore, studies have shown that BCT needs much more development in order to have a significant impact on the sustainable urban food system that is not also focussed on growth (Antonucci et al., 2019). Sai and Vranken (2024) provide valuable insights into both the scale of the problem and potential avenues for improvement. In response to the energy demands of PoW systems, technological alternatives like Proof-of-Stake (PoS) have gained traction. Ethereum's transition from PoW to PoS in 2022 marked a pivotal shift in reducing BCT's energy consumption by more than 99%, demonstrating that more sustainable blockchain models are viable. Beyond consensus mechanism reform, other strategies include the development of inherently energy-efficient blockchain protocols, the integration of renewable energy sources into mining operations, and the deployment of layer-2 solutions that process transactions off-chain to decrease computational demand. These approaches are particularly relevant in sectors like urban food systems, where BCT is often proposed as a tool for enhancing transparency, traceability, and efficiency (Antonucci et al., 2019; Astill et al., 2019). Ensuring that such applications do not worsen environmental degradation is vital. While BCT's ecological footprint remains a formidable obstacle, innovations that prioritize sustainability—such as consensus model reform and green energy adoption—offer promising pathways to reduce negative impacts (Burgess et al., 2024; Cozzio et al., 2023; Galvez et al., 2018). Moving forward, more critical engagement with blockchain's environmental costs and a commitment to sustainable design will be essential if this technology is to contribute positively to long-term global development goals.

Following (Howson, 2021) in order for BCT to ever be proven useful for the degrowth movement it would need to overcome challenges in three important areas: Firstly, building democratic and (re)distributive economies. In this global political climate, it is increasingly challenging to make sure economies are integral and equal. Raworth (2017) believes in the transformative strength of BCT, while others claim it will also be undemocratic. Secondly, regenerating the environment without commodifying it. This refers to the need to promote environmental sustainability without turning the environment into a financial asset or a resource to be bought and sold for profit. The concern is that blockchain technology, while potentially useful for tracking environmental impact or enabling sustainable practices, could also be co-opted by market-driven forces to commodify nature (Howson et al., 2021). For instance, blockchain could be used to create carbon credits or other market-based mechanisms that allow companies to "balance" their environmental damage by purchasing credits, without actually reducing their carbon footprint or changing their practices. This could result in the environment being treated as a commodity that can be traded, rather than a system that needs to be respected and preserved for its own sake. Finally, the third area of challenges is facilitating international alliances without imposing a particular set of values. In the context of blockchain and degrowth, Howson (2021) is highlighting the importance of fostering global cooperation for sustainability without pushing a one-size-fits-all, Western-centric, or market-driven set of values or solutions.

6.2 Ethical considerations

The ethical implications of blockchain technology extend well beyond technical considerations, encompassing fundamental questions about justice, equity, and human rights. Firstly, considering access and digital literacy. Blockchain technology requires digital infrastructure and literacy (Kamilaris et al., 2019). Marginalized communities, particularly those without reliable internet access or tech skills, could be excluded. This is the phenomenon of the "*digital divide*". The digital divide is a prominent ethical concern, which poses a critical challenge to blockchain's promise of decentralization. While blockchain is often celebrated for its potential to democratize access to data and decision-making, its reliance on digital infrastructure may inadvertently deepen existing social inequalities. Communities lacking reliable internet connectivity, digital literacy, or access to appropriate hardware

are at risk of being excluded from blockchain-based systems, including those designed to improve urban food distribution and supply chain transparency. This exclusion raises profound ethical questions about whether the pursuit of technological efficiency should be prioritized over inclusivity. Various scholars have argued that ethical frameworks must be integrated into blockchain development to ensure digital inclusion, particularly in initiatives that affect essential services like food access (Hyrynsalmi et al., 2020; Miatton & Amado, 2020; Pottinger, 2013). As blockchain becomes more embedded in systems that intersect with public welfare, the imperative to design inclusive technologies becomes not only a technical challenge but a moral obligation. Ensuring that everyone, regardless of socioeconomic status, can participate in and benefit from blockchain-based food systems is crucial.

Secondly, though probably obvious for most readers today, possible issues with privacy and data protection need to be considered. Blockchain systems can collect and store sensitive data, raising concerns about privacy. While BCT's immutability and transparency are often praised for enhancing accountability, these same features can pose serious risks to individual privacy. In food systems, for example, BCT can be used to trace products from farm to fork, but if personal data—such as smallholder farmer identities or purchasing behaviours—is recorded without sufficient anonymization or protection, privacy rights may be compromised. Ferrag et al. (2020) highlight the need for comprehensive data protection strategies within blockchain ecosystems, emphasizing the role of encryption, anonymization, and clear governance policies to prevent misuse. Without these safeguards, the ethical trade-off between transparency and privacy becomes particularly stark, threatening to erode public trust in blockchain systems that are meant to promote accountability. Safeguarding the privacy of individuals, especially vulnerable populations, is essential, and transparent data governance mechanisms should be established.

Thirdly, there is always a change of worsening the already massive power imbalances (Wajcman, 2015; Wajcman & Dodd, 2017). There is a risk that blockchain could further entrench power imbalances, with large corporations or tech companies gaining disproportionate control over food systems. To elaborate, in practice, control over blockchain networks and infrastructure may be concentrated in the hands of large corporations, tech firms, or a small number of developers. These actors may exert disproportionate influence over how blockchain systems are designed, governed, and monetized, sidelining smaller stakeholders and undermining community autonomy. This centralization of control risks transforming BCT from a tool of empowerment into one of digital gatekeeping. To uphold the democratic potential of BCT, it is essential to implement decentralized and participatory governance models that give voice to all stakeholders—particularly those who are most affected by the outcomes. Ensuring that governance is decentralized, participatory, and accountable is key to preventing such outcomes. Transparent and inclusive decision-making structures can help ensure that blockchain serves the public good rather than corporate interests

Finally, job displacement. As BCT can automate and streamline processes, there is a potential for job displacement, particularly in low-income communities dependent on traditional food supply chain roles. It is important to invest in retraining and upskilling to ensure these communities are not left behind. In sum, addressing ethical concerns related to access, privacy, and power is not peripheral but central to the responsible development of blockchain technology, especially in domains that affect human well-being and social equity. In further development of BCT and of urban food networks, these risks and limitations need to be reminded.

6.3 Addressing the challenges and risks

Addressing the environmental, ethical, and social challenges related to blockchain technology requires a broad and inclusive approach, one that emphasizes collaboration, inclusive governance, and strong policy development. It will take a collective effort from various stakeholders. First, bringing together a diverse range of actors—from tech developers and government agencies to nonprofits, researchers, and local communities—is crucial. This multi-stakeholder approach ensures that blockchain systems are not only technically sound but also socially and ethically responsible. By involving different groups, we can make sure blockchain applications align with public interests, promoting digital inclusion, fair access, and sustainable practices. For example, including local food producers, city officials, and civil society groups in the design process can lead to solutions that are more suited to local contexts and needs. This collaborative process can also avoid top-down approaches that might leave vulnerable groups behind or make inequality worse.

Second, developing strong governance frameworks for blockchain is essential. As blockchain becomes more involved in critical areas like food distribution, issues like power, fairness, and accountability become even more important. Governance models need to go beyond just the technical side and include principles of participation, transparency, and fair power distribution. This is especially true in decentralized networks, where the lack of formal structures can hide unequal influence. An inclusive governance system should ensure that all stakeholders, including those with limited access to digital tools, have a say in how blockchain systems are built and used. For example, community-based governance can let local stakeholders set the rules for data sharing, privacy, and how benefits are distributed, helping build trust and legitimacy.

Finally, regulatory and policy oversight is key to ensuring blockchain is used ethically and sustainably. Governments and regulators need to actively create clear and enforceable guidelines for blockchain use, particularly in areas like data privacy, environmental impact, and social equity. This could involve requiring sustainability reporting, promoting energy-efficient consensus mechanisms, and making sure data protection aligns with human rights standards. Policies should also support innovation by testing new blockchain solutions in controlled environments, with input from stakeholders. Importantly, these policies must be adaptable to the fast-paced changes in blockchain technology while remaining grounded in justice and sustainability principles.

In sum, tackling the challenges associated with blockchain technology—particularly in urban food systems—requires more than technical fixes. It needs a broader approach that combines environmental awareness, ethical considerations, and inclusive governance. By working together, creating fair governance structures, and developing thoughtful policies, blockchain can better reach its transformative potential without sacrificing sustainability, privacy, or social justice.

7 Conclusion

This research explored the role of blockchain technology in facilitating the shift of urban food systems from a growth-driven model of sustainable development to one rooted in strong sustainability, guided by degrowth and commons principles. It critically evaluated the shortcomings of existing sustainability paradigms, highlighting how weak sustainability and traditional development models fell short in addressing key ecological and social challenges. Through a philosophical and conceptual analysis, the study examined how blockchain could potentially improve transparency, traceability, and community governance. The research aimed to demonstrate how blockchain could disrupt traditional, market-driven urban food systems, offering more transparent, sustainable, and equitable alternatives. The study highlighted key insights into the role global cities play in shaping food systems, the limitations of sustainable development, the dominant growth paradigm and Ecological Modernization (EMT), the better alternatives in degrowth and commons ideas and the potential of BCT as a tool for achieving a more sustainable urban food network. While blockchain alone was not seen as a complete solution, it was found to have the potential to contribute to the creation of more equitable, localized, and ecologically sustainable urban food systems, provided it was integrated within a broader, post-growth framework focused on equity, resilience, and the preservation of natural capital.

This study started by exploring urban food systems, emphasizing their growing significance as the focal point of modern food production and consumption. As urbanization accelerates globally, cities have become the main drivers of both ecological degradation and potential solutions. The urban food system is critical because it not only sustains the growing urban population but also contributes significantly to global environmental challenges such as climate change and biodiversity loss. Cities are the central actors in promoting sustainable food systems by tackling issues of social inequality, health disparities, food waste and the environmental sustainability of food. In this context, BCT offers a promising tool for enhancing transparency and decentralization in urban food systems, addressing the demands for sustainability, fairness, and accountability in food production and distribution. The urban and local focus was put in the global perspective in the following paragraph, to underscore the importance of the globality of todays and tomorrow's urban food system.

The concept of sustainability is complex and contested, often overextended across disciplines. A critical distinction between sustainability and sustainable development is that the latter often aligns with growth-driven models, which fail to address ecological and social limitations. The debate between weak and strong sustainability highlights this difference: weak sustainability allows for substituting natural capital with man-made capital, while strong sustainability prioritizes the preservation of irreplaceable ecological systems. In urban food systems, sustainability should focus on ecological preservation, social equity, and community resilience. Blockchain technology is proposed as a tool to promote transparency, fairness, and localized food systems, supporting a sustainability model that respects ecological limits and prioritizes long-term social well-being.

Current sustainable development policies are shaped by the growth paradigm and Ecological Modernization Theory (EMT). The growth paradigm assumes that economic growth is limitless and can solve societal problems, often disregarding ecological constraints. As ecological limits become clearer, the idea of decoupling growth from environmental harm, through green or smart growth, has been criticized. EMT aligns with weak sustainability, assuming human-made capital can replace natural capital, and promoting technological innovation and market efficiency as solutions to environmental challenges. Both the growth paradigm and EMT overlook the finite nature of resources, making their focus on continuous growth increasingly incompatible with true sustainability.

The 1972 *Limits to Growth* report, along with later critiques, challenged the decoupling of growth from environmental impact. This view ignores the planet's finite resources and social inequalities built into growth-driven models. The result has been an unsustainable pattern of consumption and production, particularly in large-scale industrial farming, which harms environmental health, social justice, and local food sovereignty. Issues like food insecurity, unequal access to healthy food, and environmental degradation are exacerbated by growth-focused models. EMT's reliance on technological innovation as a fix for environmental crises has proven misguided, as both technological progress and faith in limitless growth have led to ecological and social breakdowns.

This debate is encapsulated in frameworks like the United Nations' Sustainable Development Goals (SDGs), which paradoxically call for continued economic growth while addressing climate change. Critics argue that such growth models contribute to environmental harm and social inequality by prioritizing profit over ecological health and social welfare. Strong sustainability offers an alternative, emphasizing long-term preservation of the environment, social equity, and well-being over economic expansion. To achieve true sustainability, we must break free from the entrenched growth mindset and explore alternative models—such as degrowth or steady-state economics—that prioritize ecological balance, social justice, and a redefined sense of prosperity.

Blockchain technology (BCT), as a decentralized digital ledger system, makes sure that data can be securely stored and shared across multiple entities without the need for a central authority. Each record, or "block," is linked to the previous one. This creates a chain that is resistant to manipulating or adjustment, offering an immutable record of transactions. BCT plays a significant role in enhancing the transparency and efficiency of urban food systems. By using a decentralized, tamper-proof ledger to record transactions, BCT ensures that all stakeholders in the supply chain have access to accurate, real-time information. This transparency is crucial for improving food safety and traceability, particularly in response to foodborne illness outbreaks or issues like food adulteration. Moreover, BCT can reduce inefficiencies and improve product quality by eliminating redundant data and ensuring all participants operate from the same trusted record. In urban food systems, blockchain's capacity for enhancing transparency in supply chains could be transformative, particularly in addressing the increasing demand for sustainable, ethically sourced food products. By removing intermediaries and enabling peer-to-peer transactions, BCT could create a more accountable food system, where consumers, producers, and other stakeholders have access to reliable, real-time data about the origins, sustainability, and ethical standards of food products. However, while BCT offers substantial benefits, its current applications in food systems primarily focus on improving operational efficiency within existing frameworks of weak sustainability, which may not sufficiently address broader environmental and social challenges.

For BCT to play a meaningful role in strong sustainability, it needs to be integrated into systems that focus on ecological limits and social justice. Strong sustainability in urban food systems isn't just about being more efficient—it requires a shift away from traditional growth models. Right now, blockchain's potential in driving systemic change is limited. Strong sustainability calls for tougher ecological boundaries, resilience, and fairness, and blockchain can support these goals by providing real-time, tamper-proof data that reveals risks like deforestation or exploitation of workers. This kind of transparency encourages accountability and inclusion, giving small producers, cooperatives, and consumers access to reliable information. Projects like FairChain show how blockchain can help distribute value more fairly and support ethical sourcing. When paired with strong sustainability, blockchain could become a key tool in building food systems that prioritize long-term ecological health and social equity over short-term profit, tackling governance issues, and empowering marginalized groups.

To move this forward, alternative frameworks like degrowth and commons-based approaches offer valuable insights. Degrowth promotes reducing production and consumption to achieve long-term sustainability, arguing that true sustainability demands a shift in our values, lifestyles, and institutional structures. Degrowth challenges the traditional paradigm of continuous economic growth, which has long been at the heart of sustainability discussions. Rather than simply reducing consumption or production, degrowth advocates for a fundamental shift in societal values—emphasizing solidarity, sustainability within ecological limits, and a rethinking of prosperity that moves beyond GDP. It rejects the notion that growth, even if “green,” is compatible with true sustainability, highlighting the need for qualitative over quantitative growth. As support for degrowth grows globally, it offers a vision for societal change that works within ecological limits.

The commons-based approach, on the other hand, emphasizes collective ownership and management of resources, focusing on local food sovereignty and community resilience. Historically, commons-based systems have thrived, especially during times of crisis, where communities come together to address mutual needs. Today, grassroots initiatives, cooperatives, and digital platforms revive the commons model, challenging the "Tragedy of the Commons" by showing that shared resource management is sustainable through cooperative governance and collective action. This resurgence, supported by technology, aligns with degrowth principles, offering a reimagined approach to food systems that promotes social and ecological justice

In the context of urban food systems, a shift away from profit-driven, market-oriented food production towards cooperative, decentralized models of food governance could help communities take control of food resources to meet their own needs in ways that are ecologically responsible and socially just. Blockchain technology (BCT) can play a key role in supporting the principles of degrowth and the commons in urban food systems, offering new ways to manage resources more equitably and sustainably.

By decentralizing governance and enabling transparent, peer-to-peer interactions, blockchain allows communities to directly manage their food systems without relying on large corporations or state-run agencies. In doing so, it helps to empower local actors—whether producers, cooperatives, or consumers—and enables them to collaborate on sustainable, resilient food systems. With its tamper-proof ledger, blockchain ensures transparency and accountability, allowing for easy tracking of food resources from production to consumption. This transparency is essential for fostering trust in food networks, reducing waste, and promoting ethical practices such as fair labour and sustainable sourcing.

Blockchain also supports food sovereignty, a key goal of the commons-based approach, by ensuring that local communities can take control of their food systems and break free from the dominance of global supply chains. For example, blockchain can enable traceability in food production, ensuring that local sourcing is prioritized over long, resource-intensive supply chains, while small-scale farmers and producers are compensated fairly. This shift aligns with degrowth principles, which prioritize ecological limits, long-term sustainability, and community well-being over continuous economic growth. In this model, the focus is on quality over quantity, as well as equitable resource distribution rather than profit maximization.

Blockchain can also promote social cooperation by enabling community-driven governance models. Through digital platforms, blockchain facilitates participatory decision-making processes that include both producers and consumers, ensuring that the food system reflects local needs and values. These collective models of governance are critical in the transition to a more equitable and resilient food system, especially in marginalized communities that often struggle to access healthy food. Moreover, blockchain's ability to automate processes using smart contracts ensures that agreements between parties are honoured fairly, promoting transparency and reducing conflicts.

Additionally, blockchain supports resource efficiency by enabling the tracking and trading of food resources through tokenization. This allows communities to monitor and exchange goods more effectively, minimizing waste and ensuring optimal use of resources. Tokenization can also incentivize sustainable practices, rewarding actions such as eco-friendly farming, waste reduction, or community engagement in food security efforts. By reducing transaction costs and improving inventory management, blockchain further enhances the efficiency and fairness of urban food systems, making it easier for small-scale producers to compete with larger agribusinesses.

In essence, BCT offers a way to bridge the gap between degrowth and the commons, providing an infrastructure that supports localized, sustainable, and equitable food systems. By decentralizing control, improving transparency, and enabling participatory governance, blockchain has the potential to transform urban food networks. It provides communities with the tools to take charge of their food resources, ensuring that these systems prioritize ecological sustainability, social justice, and long-term resilience over short-term economic growth. Embracing blockchain technology in urban food systems can thus offer a tangible pathway toward achieving a more just and sustainable food future, aligned with the values of solidarity, sustainability, and equity.

Though BCT shows great potential to improve urban food systems, its implementation also presents a range of challenges and risks, particularly in environmental, ethical, and social dimensions. One major issue is its environmental impact, especially due to the energy-intensive processes behind some blockchain systems, like Proof-of-Work (PoW). These systems can consume large amounts of energy and contribute to carbon emissions. While alternative methods like Proof-of-Stake (PoS) and the use of renewable energy sources are being explored, the environmental footprint of blockchain remains a concern.

Another challenge is the ethical implications of BCT, particularly regarding digital knowledge and access. The reliance on digital infrastructure can exacerbate the digital divide, excluding marginalized communities from the benefits of blockchain-based systems, in other words, it could lead to inequality, leaving people out that lack internet access or tech skills. Also, blockchain's focus on transparency can raise privacy concerns—sensitive data, like the identity of small-scale farmers, could be exposed without proper protection. There’s also a risk that blockchain could reinforce power imbalances if big corporations or tech companies control blockchain networks, sidelining smaller stakeholders and undermining the system’s potential for decentralization. Moreover, job displacement is another issue, as automation in food supply chains could take jobs away from those in low-income communities who depend on traditional roles in the sector.

To address the challenges of blockchain technology in urban food systems, a broad, inclusive approach is essential. This involves collaboration between diverse stakeholders—such as tech developers, governments, nonprofits, and local communities—to ensure blockchain systems are not only technically effective but also socially and ethically responsible. Developing strong governance frameworks that emphasize participation, transparency, and fairness is crucial, particularly in decentralized networks where influence can be uneven. Additionally, clear regulatory guidelines are needed to ensure blockchain use aligns with sustainability, privacy, and equity goals. By integrating these elements, blockchain can fulfil its transformative potential while promoting sustainability, privacy, and social justice.

Though questions were answered, more questions emerged from this thesis. Examples include: how can BCT be used to address the urban food waste challenges? How can BCT support the scaling of local food initiatives to global networks without losing their community-driven essence? How can the governance of blockchain-based food systems be structured to ensure that power remains decentralized and accessible to all stakeholders? Many questions like these arose, identifying various issues that could guide future research. First, there is a need for further study of BCT’s potential in urban food systems, particularly in the context of different geographical regions and socio-economic contexts. While this study focused on the theoretical application of blockchain in postgrowth urban food systems, empirical research is needed to test these concepts in real-world settings and assess their practical viability. Second, the integration of BCT with commons-based governance models requires more in-depth research into how these two frameworks can be effectively combined to support sustainable and equitable urban food systems. Finally, the ethical implications of BCT, particularly its impact on marginalized communities, need further investigation to ensure that blockchain applications do not exacerbate existing inequalities but instead contribute to greater social and economic justice. But we need more than research. There should be more transdisciplinary, greater collaboration and coordination at broader levels to reach success. Members of all different stakeholder groups should be included, corporations, associations and research groups (industrial stakeholders), and non-governmental organizations, governmental organizations, labour organizations and community organizations.

In conclusion, while blockchain technology offers promising opportunities to improve urban food systems by enhancing transparency, equity, and sustainability, its full potential can only be realized if it's integrated into a broader framework that prioritizes degrowth and the commons. To make sure blockchain truly supports strong sustainability, we need to carefully address the environmental, social, and governance challenges that come with it. This way, it can contribute to, rather than undermine, the broader goals of sustainable, community-driven food systems. Ultimately, creating resilient, fair, and community-focused urban food networks requires a collaborative approach, built on the principles of sustainability and involving a wide range of stakeholders to tackle the pressing challenges of our time.

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