Balancing Green Ambitions and Social Needs

Exploring Sustainability and Affordable Housing in KnoopXL Eindhoven While Avoiding the Risks of Greenwashing

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Abstract

As cities emerge and expand, achieving both sustainability and affordable housing presents a challenge for cities. By 2050, it is predicted that 68% of the world's population will be urban, exerting pressure on cities to tackle climate change while being liveable. The KnoopXL project in Eindhoven aims to transform a grey office district into a dynamic, green, and sustainable city hub with 9,000 new homes. However, conflicting interests between urban densification, green space, and housing affordability pose challenges during the planning and implementation phases. This research explored how urban area development projects like KnoopXL have addressed sustainability and affordable housing without running the risk of greenwashing. Greenwashing is an emerging challenge in urban planning as planners propose development plans claiming to be sustainable while not providing a meaningful environmental or social benefit. By using KnoopXL as a case study, it provides an understanding of the different aspects that shape the development of affordable housing and sustainability in relation to greenwashing, including stakeholder dynamics, technological innovations, economics pressures, and transparency and communication in planning. Ultimately, through the perspectives of various stakeholders involved in the project, this research will show how complex the balance between sustainable and affordable housing is, but greenwashing risks can be mitigated. This research aimed to reveal more appropriate strategies for urban area development, and to improve social equity and environmental quality.

Keywords: Greenwashing, urban development, affordable housing, power dynamics in participatory planning, Eindhoven KnoopXL

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1. Introduction

The world is urbanising, more and more people are moving to urban areas. In 2021, 56% of the world's population already lived in urban areas, and this will increase to 68% in 2050 (Un-Habitat, 2022). In European cities, climate change is seen as the biggest threat to sustainability, affecting both quality of life and economic growth. Fighting climate change will be a city priority over the next 10 years. Due to the increased complexity of urban areas it is challenging because of the interconnected networks of people, infrastructure, and services (Lomba-Fernández et al., 2019). Rural populations are decreasing while urban populations are increasing, which is rapidly accelerating city expansion. This growth significantly changes the land use by concentrating materials that trap heat and creating surfaces that do not absorb water, impacting the local climate and water systems in urban areas. To address these challenges, new building strategies are needed to reduce the harmful environmental effects of urban infrastructure while improving its social and economic benefits. Urban greening efforts offer a way to meet ecological goals and lessen the negative impacts of urbanisation (Pérez-Urrestarazu et al., 2015). Rapid urban development challenges planning systems and calls for integrated solutions to address the negative environmental, social, and economic impacts. There is a challenge to achieve a balance when managing urban growth. When making cities more compact to reduce urban sprawl, it can lead to problems like reducing green spaces and lower environmentally quality. The lack of green spaces can lead to social disadvantages. The challenge of controlling sprawl while keeping cities liveable and green is known as the "compact city paradox." (Artmann et al., 2018). When both urbanisation and environmental degradation continues to rise, there is potential for the field of green architecture to help create sustainable, liveable cities. In contrast to traditional building design, green architecture integrates nature into the built urban setting, and aims to lower the ecological costs of buildings while enhancing the urban experience overall. One solution is vertical greenery. This results in better air quality, reduced urban heat island effect, and increased biodiversity. It also has social and economic benefits, including improved mental health, higher property values, and the aesthetic enhancement of urban spaces (Okwandu et al., 2024).

1.1. Contextual background

Eindhoven has a thriving economy and is engaged in technology, design and knowledge. The city is growing from 230,000 residents now to 300,000 in 2050, creating a high demand for housing (Open Eindhoven, 2020). Eindhoven wants to densify and reduce heat stress, but this requires a draft plan, strict greening requirement for developers and green facades because the city is a multiple winner of the title “warmest city in the Netherlands”. Imposing a greening measure on developers and builders in the city centre is one of the other measures in the package. Eight square meters of green space will be required for each new house (Monster, 2020). The current area around Eindhoven Central Station is seen by visitors as an open plain with lots of asphalt and concrete. So it is an unattractive grey area that often makes visitors want to leave the area as soon as possible (Open Eindhoven, 2020). In the coming years, a major area development is going to take place in the centre of Eindhoven, the KnoopXL project (Open Eindhoven, 2020). Eindhoven's rapid urban expansion and related area developments demand an updated

strategic framework. In response, the 2017 Land Policy Memorandum was revised in 2023. The municipality is moving away from a purely market-driven approach and is adopting a more directive land policy, using legal instruments to retain control over developments. whether through active involvement, facilitation, or partnerships. Rising labour shortages and material costs have led to significantly higher project expenses, adding uncertainty to future financial outcomes. At the same time, the housing challenge is growing more complex, as large-scale expansion areas are no longer available. Instead, densification within the existing city is required, increasing complexity due to underground infrastructure, archaeology, and logistical constraints, resulting in longer timelines, higher costs, and more risk (Gemeente Eindhoven, n.d.-b).

1.2. Problem statement

Eindhoven has become increasingly urbanised over the past five years. Due to the rise of high-rise buildings, the amount of green space per home has dropped by 21%. This is part of a broader trend, shown in the study 'Lack of Green in Dutch Cities'. Urbanisation has several negative effects on the living environment. Over the past five years, the population of Eindhoven has grown by more than 10%. In the past, the city used to expand gradually, but now the city is primarily densifying through high-rise development. This leads in some cases to the loss of green areas. Green roofs and vertical gardens are seen as possible solutions, but it will still be a challenge to limit further urbanisation (Van Houtert, 2025). The KnoopXL project in Eindhoven brings together conflicting interests and perspectives among stakeholders, with the challenge of balancing housing development, green spaces, and infrastructure. The municipality and developers prioritise urban densification and housing. Environmental organisations like Trefpunt Groen Eindhoven (TGE) emphasise the need for green spaces to support climate adaptation and liveability. Businesses and investors are focused on economic development and improving infrastructure, which may be at odds with sustainability. Residents have different concerns, weighing housing demands with quality of the environment. The management problem is how to balance all these different interests (Trefpunt Groen Eindhoven, 2019). The KnoopXL project in Eindhoven aims to tackle the current housing crisis while promoting environmental sustainability by transforming a transit area into an sustainable destination. The key challenge will be whether it is possible to make the type of green oasis described without sacrificing housing that it has to offer while balancing sustainable development, population growth and interests of residents, property developers and other stakeholders.

Even with urgent calls to address climate and nature problems, cities have not fully achieved sustainable development. The challenge is to make cities liveable while also protecting the environment, but many uncertainties make this difficult to do (Un-Habitat, 2022). Public participation in land-use planning is seen as crucial for improving urban green spaces by involving various stakeholders. However, many cities, especially those becoming denser, still face gaps between ideal and actual citizen involvement (known as Arnstein gaps) and a lack of sufficient green spaces (Wang & Chan, 2019). Urban green infrastructure (UGI) is used to manage and preserve green spaces, especially under the pressure of urban investment. UGI planning plays a crucial role in residential areas, where green elements are often highlighted in developers' marketing campaigns. However, when developers promote ecological values and

green spaces in their plans, these claims are frequently criticized as greenwashing (Gałecka-Drozda et al., 2021). Greenwashing is mostly focused in the sector of consumer products but rarely examine how greenwashing manifests in urban planning and real estate development (Kumar & Kumar, 2013; Lupinu & Machura-Urbaniak, 2024; and Szopińska-Mularz & Lehmann 2023). So there is a lack of focusing on greenwashing in urban development projects.

Another research gap is related to the fact that many studies have a separated focus on sustainable urban development or affordable housing, without balancing the two conflicting priorities in cities to avoid the risks of greenwashing. So Szopińska-Mularz & Lehmann (2023) mention how urban densification strategies impact green spaces and Grant et al. (2016) discuss that sustainable planning often becomes a branding tool rather than a well-integrated urban strategy and fails to address housing needs meaningfully. When looking at the literature there is an absence of conclusive empirical findings on the mechanisms or factors influencing the balance between sustainability and affordable housing in urban development initiatives aimed at mitigating greenwashing risks. For instance, Wang & Chan (2019) and Van De Meene et al. (2020) suggest that stakeholder dynamics could be a driving factor behind greenwashing in urban development. On the other hand, Lupinu & Machura-Urbaniak (2024) and Kronenberg et al. (2023) indicate that greenwashing in urban development projects may be driven by market forces and economic pressures. Additionally, Pérez-Urrestarazu et al. (2015) and Schoeman & Gunter (2018) suggest that technological and design innovations could contribute to greenwashing in urban developments. Meanwhile, Tateishi (2017) argues that a lack of communication and transparency may be a key factor in greenwashing.

While existing studies provide valuable insights into aspects of sustainable urban development, citizen participation, and greenwashing, they remain insufficient for fully explaining the complex societal challenges faced in Dutch urban area development. Wang & Chan (2019) primarily focus on gaps in citizen participation without adequately addressing the tension between sustainability and housing affordability. Grant et al. (2016) emphasise sustainability planning challenges but tend to overlook the critical affordability dimension and the complex dynamics present in densely populated urban areas. Szopińska-Mularz & Lehmann (2023) address greenwashing risks related to urban densification but do not explore the nuanced interplay between sustainable development and affordable housing in the Dutch context. Consequently, these studies fail to capture the full complexity of balancing environmental, social, and economic priorities in large-scale urban projects in the Netherlands, limiting their relevance for guiding effective policy and practice in this area.

1.3. Research Objective and Research Questions

The research objective is 'to gain a better understanding of how urban area development initiatives balance sustainability and affordable housing while avoiding greenwashing risks.'

The research question is 'Using KnoopXL project as a case study, what mechanisms or factors shape the balance between sustainability and affordable housing in urban area development initiatives to mitigate greenwashing risks from the perspectives of the stakeholders?'

The sub questions are:

1. 'How do stakeholder dynamics and power relations shape the balance between sustainability and affordable housing in the KnoopXL project?'

2. 'How do stakeholders perceive the influence of market forces and economic pressures on the KnoopXL project's balance between sustainability and affordable housing, given the risks of greenwashing?'

3. 'How do stakeholders perceive the role of technological and design innovations in balancing environmental sustainability with affordability in the KnoopXL project?'

4. 'How do stakeholders perceive the role of communication and transparency in shaping the balance between sustainability and affordable housing in the KnoopXL project?'

1.4. Relevance

1.4.1. Societal Relevance

City development often brings challenges, especially when addressing the reduction of negative impacts. One way to tackle this is by involving people in the planning process. This means supporting those who are already in favour of urban green spaces and helping those who are hesitant to understand their benefits. Offering incentives like tax breaks, bonuses for higher-density projects, or conservation subsidies can encourage developers to involve people in participatory processes. It is also important to engage people, like residents, by educating them and gathering their input on how to protect the environment (Wang & Chan, 2019). Involving residents and other groups in the planning process can help ensure that a variety of needs and ideas are considered. This helps create a fairer, more inclusive planning process towards sustainable cities. Educating people and encouraging them to take part also helps build a sense of responsibility and long-term care for the environment.

Social inequality cannot be effectively addressed without also tackling the housing crisis. Affordable housing plays a key role in sustainable urban development, and the lack of it only deepens existing social divides. This is why it is important to re-engage both public and philanthropic sectors in supporting the creation of affordable and environmentally responsible housing. Recognising the housing crisis as a root cause of inequality makes the need for inclusive and socially fair urban policies even more pressing (Burns & Vaccaro, 2015). Improving the system for affordable housing is a global priority and requires a stronger commitment to fully

sustainable design and construction processes. The current system is hindered by socio-economic, cultural, and environmental factors, which often prevent low-income groups from accessing safe, healthy, and affordable housing. Resident participation and diversity in housing types at the neighbourhood level have proven to be essential for the success and acceptance of affordable housing projects. A more inclusive and socially aware approach, where residents are actively involved in the design process, can lead to better solutions that reflect the needs of diverse and vulnerable groups, who are often underrepresented in decision-making (Reid, 2023).

Sustainable property development, also known as green building, focuses on minimising environmental damage and maximising positive impacts over a building's lifespan. These structures are designed to be environmentally friendly, using resources efficiently, renewable energy, recyclable or biodegradable materials, and harmonising with the surrounding environment. However, greenwashing is an issue in sustainable property development when developers make exaggerated or false claims about their projects' environmental benefits, undermining trust in sustainable practices. Building certification systems help reduce environmental impacts throughout a building's lifecycle and assess its environmental and resource efficiency. There are over 100 certification systems globally, all aiming to promote sustainable building practices. However, certification alone does not eliminate the risk of greenwashing by housing developers (Quoquab et al., 2021). Greenwashing can undermine public trust and distort perceptions of environmental responsibility, especially when development plans present misleading or exaggerated claims of sustainability. This research contributes to addressing these societal concerns by examining how green claims are interpreted and contested by key stakeholders in the major Dutch urban redevelopment project, KnoopXL Eindhoven.

1.4.2. Scientific Relevance

Researchers are increasingly recognising the potential and positive impact of urban greening initiatives on various aspects of urban environments. Over the past 25 years, the scientific community has made significant efforts to highlight the ecological, environmental, and social benefits of green roof systems (Pérez-Urrestarazu et al., 2015). It is important to understand how cities address sustainability and incorporate green initiatives into urban development. A clear comprehension of these processes enables more effective strategies to maximise the integration of green spaces, which are essential for creating sustainable, resilient, and future-proof urban environments.

In many post-industrial cities, the desire to move away from images of pollution and poor health has led to environmental policies that help create a cleaner, more attractive identity. Green place branding can build on past environmental efforts to shape a new identity or guide future policies. The goal of becoming the "greenest" city often involves a clear local policy aimed at creating a more sustainable, environmentally friendly city, while also boosting its competitive appeal. In some cities, their leadership in environmental policy has encouraged local governments to use this focus for place branding. Some critics contend that the development of green cities and policies is nothing more than a façade, often referred to as "greenwashing", where the term "green" signifies only an awareness of environmental issues, but little real

political action is taken toward true sustainability (Andersson, 2016). Greenwashing practices are increasing alongside rising consumer and government focus on environmental issues. According to evidence from the European Commission, over 53% of environmental claims may be misleading. This indicates that many claims are vague, inaccurate, or lack proper evidence. A systematic review by researchers further confirms that greenwashing has become a major issue over the past decade, highlighting the urgent need for a standardised approach to address the problem. Greenwashing practices are commonly associated with industries like food and textiles. However, other economic sectors, such as real estate, are highly vulnerable to these practices but receive far less attention. With the ongoing housing crisis and the rapid growth of the real estate market, it is crucial to manage greenwashing risks linked to investments in real estate financial products (Lupinu & Machura-Urbaniak, 2024). So greenwashing in the real estate and urban development sector is a significant but underexamined issue. Despite growing attention to environmental claims in other sectors, the real estate sector receives less scrutiny. This highlights the need for research on how to effectively address greenwashing in real estate and urban development, particularly in connection with financial products, affordable housing, sustainability and green claims.

Some researchers argue that government rules alone are not enough to make cities more sustainable. Development areas also need extra support to take real action. Cities are more likely to use sustainable ideas if they receive help, such as funding or expert advice. This shows that involving experts, like universities or knowledge institutes, is important for creating innovative and effective solutions. In many cases, this kind of support and knowledge-sharing is missing. Stronger cooperation between different levels of government and experts can help cities build better, greener, and smarter plans for the future (Grant et al., 2016). Even though many researchers say support and knowledge-sharing are important for sustainable city development, it is still unclear how this works in real-life projects. The gap between goals, collaboration, and real action explains why many plans do not lead to real change.

Collaborations can have advantages over more rigid bureaucratic approaches when it comes to implementing a collective goal. Sustainable development presents many challenges. Collaborations can ensure the generation of creative, adaptive and flexible qualities needed to address systemic problems in innovative ways. Collaborations can also be carried out across borders in order to define and focus on new priorities together with all stakeholders on important complex problems. With a collaboration, broad expertise and diverse sources of knowledge can be drawn upon (Van De Meene et al., 2020). Research highlights also the importance of participatory management in urban green space planning. Involving people in management can democratise processes and improve decision-making. However, most research focuses on user and manager interests rather than the physical quality of green spaces, showing little connection between participation and the actual improvement of these spaces. Studies often ignore how personal characteristics and workplace environments affect people's connection to nature. To make urban green spaces better, partnerships should focus not just on participation but also on improving the physical quality of these areas. Green spaces are essential because they offer recreation, conserve biodiversity, reduce climate stress, and improve health, well-being, and cultural identity (Bagheri et al., 2020). So urban greenery provides numerous benefits. It is also important to organise participatory processes for greening in a way that works well. Involving communities, stakeholders, and policymakers in a

collaborative approach helps ensure that green projects meet local needs, gain public support, and succeed over time. Research shows that cities with strong participation systems often achieve better sustainability outcomes. By making the process inclusive and transparent, urban greening can become a shared goal, leading to greener, healthier cities. Understanding the power dynamics in these processes is also crucial to ensure fairness and effectiveness.

By answering the research questions, this research contributes empirically to ongoing debates on greenwashing in urban planning and real estate development (e.g., Lupinu & Machura-Urbaniak, 2024; Tateishi, 2017; Grant et al., 2016), particularly by grounding the analysis in a highly complex Dutch case marked with ambitious affordability and sustainability goals in a high density development area.

2. Critical Literature Review and Theoretical Framework

2.1. Critical Literature Review

2.1.1. Greenwashing

Greenwashing refers to companies misleading consumers by pretending their policies or products are environmentally friendly through green marketing, often to boost profits. Research on this topic revealed that many companies invest in creating a false impression of eco-friendliness (Kumar & Kumar, 2013).

The "Seven Sins of Greenwashing" highlight common tactics used:

1. Hidden Trade-off: Focusing on one "green" attribute while ignoring other environmental issues.
2. No Proof: Making unverifiable claims without supporting evidence or certification.
3. Vagueness: Using unclear or overly broad claims that confuse consumers.
4. False Labels: Implying third-party endorsement when none exists.
5. Irrelevance: Highlighting truthful but insignificant environmental claims.
6. Lesser of Two Evils: Highlighting smaller eco-benefits within a product category with broader negative impacts.
7. Fibbing: Making outright false environmental claims.

These tactics show how companies can exploit consumer trust by pretending their policies are environmentally friendly, often at the expense of genuine environmental progress (Kumar & Kumar, 2013).

The green building industry is especially at risk of greenwashing because many factors define a green building. These include the materials used, water and electricity usage, and how natural resources are extracted for construction (Schoeman & Gunter, 2018). According to the study of Schoeman & Gunter (2018) greenwashing occurs in green building ratings when designs promise sustainability, but construction and operations fail to deliver. Companies also exploit consumer demand for sustainability by falsely marketing themselves as environmentally friendly. Lastly, financial benefits, like cost savings and market expansion, drive greenwashing practices.

The best way to avoid a project being linked to greenwashing is to genuinely and transparently explain the actual intentions of a project. This includes the building methods, how the project is promoted, and how sustainability is evaluated. Knowing the project's true intentions and what has actually been done helps in using the best tools to measure sustainability that match the project's needs and goals (Oriol et al., 2024).

The literature mainly focuses on how companies engage in greenwashing but does not consider how consumers experience or respond to greenwashing. It is also unknown how awareness around the issue is changing. It remains unclear to what extent consumers realise they are being misled by green claims. Transparency is mentioned as a possible solution, but the challenges of

greenwashing are not mentioned. As a result, a critical reflection on how consumers and governments can effectively tackle greenwashing is missing.

2.1.2. The Governance mechanism in urban development

Cities are made up of different urban areas that interact with various institutions, including different stakeholders and decision-makers. With many stakeholders involved, planning and designing urban spaces can lead to conflicts about priorities and decisions (Semeraro et al., 2020). Taking part in urban planning is a political act. When residents oppose planning proposals that could lead to environmental, social, or economic injustices, their participation becomes a way to challenge these issues. People get involved for different reasons because some may want to stop or change a proposal completely, while others may push for alternative ideas and solutions. Whether inside or outside official planning channels, citizen participation is often driven by a desire to shape the future of their communities (Legacy, 2016). Urban planning should be seen as a shared responsibility, aiming to balance the use of space while considering social, environmental, and cultural factors. A successful urban transformation requires understanding how people feel about their surroundings, their awareness, values, behaviours, and attitudes. That is why urban planning should combine both top-down strategies from authorities and bottom-up input from the community. By involving the community in the decision-making process, urban planning becomes more effective and responsive to real needs. So that decision-makers can take accountability for their choices and giving citizens more confidence in proposed changes and concerns about urban transformations. Scholars agree that stakeholder participation is essential for high-quality urban development (Semeraro et al., 2020).

Modern cities are changing rapidly due to environmental, social, and economic factors, which can impact urban quality. Participatory planning aims to improve cities by involving stakeholders in sustainable urban development. Sharing ideas and knowledge in an interactive way makes planning more effective and brings in fresh perspectives that might be overlooked in formal processes. Since stakeholders play a key role in decision-making, sustainable development should actively involve them to better manage resources and ensure cities meet the needs of future generations (Kunze et al., 2011). Participatory planning is constantly evolving, shaped by political dynamics and shifting ideas about what it means to take part in decision-making. The idea of a "crisis" in participation reinforces the belief that engagement must come from formal planning systems and existing participation methods. However, this overlooks the broader issues of marginalisation, unequal access to decision-making, and power imbalances. These challenges have long been debated in planning theory and practice, questioning the very foundations of how planning and participation work (Legacy, 2016).

Research on participatory planning has shown that while citizen involvement is important, it often has limited impact on government decisions. To improve participation, various methods have been introduced, such as town hall meetings, social media outreach, and citizen panels. These approaches are popular because they make community engagement more accessible and acceptable to political leaders. However, critics argue that these methods are just one part of the planning process and do not always lead to real influence over decisions. The crisis of

participatory planning is often linked to a focus on consensus and outcome-driven approaches that prioritise economic growth over fair access to social and public infrastructure. Some argue that governments use participatory processes as a way to gain public approval for decisions like land use, or development plans that may have already been decided or that follow existing planning norms without real challenges (Legacy, 2016). According to Semeraro et al. (2020) it is also a strength that conflicts can be identified and resolved by encouraging open dialogue between decision-makers and the community, to make the planning process more reliable and inclusive.

According to Khan et al. (2014) urban management faces complex challenges and provides a suitable and necessary platform for participatory urban planning, policy development and collaborative decision-making by utilising new ICT tools. Innovative ICT solutions offer significant opportunities to ameliorate the substantial challenges arising from this urban complexity. Furthermore, such ICT solutions offer the potential to provide policymakers and urban planners with the tools and intelligence needed to actively manage the urban environment.

Participatory planning is a key part of democracy, ensuring that decision-making, consultations, and public interests are represented. The growth of social media and mobile technology opens up new opportunities for engaging hard-to-reach groups in participatory planning. These tools provide new ways for people to get involved and have their voices heard in the planning process (Medeiros, 2021). A participation process keeps local people engaged, makes them feel connected to decisions about their community, and boosts their creativity and sense of involvement. Participatory planning can help engage a wider and more diverse audience, enhance mutual understanding, encourage cooperation, build connections across different interests, and bring in fresh ideas and solutions that might not have been considered before (Nared et al., 2015).

Participation has its challenges, especially because it can take a long time and be expensive. Some groups may be left out if they do not have the knowledge, skills, or resources to take part in such a complex process. Problems also arise when participation is informal because without legal support, participants may have no real power to take action, their suggestions might not be enforced, and they may have little influence over final decisions (Nared et al., 2015). The research of Nared et al. (2015) shows that spatial planning and participation rules vary widely between countries and even within regions of the same country. These rules reflect local planning cultures and responsibilities, with regional and local authorities mainly in charge of sustainable planning. Over time, stakeholder participation in spatial planning has grown, but there are still gaps in how it is put into practice. The main issues are vague laws that only require basic participation, like showing the plan before approval, and unclear guidelines for planners on how to carry out effective participation. Planners often lack the resources and skills to properly assess, manage, and incorporate input from the participation process into their plans.

It can be argued that the literature makes participation seem more effective than it actually is. It is pointed out that deep-rooted power imbalances and bureaucracy can limit the real impact of citizen involvement. Often, participation ends up being more of a formality, with people's input not genuinely shaping decisions and citizens often have limited impact on actual decisions, suggesting a gap between participation and real influence. Essentially, while participatory

planning sounds great in theory, there are many challenges in making it work effectively in the real world, which is also mentioned in literature.

2.1.3. Greenwashing & urban/real estate development

Real estate greenwashing occurs when a builder, developer, or real estate agent misleads potential buyers and investors by making false or exaggerated claims about the environmental features of a building or construction (Lupinu & Machura-Urbaniak, 2024). The study of Sivadasan & Basiruddin (2019) indicates that marketing green housing developments requires innovation to effectively reach, educate, and attract consumers. However, it also reveals that greenwashing is a common issue within the industry of green property developments in the case of Malaysia, underscoring the need for genuine and transparent practices. According to the study of Tateishi (2017) real estate developments often label themselves as eco-friendly, sustainable, or green. Green cities, especially those planned in Asia and the Middle East, often promote their "eco-ness" with bold claims, ambitious goals, eye-catching designs, innovative technologies, and plenty of greenery in their marketing materials. Advertising for greenfield housing development often hides impacts by using unclear or misleading "green" language. Visual materials are especially deceptive, showing inaccurate representations of environmental benefits.

Marketing campaigns in Rzeszow take advantage of buyers' lack of knowledge about the ecological costs of living in these areas. Instead of being honest, developers use false environmental claims to attract eco-conscious buyers. Greenwashing helps developers improve their image, increase sales, and avoid criticism from environmental groups. Some key points on how greenwashing was used in the case of Rzeszow was by misleading claims about environmental benefits of projects, a lack of transparency by using vague terms to describe the development project and ignore negative impacts of the project, greenwashing of harmful materials that some developers used for the buildings of the project, non-compliance with regulation when developers make false or misleading claims that are not allowed by law in Poland (Szopińska-Mularz & Lehmann, 2023).

Canada's sustainability planning initiative helped identify local infrastructure priorities but often fell short of advancing true sustainability as intended. Many plans became formulaic, with generic visions and limited implementation mechanisms, serving mainly as infrastructure priority lists. While some communities engaged seriously, others treated the plans as mere requirements. The initiative supported local governments with funding and planning resources, but its narrow focus and political shifts limited its long-term impact, particularly on social and cultural aspects of sustainability. Overall, the program highlighted the challenges of transferring responsibilities to local governments without sufficient capacity (Grant et al., 2016).

Higher densities in the city are necessary, but they must be planned carefully. Growth should focus on "quality density," meaning building in a way that improves the city. Empty spaces within the city should be developed first. New housing should be built in areas that already have roads, utilities, and other infrastructure. This is better than building more greenfield developments outside the city (Szopińska-Mularz & Lehmann, 2023). According to the study of Tateishi (2017)

the larger a greenfield real estate project is in size and the amount of land it builds on, the more the developer highlights how "green" the project is, even if it involves greenwashing.

Developers often make false claims about how much green space there is. At the same time, they take advantage of green spaces cared for by local governments using public money. On one hand, developers profit from green spaces. On the other, they harm them by building on land that was previously undeveloped. Despite this, they market new housing projects as "green" and close to parks, benefiting from the remaining protected green spaces. This also helps brand cities as "green," which benefits developers and local governments. Local governments support developers by relaxing planning rules, hoping for "green growth" through these new housing projects. However, this comes at a cost: informal green spaces are lost as developers take them over (Kronenberg et al., 2023).

Rapid urban growth has provided housing and jobs but caused environmental, social, and economic problems in Poland. Medium-sized cities in Poland face challenges balancing urban growth with natural integration, especially with limited resources. Effective planning is needed to make cities sustainable, resilient, and prepared for threats like climate change or pandemics. Urban densification has become a key strategy to promote compact development and add green spaces to build areas. However, poor planning has resulted in low-density urban sprawl and car-dependent greenfield housing developments. Developers often advertise these housing projects as environmentally and socially beneficial, overlooking their negative impacts. Urban density and compactness are vital for sustainable development but must be balanced to avoid harming health and well-being. Understanding the difference between density and compactness is essential for planning future cities effectively. New urban concepts should focus on integrating greenery and biodiversity into urban areas for improved sustainability (Szopińska-Mularz & Lehmann, 2023).

Green property prices are influenced by two factors, eco-conscious buyers willing to pay for green-labelled properties and developers seeking financial rewards to cover the extra costs of building genuinely or seemingly green buildings. Developers often use green claims to justify large-scale projects amid stricter regulations and ecological concerns, with bigger projects emphasising "greenness" more strongly. However, there is no solid evidence yet to prove this trend. Greenwashing in real estate, especially large developments, undermines efforts to reduce ecological damage which harms global ecosystems (Tateishi, 2017). A recent study revealed that developers often market housing estates by highlighting greenery or nature-based solutions, such as recreational infrastructure, green roofs, rain gardens, and amenities promoting outdoor activities. Researchers observed that many advertisements emphasise green spaces in the surrounding area (gardens, parks, forests) or feature greenery within the properties themselves. Additionally, references to nature are frequently used in graphic designs and project names. This strategy aligns with the fact that people are generally willing to pay more for properties located near green spaces (Lupinu & Machura-Urbaniak, 2024). Developers often use green claims to boost market value and justify higher prices by incorporating "green costs." For green housing developments, strong green marketing allows them to command higher prices. However, as these green claims become stronger, developers are more likely to make deceptive claims, which can undermine the credibility of their green messaging unless they actively work to ensure their claims are valid. Additionally, developments that rely on greenwashing with high

green claims tend to have higher prices compared to those with more honest, though slightly misleading, green marketing. This emphasises the importance of monitoring and regulating green marketing in real estate (Tateishi, 2017).

Many studies highlight how developers often exaggerate environmental claims to improve their image. However, they tend to rely on examples or general descriptions rather than solid, cross-context research. The focus is often on marketing strategies without looking closely at the wider socio-economic effects or long-term sustainability. Additionally, there is a common gap in exploring how consumer behaviour and regulatory enforcement play into the issue.

2.2. Theoretical framework

In 1994, John Elkington introduced the concept of The Triple Bottom Line (TBL) in his book 'Cannibal with Forks: The Triple Bottom Line of 21st Century Business' (Elkington, 1998). Elkington introduced the concept of TBL to change the way businesses measure success. Instead of focusing only on financial profits, this approach encourages companies to consider their impact on the environment, society, and long-term financial stability. Because of this concept, some businesses started realising that their financial success is linked to social well-being and environmental health (Collaboratives, 2024). After 25 years, the original purpose of the triple bottom line has largely been forgotten. Instead of inspiring real change, it has been reduced to just another accounting tool, a way for businesses to balance trade-offs rather than truly rethink how they operate. Meanwhile, there is a push against the planetary boundaries with no real signs of slowing down. Seeing this, Elkington proposes a "recall" of the concept, urging businesses to either take sustainability seriously and make meaningful changes or step aside for those who will (Harvard Business Review, 2018). While the sustainability sector has grown, progress remains insufficient as environmental and social issues continue to worsen. Many companies have failed to integrate TBL into their core strategies, focusing primarily on profit while neglecting people and the planet. The core issue lies in the business world's ingrained focus on financial success, with CEOs and executives prioritising profit targets while failing to set equally ambitious goals for sustainability. The TBL's original goal was to transform capitalism. The concept requires a "recall" to restore its radical intent and ensure that companies genuinely work toward a sustainable future rather than just pretend to be sustainable (Elkington, 2018).

Triple Bottom Line (TBL) approach: (people, planet, profit)

Environmental Dimension: Assess whether the "maximum green effort by implementing a green infrastructure" aligns with genuine sustainability principles.

Social Dimension: Evaluate the project's impact on how societal needs are achieved like demand for affordable housing, while ensuring liveability through green and sustainable urban development and look to community well-being and stakeholder engagement by exploring the role of participatory planning in the decision-making process.

Economic Dimension: Investigate whether the project supports long-term economic growth without resorting to greenwashing to attract investments or stakeholders.

Sustainability planning offers a comprehensive approach to resource management by integrating local and broader decision-making, considering all community members, focusing on long-term outcomes, and reducing environmental harm. Early discussions used the metaphor of a three-legged stool, representing the balance among environment, economy, and society. This evolved into the concept of three pillars or the "three Es": environment, economy, and equity (Grant et al., 2016). To achieve a sustainable built environment, ecological planning becomes a functional requirement. This tool aims to create an urban development in balance with ecological, social and economic values. In a sustainable environment resources must be used carefully and preserved for future generations. Sustainability applies to three key aspects of life: nature, people, and business. These three elements are deeply interconnected and mutually dependent. When greening the city there are strategies and techniques used that protect and restore ecology within urban communities. Urbanism and nature are combined to create healthy, civilising and enriching places to live. The living area is governed more by nature than legislation and the sustainable human settlement is based on ecological balance, community self-service and participatory democracy. A new way of addressing urban problems is needed which has to be more efficiently integrated, more sensitive to ecology and community, more respectful to uncertainties and more open to citizen involvement. The ecosystem approach to planning focuses on starting with a specific ecological area and combining social, economic, and environmental factors. It aims to involve all relevant stakeholders in shaping future goals, assessing different options, and implementing the best solutions (Mersal, 2016).

Power dynamics mean an uneven distribution of influence, resources, and authority which can play a big role in decision-making, especially when multiple groups have to work together. When power is not shared equally, collaboration can become difficult, and some voices may be overshadowed. Research shows that understanding these power imbalances is key in making governance more inclusive and effective. Traditionally, power has been seen as the ability to influence or control others, but it is also shaped by social and cultural structures. In collaborative governance, different stakeholders come together to reach decisions, but hidden power struggles can create tension. Even though the goal is to share power and make collective decisions, some stakeholders naturally have more influence than others. This creates power asymmetry, which results in some groups dominating while others struggle to be heard. Recognising and addressing these imbalances is crucial for making governance fairer and ensuring that all voices contribute meaningfully to decision-making (Delgado-Baena & Sianes, 2024). Recently, power dynamics in governance have shifted, with governments pulling back and market-driven solutions becoming more common. However, research on corporate involvement in governance is still lacking. One challenge is that power in governance is not always clearly defined or evenly distributed, making it difficult to study. The complexity of interactions between stakeholders and their environments adds another layer of difficulty. More research is needed to fully grasp how corporate power shapes governance and decision-making, especially in environmental matters. Power distribution in non-state environmental governance (EG) is complex due to several challenges. These include delays between actions and environmental

effects, uncertainty in climate responses, and conflicts between development and sustainability. Balancing collective environmental benefits with local interests adds further difficulty. Additionally, political and economic shifts can create new power imbalances. Given these factors, understanding power dynamics is essential for effective environmental decision-making and governance (Ba, 2021). Stakeholders in urban sustainability projects hold three types of power: expert power (academics), statutory power (policy-makers), and power over local knowledge (residents). Scientists often dominate early stages by setting research agendas with technical terms. Policy-makers use statutory power to align projects with policies and regulations. Local communities exercise power through networks, citizen groups, and informal associations. Their role is crucial in sharing knowledge, challenging inequalities, and driving local solutions. Collaboration between these groups helps reshape research and governance (Buyana et al., 2021).

Digital technologies improve efficiency in resource governance and business operations, enhancing sustainability across economic, environmental, and social dimensions. They enable smart systems for managing water and energy use, boosting awareness and encouraging eco-friendly behaviour. Successful technology adoption depends on understanding consumer and organisational needs, overcoming barriers, and ensuring acceptance for sustainable development (Al-Emran & Griffy-Brown, 2023). Design is often seen by the public through the products or processes it creates, but its true role goes beyond just visible outcomes. It plays a key part in generating knowledge and shaping strategies, especially when it comes to big, system-wide changes needed for sustainability. However, both design and the broader discussions on system innovations and transitions have not fully explored how design can inspire, guide, and drive these large-scale societal transformations (Gaziulusoy & Ryan, 2017).

In order to achieve real sustainability and avoid greenwashing in urban development projects, it is essential to integrate the “three Es”, according to Grant et al. (2016). However, the TBL can be improved by including the concepts “Governance and Power Dynamics” and “The role of technology and design” to reach sustainability. Unequal power distribution can undermine fair decision-making, especially in environmental governance, making sustainability efforts less inclusive. Additionally, technology and design play a crucial role in driving long-term sustainability. Without addressing these factors, TBL risks falling short of its transformative potential.

2.3. Conceptual model

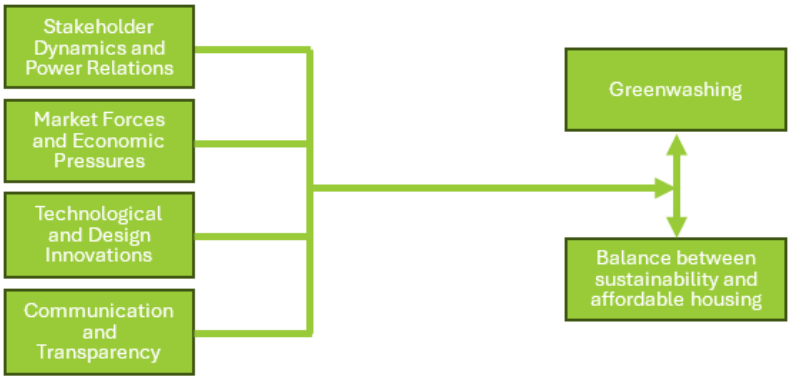

Figure 1 Conceptual model

This conceptual model shows how the four key factors influence the balance between sustainability and affordable housing in urban development projects, as well as how this is related to the risk of greenwashing. The factor 'Stakeholder Dynamics and Power Relations' explains how different stakeholders like government, municipality, project developers, residents, experts and academics collaborate, who has influence about decision making, and how interests are considered. The factor 'Market Forces and Economic Pressures' refers to factors like housing prices, construction costs, subsidies, market conditions, government financing, profit goals, land value, real estate speculation, policy incentives and how these factors put pressure on the balance between sustainable building and affordability. The factor 'Technological and Design Innovations' includes how green building technologies, smart energy systems, sustainable materials and innovations, smart designs, circular constructions and nature-based solutions, etc. are applied in the urban development. The factor 'Communication and Transparency' involves how information is shared with stakeholders, public discourse, the use of labels/certifications, and clarity about goals and outcomes of the urban development project. The relationship between 'Greenwashing' and 'Balance between sustainability and affordable housing' is characterised by an inherent tension. There are efforts to achieve both sustainability and affordability in urban development areas but if this is not carefully managed it can lead to an increased risk of greenwashing. When this balance is not approached with transparency and accountability, sustainability claims may be exaggerated or strategically framed to align with market preferences or policy requirements, rather than grounded in measurable outcomes. It highlights the importance of clear communication and responsible stakeholder engagement in the process of decision making to ensure that sustainability efforts are both credible and effective.

'Greenwashing' refers to the practice of portraying sustainability in a more positive way than it actually is, often for marketing purposes. In the context of urban development, this can occur when sustainability claims are exaggerated, not realised in practice, or lack transparency, resulting in a misleading image of environmentally or socially responsible development. The concept 'Balance between sustainability and affordable housing' focuses on the challenge of combining sustainable requirements with housing affordability. The idea is that ambitious sustainability goals should not compromise affordability, so that people with lower and middle incomes also have access to high-quality, sustainable living environments. In this research, a broad and integrated view of sustainability is taken. It goes beyond just environmental measures

like energy efficiency, materials, and greenery. It also includes social, spatial, and economic aspects. Within the scope of area development, this means looking at all these aspects in relation to each other. It is about developing in a way that not only addresses ecological concerns, but also supports social equity, economic feasibility, and spatial quality. So that new urban areas genuinely contribute to a sustainable and future-proof city.

3. Methodology

3.1. Research Strategy & Research Philosophy

The subject of this research, sustainable urban development within KnoopXL Eindhoven, involves multiple stakeholders, conflicting interests, and concepts such as greenwashing and the balance between sustainable ambitions and affordable housing needs. These complex and context-dependent issues require a careful methodological approach.

For this research, a qualitative method was chosen, where the results are expressed in words. This data was needed to try to answer the research question. The study used a single case study approach to collect qualitative data. The case study was about KnoopXL, an urban development in Eindhoven. During the research there was an in-depth description and analysis of the main question along with supporting sub-questions (Gupta, 2024). To move from a general perspective to a specific situation, the research was started with the existing view on the balance between sustainability and affordable housing in urban development initiatives to reduce greenwashing risks from a stakeholder perspective. From there, it shifted to the KnoopXL case to examine how Eindhoven approached sustainability, affordability, and green claims in urban and real estate developments and how the decision-making process was carried out. According to Creswell (2013), a case study focuses on a specific case to illustrate an issue. The KnoopXL project was chosen as case study because it showed the challenges of urban development, the need for affordable housing, and the strong focus on sustainability, which are all key parts of the research. It gave a real-life example of how these issues connect and the challenges of handling different stakeholder views, as well as dealing with the risk of greenwashing in big city projects. The case of KnoopXL helped to understand the real-world issues of balancing sustainability, affordable housing, and the tension between ambitious environmental goals and misleading "green" claims. The research was about an intrinsic case study (Stake, 2005), because the research was focused on understanding the unique characteristics and dynamics of the KnoopXL project in Eindhoven, rather than trying to generalise findings to a broader population.

The research was about a qualitative, exploratory case study question which was designed to identify factors and stakeholder perspectives on balancing sustainability and affordability while mitigating greenwashing risks in urban development. The research was part of an inductive approach because the research question tried to explore and seek to understand phenomena (i.e., sustainability, affordable housing, and greenwashing) through observation of the case study KnoopXL.

Interpretivism believes reality is a product of people's interpretations and experience. This means there is no one truth, but many truths. In terms of ontology, it assumes that multiple individuals construct their own social reality. Epistemological interpretation focuses on context specific, inductive research. It is subjective, owing to the subjective meanings humans give to their experience and to the social world in general. Interpretivism stands opposite positivism, since positivists develop universal laws for human behaviour, while interpretivists seek to better understand how people interpret their world (Mack, 2010). Interpretivism is grounded in a number of philosophical traditions, such as hermeneutics, phenomenology, and symbolic interactionism, all of which value meaning and the context of situated experience. Because

humans are not passive objects, an interpretivist would argue that humans cannot be studied in the same manner as physical phenomena. Similarly, although the knowledge produced from research is subjective, the researcher would try to remove as much of their own subjectivity as possible. Interpretivism does not seek to generalise knowledge, but instead, to get a little deeper into what it might mean to understand lived experiences and sense making, through a qualitative lens. By aligning research closely with the perspectives and interpretations of individuals, interpretivism enhances the validity of findings, offering nuanced and contextually grounded understandings of social phenomena (Alharahsheh & Pius, 2019).

Interpretivism is relevant here, as the research deals with subjective perspectives, meanings, and interests around sustainability, affordability and urban development. The aim is not to find one objective truth, but rather to gain insight into how different actors such as government, private sector, community and experts, perceive and respond to sustainability and affordability challenges within a specific urban project. This research philosophy supports the need to explore how meanings around concepts like "sustainability", "affordability" and "green development" are shaped and potentially contested within KnoopXL. The combination of an interpretivist philosophy and a qualitative strategy provides the tools needed to explore the social and political dynamics behind sustainable urban development, especially when environmental goals are combined with market pressures and housing demands.

3.2. Research Methods, Data Collection and Data Analysis

This research is a qualitative based study on a sustainable urban development approach with a special focus on KnoopXL, Eindhoven. This case was chosen due to the complex challenges. KnoopXL is an area of relatively high-density urbanism, but covers a small area. Various sustainability aspirations must be addressed, along with the need for (affordable) housing. In addition, there are many different stakeholders with multiple interests involved in the development process. It is the challenge of transferring these different aspects into one interrelated understanding, to generate further insights into how to manage complex urban development projects, while realising the shared interests of actors with conflicting interests. Data collection was based on the interviews. In addition, also documents and online sources were consulted to better understand the KnoopXL project and to prepare thoroughly for the interviews. In qualitative research it is possible to collect the data with multiple methods, including, observations, interviews, (policy) document analysis, open-ended questionnaires and literature reviews, where these methods can generate rich, deeper information (Gupta, 2024). Moreover, it is important to present the situation from different perspectives to capture its complexity.

This research gathered multidimensional data that takes into account the social, environmental, and economic dimensions based on the theoretical framework of the Triple Bottom Line (TBL). The research also collected data about governance and power, as well as data on technology and design. The research used semi-structured interviews to gather perspectives from different stakeholders involved in the urban development. The semi-structured interviews used a topic guide with questions by theme that had been prepared, but offered flexibility to explore relevant issues that arise in the interview context.

According to Van Thiel (2014), in inductive research, interview questions are derived from the research problem and focus on gathering specific information.

The aim of these interviews was to explore stakeholders' perspectives on greenwashing, sustainability ambitions, and housing affordability. For participant selection, purposive sampling was employed, targeting only those individuals who possess relevant knowledge for this study (Gupta, 2024). These participants included representatives from organisations, institutions, companies, developers, and other actors involved in KnoopXL Eindhoven, but also experts in the field of sustainable area development. Seventeen interviews were conducted with various stakeholders and experts, and one additional response was received via email. Table 1 provides an overview of the potential respondents who were identified as relevant for this study and were approached for participation. Table 2 presents the seventeen stakeholders and experts who ultimately participated in interviews.

Data analysis involved identifying patterns and themes within the interview transcripts (Creswell, 2013). In this study, a deductive coding approach was used, in which predefined themes and codes were used to guide the analysis (Chandra & Shang, 2019). The six key concepts derived from the theoretical framework serve as the main coding themes, each accompanied by related variables and indicators. These concepts, variables, indicators, and their definitions are summarised in table 3. The coding process was supported by the software Atlas.ti.

Potential respondents	Involvement KnoopXL
Province North-Brabant	Government
Municipality Eindhoven	Government
Brainport Development	Experts
APPM	Experts
Fellenoord B.V.	Fellenoord development manager
TU Eindhoven	Experts
Fontys University of Applied Sciences	Experts
Van Deursen Vastgoed	Private sector
REBEL Group	Experts
Cocomos	Community
Renda	Community
EHVXL	Community
Van Wonen	Private sector
AM	Private sector
EDGE	Private sector
City council Eindhoven	Government
D66	Government
Amvest	Private sector

Potential respondents	Involvement KnoopXL
GroenLinks	Government
TAUW	Experts
Trefpunt Groen Eindhoven	Community
Duurzaamheid Eindhoven	Community
Movares	Experts
Arcadis	Experts
BESIX	Private sector
Sweco	Experts
ASR Real Estate	Private sector
Volkerswessels	Private sector
Water board de Dommel	Government
Lodewijck group	Experts
Trudo	Private sector / experts
UrbanXchange	Private sector / experts
FOUR-D	Private sector
Brink | bouw, infra en vastgoed	Experts
Focus on impact	Experts

Table 1 Overview potential respondents

Interviews				
Who	**Group**	**Date**	**Location**	**Duration**
Fontys University of Applied Sciences	Experts	April 2025	Online	48:37 min
Movares	Experts	May 2025	Online	35:38 min
TU Eindhoven	Experts	June 2025	Online	34:11 min
APPM	Experts	June 2025	Online	19:43 min
Arcadis	Experts	June 2025	Online	33:58 min
Brink | bouw, infra en vastgoed	Experts	June 2025	Online	33:32 min
Province North-Brabant	Government	April 2025	Online	52:11 min
Municipality Eindhoven	Government	April 2025	Eindhoven	41:58 min
Water board de Dommel	Government	May 2025	Online	27:34 min
City council Eindhoven - GroenLinks	Government	May 2025	Online	33:54 min
Province North-Brabant	Government	May 2025	Online	35:23 min
Municipality Eindhoven	Government	June 2025	Online	40:44 min
UrbanXchange	Private sector	May 2025	Online	32:35 min
AM	Private sector	May 2025	Online	30:14 min
EDGE	Private sector	June 2025	Online	24:45 min
Fellenoord B.V.	Fellenoord development manager	May 2025	Online	31:06 min
EHVXL	Community	May 2025	Online	29:07 min
Trefpunt Groen Eindhoven	Community	May 2025	Mail	-

Table 2 Overview interviews

Key concept	Variable	Indicators	Definition
Balance between sustainability and affordable housing	Sustainability and affordability integration	Affordability objective	Aiming to deliver affordable housing for a broad range of target groups, along with cost-effective sustainability measures.
		Sustainability objective	Aiming to create energy-efficient, environmentally friendly, and green homes and designing sustainable and green public spaces.
		Affordability challenge	Tensions between rising costs and the need to keep housing and sustainability measures affordable.
		Sustainability challenge	High investment requirements and conflicting interests make the implementation of sustainable measures more difficult.
		Property value	The market value of housing, influenced by location, level of sustainability, and affordability.
		Awareness sustainability	The extent to which stakeholders are aware of sustainable choices and their impact.
Greenwashing	Green claims	Sustainable plans realistic	The extent to which sustainability plans are feasible and practically achievable.
		Taboo greenwashing	The degree to which greenwashing is recognized and socially or politically unacceptable.
		Control of sustainability requirements/claims	The presence of checks or regulations to verify sustainability claims.
		Avoid greenwashing	Measures taken to ensure transparency and prevent misleading sustainability messaging.
		Green as marketing tool	The use of sustainability claims primarily to enhance image or attract support, rather than to achieve real impact.

Stakeholders' Dynamics and Power Relation	Stakeholder involvement and participation	Perspective	The views and interests each stakeholder brings to the development process, especially on sustainability and affordability.
		Collaboration between other stakeholders	The degree of cooperation and alignment among different involved parties.
		Challenges to integrate different perspectives	Difficulties in reconciling conflicting stakeholder interests and priorities.
		Power dynamics	The influence and control certain stakeholders have over others in the process.
		Regulatory power	The authority of public bodies to enforce rules and guide the development.
		Research	The role of knowledge and data in informing stakeholder decisions and strategies.
		Decision making-process	How final choices are made, including who is involved.
Market Forces and Economic Pressures	Demand for affordable housing	Market conditions	Current trends and demand in the real estate and housing market.
		Financial rules/agreements	Regulations and contracts that define funding structures and responsibilities.
		Government financing	Public funding or subsidies supporting development projects
		Economic incentives	Financial benefits aimed at stimulating investment or desired outcomes.
		Financial risks	Potential economic losses due to uncertainty or market volatility.
Technological and Design Innovations	Integration of technological advancement and sustainable innovations embedded in the design and construction of urban development	Technological applications	Use of digital tools or smart systems in planning and construction.
		Sustainable innovations	New methods or materials that reduce environmental impact
		Examples	Concrete cases of implemented technologies or design solutions.
		Smart design	Efficient layouts that enhance functionality and sustainability.
		Identity	Unique architectural or design elements that give the area the character of Eindhoven.
Communication and Transparency	Stakeholder engagement	Public participation	Involvement of residents and stakeholders in urban planning decisions.
		Transparency and clarity of plans	Clear and accessible communication about goals and developments.
		Concerns and objections	Space and process for addressing public worries or opposition.

Table 3 Coding scheme

3.3. Validity and Reliability of the Research

Reliability in research denotes the dependability and consistency of measurements of variables. The accurate measurement of variables guarantees accurate results while consistent measurements can be replicated whereby the same conclusion can be made with confidence, there is greater warrant for the findings when similar conditions are replicated or accounted for. To increase reliability, one can use instruments that evaluate reliable measurements, ensure replicability by replicating the interview processes along with adequate amounts of participants (Van Thiel, 2014).

Reliability was increased in this study with the use of a standardised interview guide pertaining to the six key concepts in relation to the indicators. Although not all respondents could be asked the exact same questions, due to varying degrees of expertise from respondent to respondent. Reliability was assured further by interviewing only respondents who had (in)direct knowledge of KnoopXL or sustainable urban development. This ensured that information was obtained which offered insights into their views and experiences. Respondents admitted when they were unsure of an answer, which contributed to honest data collection. A conscious decision was made during the interview process to selectively discuss the term 'greenwashing' during interviews, because it was a sensitive and taboo topic for some stakeholders. This approach helped to minimise the potential negative effects on the research by avoiding situations where stakeholders might have felt uncomfortable.

Validity concerns whether the research truly measures what it intended to measure. Internal validity in this study relates to the accuracy of conclusions drawn about the relationships between factors in the conceptual model, specifically how these contribute to balancing sustainability and affordable housing while mitigating greenwashing risks. Internal validity was safeguarded by asking open-ended questions that allowed respondents to express their own perspectives without being led by the questions. External validity concerned the generalisability of findings beyond the specific case of KnoopXL. Although the research focused on KnoopXL, the insights are relevant for comparable urban development projects facing similar challenges in high-density transit areas. External validity was supported by deliberately including diverse types of respondents representing different perspectives, including some not directly involved in KnoopXL but experts in sustainable area development more broadly. The detailed description of the KnoopXL context further allows readers to assess the applicability of the findings to other projects.

To strengthen both reliability and validity, triangulation was applied by using multiple data sources: semi-structured interviews, document analysis (policy documents, plans, websites), and literature review (Van Thiel, 2014). This approach helped develop a more comprehensive understanding of the research topic, while also reducing potential bias from relying too heavily on a single source. It is worth acknowledging that the researcher's academic background and personal interest in sustainable urban development may have influenced the interpretation of the data. To mitigate the risk of bias, a formalised coding framework grounded in the theoretical model was consistently used for data collection and analysis. In addition, situated within the process was continual critical reflection on personal assumptions, resulting in a more deliberate and multi-faceted interpretation of the perspectives of a range of stakeholders.

3.4. Ethics

This research followed key ethical principles to protect the integrity and credibility of the study, and the research respondents. One of the main principles was to obtain the informed consent of all interview participants. At the beginning of the interview, the participants were clearly informed about the purpose of the research, the voluntary nature of their participation, and the manner in which the data would be utilised. Also the confidentiality and anonymity of the participants were safeguarded. Personal data is not published or shared, and all information is anonymised in the results of this research. Interview transcripts and audio files were securely stored and only accessible to the researcher. The research was conducted with openness and respect toward all stakeholders, with careful attention to potential power dynamics during interviews to ensure that participants did not feel pressured or misrepresented. Ethical considerations were also applied during the analysis phase, with the aim of presenting a fair and balanced interpretation of the diverse perspectives shared throughout the study.

4. Eindhoven KnoopXL

There is a great shortage of affordable housing in Eindhoven, which makes building necessary. (Gemeente Eindhoven, n.d.-a). The area development of Knoop XL around Eindhoven Central Station will continue until 2050. This development will bring about major changes in the area, giving the city a new appearance (OpenEindhoven, n.d.). Over the next 20 years, KnoopXL, the urban area around Eindhoven Central Station, will undergo a major transformation. It is now a grey office area with lots of space for cars, but the area will be redeveloped to an attractive area for living, working, studying and recreation with a focus on greenery as well. The ambition of the Municipality of Eindhoven is to make the station area the business card of Brainport Eindhoven. The aim is to create a green residential area for everyone, with space for 9,000 new homes, good accessibility by public transport and a strengthened nature function of the Dommel river. The transformation of KnoopXL is a complex task given its multifunctionality and the involvement of various stakeholders (Yang et al., 2023). Maximum efforts will be made to be green, by applying trees, small parks, green facades, green roofs and more space for nature development near the river Dommel. These green measures aim to create a green oasis in the heart of the city of Eindhoven. In addition, between 6,000 and 7,000 homes will be built in Fellenoord for smaller households (Open Eindhoven, 2020). The plan is to optimally use the green axis of Fellenoord for a combination of trees, planting areas and space for water storage. This area should be inviting and traffic-free. Along the railroad tracks there can also be a green strip. Courtyards will have small parks, but the focus will be on urban growth. New buildings will contribute to a pleasant living environment with green roofs, facades and solutions for climate change. Fellenoord will also be connected to larger green zones, such as the Boschdijk and Kennedylaan (Open Eindhoven et al., 2021).

Figure 2 Possible map of KnoopXL Eindhoven future plans – (KCAP, n.d.-b)

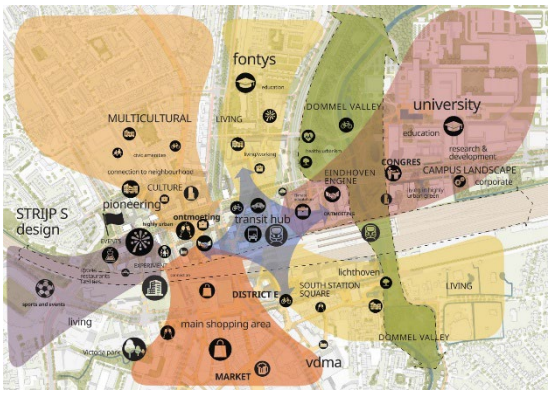

Figure 3 Map facilities KnoopXL Eindhoven – (KCAP, n.d.-c)

The Municipality of Eindhoven and the Province of North Brabant have together set up a private limited company, Fellenoord B.V., to realise an inner-city area development, sealing their commitment to the implementation of large-scale plans for Fellenoord (north side of KnoopXL). The area development is complex due to the interconnectedness of infrastructural projects and the fragmentation of ownership. There are more than 50 different owners of land and buildings in Fellenoord (PPS Netwerk, 2023).

The Dutch Mountains will be developed next to the Eindhoven University of Technology and the Dommel Valley. The building's design consists of two towers largely made of biobased materials, primarily solid wood, which enables long-term CO_2 storage. The towers are connected by a green inner courtyard. The building is intended to function as Eindhoven's living room, open to everyone. It will offer space for living, working, staying, and socialising (The Dutch Mountains, n.d.).

EDGE Eindhoven is being developed on the southern side. The project includes an office tower and a residential tower. The buildings will utilise smart technologies aimed at promoting sustainability. The atrium will serve as a central meeting place, with a bar at its heart as a social focal point. In addition, greenery will be integrated to create a natural atmosphere (EDGE Technologies, n.d.).

Lightyards is also being developed on the southern side and consists of four buildings: a residential building, a residential tower, an office building, and a student hotel/community hub. The Social Hub has already been completed. The buildings will also house hospitality concepts and other facilities. The development will have a park-like layout with attention to greenery and nesting provisions (AM, n.d.-a).

District E is being built on the southern side as well. This project consists of three towers, one of which will be the tallest in Eindhoven. It will accommodate residential units as well as public and commercial functions. The plan includes homes, lobbies, retail spaces, hospitality venues, and rooftop terraces (Amvest, n.d.).

Figure 4 The Dutch Mountains Eindhoven – (BLOC, 2024)

Figure 5 EDGE Eindhoven – (n.d.)

Figure 6 Lightyards Eindhoven – (AM, n.d.-b)

Figure 7 District E Eindhoven – (Amvest, n.d.-b)

More and more travellers have been using Eindhoven Central Station. To accommodate this growth, expansions of the bus station, railway tracks, and the station itself are planned. This will ensure that Eindhoven remains accessible. The public transport hub in the Brainport Region of Eindhoven is evolving into a high-quality mobility node. Here, buses, trains, taxis, shared transport, and bicycles will converge, with space for all key connections: regional, national, and international. Major changes are taking place around the station. The precise details of the expansion have not yet been determined. In the coming period, various steps will be taken to jointly arrive at the best possible design. The project is part of MIRT: the Dutch government's Multi-Year Programme for Infrastructure, Spatial Planning, and Transport, focused on large-scale rail, road, and waterway projects. The Multimodal Mobility Hub (MMK) is being carried out by the Municipality of Eindhoven and includes the bus station, northern bicycle parking, kiss & ride, taxi, and shared mobility, and the renovation of the northern station building. The Eindhoven rail junction is being carried out by ProRail and involves expanding the rail infrastructure to allow for more train services (OpenEindhoven, n.d.).

Figure 8 Bus station Maaiveld MMK – (Arcadis, n.d.)

5. Results

5.1. Balance between sustainability and affordable housing

The balance between sustainability and affordable housing is an interdisciplinary issue that presents challenges. Sustainability goals are often inherently linked to affordability objectives. The municipality of Eindhoven experiences a tension between achieving affordable housing, with a target of 85% affordable homes, and ensuring sustainability and quality in the built environment. Previously, the focus was on building as many homes as possible. However, there is growing awareness that the quality of public space and amenities is also crucial. Robust structures are becoming increasingly important with attention to long-term value. There is a clear shift from fragmented projects toward more integrated area developments. "You don't want all kinds of green-looking patches stuck onto your building."[1] – respondent 13. Thus, it remains a continuous balancing act between ambitions and reality. The question is not whether it is possible to combine sustainability and affordability, but how to do so and under what kind of governance, collaboration, and long-term vision.

In many developments, housing is built before green space is added. Over time, however, green surroundings can increase property values, rendering affordability temporary. Green surroundings are appreciated as long as it yields advantages. "People will not describe the area as full of asphalt, but rather as pleasantly green."[2] – respondent 11. Interestingly, one expert noted that nature itself actually costs nothing. Nature arises by itself if humans do not interfere. It is precisely human demands and the repair of previously inflicted damage that make nature expensive. "So anyone who says this is all too expensive, all that green and trees and parks and so on. Well, that tree costs nothing. It just grows. If you wait long enough."[3] – respondent 15. According to one expert, location determines real estate value. Whether sustainability entails higher costs depends on context. The ambition is to create a mixed living environment in KnoopXL. "Where someone in expensive rental housing can meet someone in social housing in the elevator."[4] – respondent 11. Developers face the challenge of making this financially viable, including the green ambitions. This complexity reflects why sustainability is often seen as a broad term. ''Sustainability is a container term. It includes many different elements, across various scales."[5] – respondent 2. Inner-city construction is seen as sustainable because it saves space, uses existing amenities, and promotes sustainable mobility. Eindhoven has a low parking standard (1 in 3), encouraging cycling and public transport use. However, the question also arises of what it will actually be like to live here in a dense urban area with many people on a small surface. "We always talk about beautiful images. About buildings, homes, infrastructure, greenery. But how will such an area actually function and live? What identity will such a place

[1] "Je wil ook niet allerlei groenogende plaksels aan je gebouw." – respondent 13
[2] "Die omgeving zullen mensen niet omschrijven als vol met asfalt, eerder als lekker groen." – respondent 11
[3] "Dus iedereen die zegt, hé, dit is allemaal veel te duur, al die groene en bomen en park enzovoort. Die boom kost helemaal niks. Die groeit gewoon. Als je maar lang genoeg wacht." – respondent 15.
[4] "Waar iemand die in de dure huur zit, ook iemand in de sociale huur kan tegenkomen in de lift." – respondent 11
[5] "Duurzaamheid is wel een containerbegrip. Duurzaamheid kent ontzettend veel verschillende elementen. En ook op verschillende schaalniveaus." – respondent 2

still have?"[6] – respondent 2. Social sustainability is therefore also part of the task, ensuring that people can live together comfortably, even in densely built areas.

The area development of KnoopXL illustrates the complexity of this issue. Major ambitions are combined: greening, sustainability, and affordability. The aim is to realise 8 m^2 of green space per dwelling. This is a significant challenge, given the planned addition of 9,000 dwellings and additional office space. Sustainability is essential. The municipality is targeting energy-neutral homes, maximum energy generation, and minimal energy consumption. Affordability remains a key point. Eindhoven is maintaining the previously established 85% affordable housing target, a wish from the municipal council, despite national guidelines that assume 66%. "That was a political desire. One that goes somewhat against national policy."[7] – respondent 11. This choice stems from local housing needs assessments and a deliberate political course, where Eindhoven also wants to continue serving lower-income groups, despite the increase in more affluent internationals in the city.

There is a risk that affordable homes in KnoopXL will become less affordable over time. There is a concern that creating affordable homes may lead to very small dwellings. The question is whether the type of homes being realised truly meets residential needs. The area has high density and much high-rise construction, which entails high building costs. The municipality wants to prevent the area from becoming filled with small, affordable units, as it is an important urban location. The designs of some developments are flexible, apartments can be merged or split depending on market demand. This makes it more efficient to design a single standardised dwelling type with multiple variations. EDGE has some large owner-occupied homes, but also smaller ones of around 50 m^2. "So yes, they are urban apartments, let's say."[8] – respondent 14. On the other hand, smaller homes can be seen as sustainable, especially in an international comparison, as Dutch homes are relatively large.

The revision of the spatial framework will be used to reassess the balance and to safeguard broader residential quality. One of the key performance indicators (KPIs) is the housing ladder, with the aim of achieving 30% social rental, 55% mid-range rental and mid-priced owner-occupied homes, and 15% free-market sector. This KPI makes it challenging for developers to complete a building. Affordability often hinges on small margins, so if public institutions can contribute just a few percentage points, it might make the business cases viable.

Construction is already underway on the southern side, under different conditions than for the northern side. There, it still needs to be determined whether the ambitions are compatible or whether bottlenecks will arise. A developer indicated that realising housing within this project was quite challenging, particularly due to the combination of high municipal land prices and ambitious sustainability requirements. The houses were developed for sale to an investor, not private individuals, which made the business case extra sensitive. Much optimisation and puzzling were needed to make the design and layout of the residential tower financially feasible within the established frameworks. The higher the rent of a building, the greater the yield, which

[6] "We hebben het altijd over mooie plaatjes. We hebben het over gebouwen, we hebben het over huizen, we hebben het over infrastructuur, we hebben het over groen. Maar hoe gaat zo'n gebied straks functioneren en leven? Welke identiteit krijgt zo'n gebied straks nog?" – respondent 2

[7] ''Dat is een politieke wens geweest. Die een beetje tegen landelijk beleid in gaat." – respondent 11

[8] "Dus ja, het zijn stadse appartementen zullen we maar zeggen." – respondent 14

increases the sales value to investors. This creates more room to invest in sustainable materials. An expert indicated that project developers are private companies focused on profit, not primarily on building housing. "It is a misconception to think that a project developer is in the market to build houses."[9] – respondent 15. Whereas housing corporations build from a social mission, developers build only when it is financially viable. In a complex area development like this, with many preconditions, sustainability seems to be further marginalised than in simpler developments.

The question arises, what exactly do we mean by affordability and sustainability? "Every euro we don't spend on sustainability now, we will have to pay ten or a hundred times over later in damages. But that's far away. Not my problem anymore. That's what people think."[10] – respondent 15. Another question arises, what actually holds us back from taking sustainability and affordability seriously? "We spend ridiculous amounts of money on fantastic, beautiful things. Then surely, we can make this work too."[11] – respondent 15. According to another expert, high-density urban development offers opportunities for sustainability, provided that affordability is preserved.

Urban sustainability is no longer a choice but a necessity. The KnoopXL area will house thousands of dwellings on a relatively small footprint, contributing to sustainable land use. "That is, in itself, very sustainable. Even if you don't plant a single tree."[12] – respondent 12. Nevertheless, greening is not seen as a luxury, but as essential for quality of life in an area where spatial pressure is high. A climate change calculation tool determines how much greenery must be added per dwelling and per square metre of commercial space. This clarity in policy does not mean implementation is easy. Especially on small plots with many planned dwellings, developers struggle with the requirement for high-quality greenery because it is expensive. The balance between cost and green quality remains difficult. The Medina complex, located elsewhere in Eindhoven, shows that green implementation is possible. High-quality architecture is combined with extensive greenery. However, it mainly attracts affluent residents who are willing to pay for maintenance. The challenge lies in scaling up such examples.

Green landscaping is technically limited above structures like underground tunnels, a bus station and parking garages. Grass is possible, but trees require more extensive measures. Still, efforts are being made with a 'comprehensive package' to make planting above the tunnel feasible. In terms of policy, a clear shift is visible. From a focus on quantity to appreciation of the quality of green space. This means that greenery in open ground is now valued differently than greenery on a rooftop. However, this can be confusing for developers, especially when guidelines change over time.

A project such as Lightyards demonstrate how sustainability and affordability can be combined, although it remains a balancing act. In Lightyards, there are far more bicycle spaces than car parking spaces, with a strong focus on sustainable mobility. 85% of the total plan consists of

[9] "Maar het is een misvatting om te denken dat een projectontwikkelaar in de markt is om woningen te bouwen." – respondent 15

[10] "Elke euro die we nu niet in verduurzaming stoppen, moeten we straks in tienvoud of honderdvoud gaan betalen aan de schade. Dat is ver weg. Dat is niet meer mijn probleem. Denken mensen dan." – respondent 15

[11] "We geven belachelijke hoeveelheden geld uit aan fantastisch mooie schitterende dingen. Dan moet dit toch ook kunnen." – respondent 15

[12] "Dat is in zichzelf al heel duurzaam. Al zou je geen één plant planten." – respondent 12

affordable homes. The project includes affordable owner-occupied homes, with starter purchase schemes. There is also a portion of free-market owner-occupied and rental housing. The attractive station location generates high demand, which often leads to higher free-market prices. At the same time, the station imposes constraints on housing development for this project. The location next to Eindhoven Central presents complex challenges such as vibrations and limited space. "The trains don't have round wheels but square ones. They cause quite a bit of vibration."[13] – respondent 8. Timber construction was not an option, but quality was chosen in other areas, such as collective rooftop gardens and green courtyards. 85% of the plan is affordable, showing that sustainability and affordability are not necessarily at odds.

At the MMK, sustainability is structurally embedded. There is an ambition document with themes such as energy transition, circular economy, biodiversity, and well-being. Yet this project also presents dilemmas. An underground bus station is to be built, precisely at the city's wettest point. Water must constantly be pumped out, which is not a sustainable solution. It requires an integrated perspective on the entire area. "As a company, we also advise looking at the entire area more integrally, rather than just that small plot where the multimodal hub is located."[14] – respondent 10. The bus station requires concrete with high CO_2 emissions. An above-ground version would be more sustainable in terms of material use but worse for spatial quality.

The Water Board De Dommel wants to reserve space for water early in urban development so that peak rainfall can be absorbed. The vision for the Dommel Valley rests on three pillars: let every drop infiltrate where it falls, keep clean water clean, and use water and soil as guiding principles. This vision aligns with broader climate adaptation goals. Increasingly, greening is no longer seen as an "extra" but as indispensable. "Green contributes to residential quality and health."[15] – respondent 1. Still, greenery often has to make way for other interests. "The biggest challenge, I think, is that we all agree green is important. But there is always a reason why something should be less green."[16] – respondent 15. That is why alternative forms of green are being used, such as green facades or public green space. Where that is not possible, there is the Green Compensation Fund to enable greening elsewhere in the city.

Sustainability focuses on heat stress, water, biodiversity, energy and social well-being which is integral to area development. "In the field of sustainability, everyone agrees on what needs to happen."[17] – respondent 16. Yet sustainability is still often seen as a deviation from the norm, and therefore more expensive. "We need to make sustainability the standard. Because after that, non-sustainable will be expensive."[18] – respondent 12. This shift in mindset is crucial. Bio-based materials are still costly but will become more affordable with wider application. Moreover, they can contribute to other transitions, such as a new business model for farmers. New construction projects offer good opportunities to integrate sustainability but make up only

[13] "De treinen hebben geen ronde wielen, maar vierkante wielen. Die zorgen voor behoorlijk wat trillingen." – respondent 8
[14] "Wij adviseren ook als bedrijf, om daar eigenlijk veel integraler naar het hele gebied te kijken, dan alleen maar op die postzegel waar de multimodale knoop op zit." – respondent 10
[15] "Groen draagt bij aan de woonkwaliteit en de gezondheid." – respondent 1
[16] "De grootste uitdaging, denk ik, is dat wij allemaal wel vinden dat groen belangrijk is. Maar er is altijd wel een reden waarom iets toch minder groen moet." – respondent 15
[17] "Op het gebied van duurzaamheid is iedereen het er wel mee eens wat er moet gebeuren." – respondent 16
[18] "We moeten ervoor zorgen dat duurzaamheid de standaard wordt. Want daarna is niet duurzaam duur." – respondent 12

a very small part of the total building stock. The greatest challenge lies in making existing buildings more sustainable, which still receives relatively little attention and where interventions are often more complex and less attractive for residents and property owners. This requires a broader approach that also includes the existing built environment.

Sustainability and affordability are not separate worlds. They can continuously be balanced, though this is complex. Where physical space is limited, smart combinations of policy, technology, and vision are sought. This requires flexibility, persistence, and above all, cooperation. Only then can a liveable, future-proof city emerge.

Stakeholder group	Perspective 'Balance between sustainability and affordable housing'
Government	Strives for 85% affordable housing and strong sustainability goals, sees integration as essential but spatially challenging.
Private sector	Focused on financial viability, supports sustainability when it aligns with business models, sees affordability as viable with sufficient returns or subsidies.
Fellenoord development manager	Aims to align public goals and market logic, supports integrated area development but faces feasibility issues under complex conditions.
Community	Value affordable, liveable housing with green space, concerned about long-term affordability and liveability in dense, high-rise environments.
Experts	Emphasize long-term, systemic thinking, call for making sustainability the norm, warn against short-term trade-offs undermining future costs.

Table 4 Stakeholders' perspective 'Balance between sustainability and affordable housing'

5.2. Greenwashing

The image of Eindhoven as a grey city is gradually beginning to shift. Although the city centre is largely paved over, the city as a whole contains many green areas. “And we are the greenest of the five largest municipalities in the Netherlands.”[19] – respondent 13. Opportunities lie in the so-called ‘green wedges,’ which are essential for connecting green zones throughout the city. Especially in the station area, where densification is intense, the municipality seeks to maintain public trust through greening efforts. Visualisations present an appealing picture, but questions remain about how realistic this image is. There is also confidence that the visuals can actually be realised in practice, considering how much Eindhoven has already changed in recent years and how much greenery has been added. In the elaboration of the spatial framework, historical context is also taken into account, such as subsoils, sand ridges, and stream valleys, to give places more identity, particularly in locations like Fellenoord where the past has disappeared due to previous interventions. During working sessions, various experts contribute their knowledge on subjects including subsoil, economy, housing, urban planning, phasing, and scheduling, which enables an integrated approach.

Greenwashing as a term is not explicitly on the political agenda. Yet, in practice, there are clear tensions between ambition, appearance, and actual implementation. Visualisations of projects are effective, particularly when it comes to selling homes. At the same time, several stakeholders acknowledge that project developers often use sustainability for marketing purposes, rather than out of intrinsic conviction. However, within the KnoopXL developments, there are also developers who are genuinely committed to sustainability. Developer AM takes sustainability seriously. “We are not necessarily always aiming for the simplest route. We dare to make things harder for ourselves.”[20] – respondent 8. In their project on a formerly vacant site, 50% of the surface area will be green, making the project climate-adaptive in the future. This requires not only technical creativity but also the courage to make choices that may come at the expense of profit. Green is one of three key pillars in which they are investing heavily. Mobility is also being prioritised. Parking is intentionally limited, and emphasis is placed on STOM: walking, cycling, public transport, and shared mobility. During construction, existing wildlife must also be considered. Another decision is the installation of package delivery lockers in both buildings for residents. This reduces neighbourhood traffic, emissions, and damage to green areas. However, this decision comes with subscription costs. “You make a choice there. Do you want more quality in your area, in terms of greenery, social aspects, and comfort, even if it comes at the cost of affordability?”[21] – respondent 8. For EDGE, sustainability is also a core principle, especially in the development of office buildings according to the EDGE concept, which revolves around health, sustainability, technology, and architectural experience. The EDGE office building serves as an example of progressive sustainability: health, technology, architecture, and climate awareness are central. “But I do think we’re perceived in the market as a very sustainable

[19] ''En we zijn de groenste van de grote vijf gemeenten van Nederland.'' – respondent 13
[20] ''Wij zijn niet altijd per se uit op het simpelste. We durven het onszelf ook al moeilijk te maken.'' – respondent 8
[21] ''Je maakt daar wel een overweging. Wil je meer kwaliteit in je gebied, ook op het gebied van groen en sociaal, maar ook qua comfort, maar wel ten koste van je betaalbaarheid.'' – respondent 8

developer. That's also what we're known for. For us, sustainability is truly at the core of who we are as a company."[22] – respondent 14.

Still, concerns persist about 'token greenery', symbolic vegetation that contributes little functionally to climate adaptation or biodiversity. The municipality seeks to prevent this by including strict sustainability requirements in the KPIs for the Fellenoord project. The aim is maximum greening, through quality, customisation, and serious vegetation. The KPIs are part of the evaluation of plans and play a role in issuing environmental permits. When goals are not met, compensation may be possible, which leaves the door slightly ajar for greenwashing. The municipality itself influences public space, enabling it to pursue green quality. This public space is also necessary for creating robust structures. Nonetheless, it remains a challenge to make all ambitions achievable, as choices must be made within a complex area development like KnoopXL. "Because you can't have maximum greenery, maximum parking, and maximum leisure and terraces all at once."[23] – respondent 13.

Developers often argue that an affordability requirement of 85% is unrealistic when combined with various sustainability demands. At the same time, it is often quickly claimed that something is not possible. "And then it turns out that more is possible than you think."[24] – respondent 13. It is therefore important that the municipality remains steadfast in upholding its own policy. The city council has long advocated for an integrated dashboard that makes progress on sustainability visible. Despite the cluster passports established for Fellenoord, such an overview is still lacking. The cluster passports hinder a clear view of how individual projects contribute to the overall vision, which increases the risk of greenwashing.

The line between genuine sustainability and greenwashing is sometimes thin. According to experts, developers are primarily driven by three factors: legal obligations, financial gain, or reputation. In the latter case, actual impact tends to remain limited. In today's society, unsustainable practices are still the norm, making sustainable choices often more expensive. "If you make the unsustainable option much more expensive, people will choose the cheaper and more sustainable one themselves."[25] – respondent 15. Sustainable construction only becomes truly attractive when it yields financial advantages, for instance by taxing polluting emissions more heavily so that true societal costs become visible. At present, it is often about building "less unsustainably" rather than truly sustainably. The construction sector is traditional and slow to change, partly due to a lack of political courage to impose stricter regulations. Although subsidies can help, they tend to encourage sustainability for financial reasons rather than genuine conviction. A higher tax on polluting choices would be more effective in encouraging sustainable alternatives.

Although there is a prevailing perception that developers engage in greenwashing, there are also voices stating that developers are taking sustainability and climate adaptation increasingly seriously. In the past, developers mainly focused on building as many homes as possible and

[22] ''Maar ik denk wel dat wij ook wel in de markt gezien worden als een hele duurzame ontwikkelaar. Waar we ook wel bekend om staan. Bij ons is die duurzaamheid wel echt de kern van wie we zijn als bedrijf.'' – respondent 14
[23] ''Want je kunt niet en het maximale groen en het maximale parkeren en het maximale ontspanning en terrassen.'' – respondent 13
[24] ''En dan blijkt er toch meer mogelijk dan je denkt.'' – respondent 13
[25] ''Als je het onduurzame veel duurder maakt, maken mensen zelf de keuze om dan maar het goedkopere en duurzamere te kiezen.'' – respondent 15

making a profit. Now, there is growing recognition that without attention to water and climate, plans are not viable. “The sustainability goals are increasingly moving to the forefront. Developers also see that they must truly engage with them.”[26] – respondent 9.

For the Dommel valley and Dommel park, there are plans to create more space for water and greenery. However, in practice, there is often a lack of space due to competing urban developments, prompting parties such as the water board to submit spatial claims at an early stage. Without integrated cooperation between developers, municipalities, and managers, ambitions remain unattainable. It is essential that stakeholders are involved in a timely manner and that firm decisions are made. The original plans have already been revised. “And now you can already see that things are being trimmed down.”[27] – respondent 9. At the same time, greening is essential to combat heat stress and other effects of climate change, because a future-proof city must be liveable and pleasant. “Greening is also part of densifying.”[28] – respondent 4.

Some projects meet only the minimum requirements, while visualisations depict a much greener picture than what is actually built. The risk is that images show large trees and shrubs on rooftops, while in reality, only low vegetation can grow there due to limited roof load capacity and cost constraints. Beautiful designs may be presented, but when budget calculations are made, the elements often fall away. “And then it quickly disappears, but remains visible in the images.”[29] – respondent 13. The gap between imagery and reality fuels the greenwashing discussion. For the concept of The Dutch Mountains, a developer was sought who dares and is able to realise the ambitions, so that the plans do not remain mere illusions. The example of The Dutch Mountains shows how strong policy can have real impact. The developer will only proceed with the project if timber construction is permitted by the municipality. However, an existing substation, on the planned site, caused years of delay. Sustainability is also a matter of infrastructure and timing.

From the start, sustainability has been one of the core values within the MMK. In collaboration with partners such as Movares, these goals have been translated into a measurable approach, including the mapping of CO_2 emissions and material use. Some sustainability goals are known in advance to have a negative impact. “So what you can mainly do then is to minimise the impact.”[30] – respondent 10. At the same time, climate adaptation offers opportunities for improvement. The process begins with a wide range of options, which are gradually narrowed down to the most feasible alternatives. To ensure the MMK plans are realistic, extensive research and calculations are conducted. Whether minimal or maximal ambitions are ultimately chosen depends on the final design variant. There are currently several models in circulation, which are assessed using an evaluation matrix that also includes sustainability objectives. The decision is thus made integrally and with care.

[26] ''Het gedeelte van de duurzaamheidsdoelen, komt steeds meer naar de voorkant toe. Ontwikkelaars zien ook dat er echt iets mee moet.'' – respondent 9
[27] ''En nu zie je alweer dat ervan afgesnoept is.'' – respondent 9
[28] ''Het hoort ook bij verdichten, dat je ook vergroent.'' – respondent 4
[29] ''En dan sneuvelt het toch al snel, maar blijft het wel in de plaatjes staan.'' – respondent 13
[30] ''Dus hetgene wat je dan kan doen is vooral het minimaliseren van de impact.'' - respondent 10

Trefpunt Groen Eindhoven (TGE) responded critically and constructively to the KnoopXL plans in 2019. They expressed concerns about the economically driven nature of the vision and advocated for fair representation of all stakeholders, including nature and existing residents. TGE argued that the core ambition of KnoopXL, a liveable, sustainable, and healthy city, is too often subordinated to economic growth, warning against unchecked densification without clear boundaries.

Social sustainability is just as often presented as green sustainability, but here too, scepticism is voiced. “Social sustainability is a bit like greenwashing. Everyone says they want it. But when push comes to shove, well. As long as I and people like me are doing okay, that’s enough.”[31] – respondent 15.

Eindhoven has a clear green ambition and is making significant strides, partly due to the political majority of GroenLinks. However, vigilance is needed to ensure that sustainability does not devolve into appealing images without real impact. Greenwashing lurks, particularly where ambition and reality are still far apart. Only through strict assessment, integrated governance, and political decisiveness can the city's green promises truly be realised.

Stakeholder group	Perspective ‘Greenwashing’
Government	Municipality aims to prevent greenwashing via strict KPIs and policy enforcement. All government stakeholders acknowledge tensions between ambition, reality, and competing land uses, advocating clear, enforceable policies to prevent symbolic greening and ensure substantive environmental gains.
Private sector	Genuinely invest in sustainability. Affordability vs green demands is a challenge.
Fellenoord development manager	Recognizes greenwashing risk but commits to real sustainability in KnoopXL. Emphasizes collaboration with experts to create realistic, measurable sustainability outcomes
Community	Sceptical about green visuals versus actual implementation but there is also trust in green visuals.
Experts	Warn of greenwashing driven by legal compliance, reputation, or profit. Stress systemic, measurable, long-term approaches. Emphasize need for political courage.

Table 5 Stakeholders’ perspective ‘Greenwashing’

[31] 'Sociale duurzaamheid, het is een beetje vergelijkbaar met greenwashing. Iedereen zegt dat we dat willen. Als het puntje bepaald komt, nou ja. Als ik en mijn soort het maar goed hebben, is het oké.'' – respondent 15

5.3. Stakeholder Dynamics and Power Relations

In 2022, shortly after the installation of a new municipal council, the issue of Fellenoord's area identity appeared on the political agenda, but the decision regarding the project organisation was postponed for a more thorough process. Since then, the council has been closely involved through the KnoopXL council committee, where the project's progress is discussed. The Fellenoord area vision, adopted earlier, serves as the foundation for ongoing elaborations such as cluster passports. However, this vision was adopted relatively easily, which has now limited the room for steering. The city council mainly exerts influence over general direction and strategy. Technical and spatial details are filled in by urban designers and project developers, while the council plays a supervisory role based on established frameworks like KPIs. Although initially intended for internal use, the council insisted on reviewing cluster passports to assess whether zoning plans aligned with policy. On Fellenoord's southern side, this level of governance was missing. Projects like Lightyards and EDGE transitioned from office to residential functions without early steering on quality and green space.

Due to limited space and resources, various interests come under pressure. "You don't get a solution that works for everything and everyone." – respondent 17. Within the playing field of KnoopXL, there are diverging visions. Some stakeholders push for more ambition, while others prefer to preserve the existing situation. Ultimately, a compromise is necessary. "Every square meter is basically contested." – respondent 9. This tension requires constant coordination between stakeholders and also political support and legislation play a central role in this.

The municipality, supported by the province and the national government, has acquired substantial land through the Right of First Refusal Act, which has allowed it to take a more proactive role. The establishment of Fellenoord B.V. in March 2024, a joint venture between the Municipality of Eindhoven and the Province of North Brabant, each holding 50% ownership, marks a new phase. This public-public partnership is relatively rare. The primary task of the B.V. is to elaborate the development vision and KPIs for Fellenoord, as previously established by the council. The shareholders retain their public responsibilities, while the B.V. offers executive power at close range. Administratively, the province plays a slightly more distant role despite holding equal shares. Since this concerns the city of Eindhoven, the ultimate political influence lies primarily with the municipal council and the executive board. Elections can lead to policy shifts, which strengthens the role of the municipality.

As the Dommel river flows through the area, the water authority is directly involved. Together with the municipality, it translates policy into firm requirements using a calculation tool that obliges developers to implement concrete measures for water retention and greening. "It's about conveying that urgency and activating the initiator or developer." – respondent 9. When water-related ambitions appear infeasible, the municipality and water authority work together to find solutions. "The water board cannot do it alone, the municipality cannot do it alone. You really have to work together, integrate everything." – respondent 9.

Sustainability ranks high on the agenda for all parties. Nonetheless, debates have emerged concerning the level of ambition and the knowledge base within working groups. "We already have a considerable ambition because we have established both minimum and maximum targets for sustainability themes." – respondent 7. In such processes, it is crucial to keep

returning to the bigger picture, especially when the project is still in an early phase. It proved essential to communicate on the same level of abstraction in the early stages. Some parties focused on details too early. Maintaining focus on broad decisions was necessary. Communication between client and contractor needed to evolve, after which mutual understanding improved over time. Working across municipal departments proved challenging and required intensive coordination and collaboration to align interests. The creation of the B.V. is expected to contribute to quality improvements and to safeguarding the area development narrative, though this still requires discussion and learning. The spatial framework serves as the guiding structure for public space, real estate, and green networks. Urban planners and landscape architects elaborate this further.

The KnoopXL project area comprises 55 hectares and is divided into northern and southern sections. The northern section Fellenoord, consists of eleven development clusters, each with its own cluster passport. These passports contain a comprehensive set of KPIs that developers must meet. Multiple landowners within a cluster may have conflicting interests. Larger owners possess greater negotiation power. This sometimes results in tensions or attempts to buy out smaller owners. High ambitions are sometimes challenged by financial feasibility and the need for phasing. "These are the kinds of puzzles that come with the territory." – respondent 4. The southern section is now further along in development, with Fellenoord progressing in clusters.

Developer AM acquired the former post office and initiated the Lightyards development, initially an almost entirely commercial office project. In collaboration with the municipality, this was adjusted. Two plots were designated for housing as part of a mixed-use strategy and in response to the housing shortage. It was AM's task to create a viable business case, even though that is a challenging endeavour. "It has all kinds of complications, and quite a history." – respondent 8. In the early stages, AM and the municipality explored what was spatially feasible and what needs existed. "That's how you work from rough to fine." – respondent 8. Cooperation with the municipality was intensive and took place step by step, from urban design possibilities and concrete agreements about housing sizes, greenery, and sustainability, to issuing a permit to begin construction. "It always really goes hand in hand." – respondent 8. EDGE was also approached by the municipality with the request to realise a mixed-use project. Through constructive collaboration, a design has emerged that meets municipal requirements and remains financially feasible for the developer. Despite objections and legal challenges from local residents, the collaboration between municipality and developer remained strong.

Collaboration also occurred between the municipality, the province, the national government, and consultancies, for instance through the MIRT process for the rail and station area. The MIRT exploration provides a structured approach for such large-scale developments. The development of the MMK primarily focuses on urban sustainability. It emphasises good public transport accessibility and an efficient spatial layout. Sustainability is approached from multiple perspectives, including energy use, greenery, water management, and urban structure. Movares provides advice on the practical translation of these sustainability goals. At the same time, sustainability proves to be a diffuse concept in practice, subject to different interpretations and interests. "Sustainability is just a black box." – respondent 17. This regularly leads to tensions. Achieving sustainable goals may conflict with spatial preferences, involve higher costs, or clash with regulations and differing policy views. "Some parties want to take an extra step, others don't

see the need." – respondent 17. Tensions with stakeholders remain possible, for example concerning spatial integration. The municipality attempts to mediate, but coordination requires extensive dialogue.

APPM collaborates with the municipality and the province on spatial and mobility developments for KnoopXL. The MIRT exploration is carried out by a consortium consisting of Movares, Team V, and KCAP. APPM guides this process on behalf of the client and monitors the consortium's direction. Arcadis, an engineering and design consultancy, was previously involved in the MMK project's pre-exploration phase and provided input to get the project on the MIRT list. During this phase, Arcadis developed alternative spatial scenarios, including the layout of the bus station. The firm also designed the Dommel Passage: a wide underpass beneath the Dommel, featuring a new station entrance, retail amenities, bicycle parking, and a canopy. Arcadis primarily focuses on design and infrastructure. Movares is an engineering firm that operates based on public tenders. For KnoopXL, the firm participated in a tender and submitted a proposal balancing approach and price. Movares is involved in both the rail hub and the MMK. Within the consortium, the collaborating parties jointly strive for successful project implementation.

Collaboration between academia, developers, and government is important, but the appropriate form for this is still being sought. Eindhoven University of Technology (TU/e) has not yet been formally involved, but discussions are ongoing regarding student projects within KnoopXL.

An expert highlights that while collaboration between municipalities and developers is intensive, municipalities often hold a weaker negotiating position, especially in urgent housing contexts. This can lead to concessions that compromise original ambitions. A more assertive approach, setting clear preconditions and keeping municipally led development as a credible alternative, can help strengthen their leverage.

Stakeholder group	Perspective 'Stakeholder Dynamics and Power Relations'
Government	Holds formal political power and land. Municipality leads decision-making with provincial partnership. Water Board enforces water-related policies requiring cooperation. Governance is complex, requiring intense coordination across departments and levels. Political shifts affect priorities. Struggles with balancing competing interests and ensuring stakeholder alignment.
Private sector	Holds strong negotiation power. Collaboration with municipality can be constructive but also involves compromises on ambitions. Financial feasibility often shapes decisions.
Fellenoord development manager	Acts as executive entity managing development with delegated powers from municipality and province. Facilitates integrated vision and KPI enforcement. Expected to improve coordination and quality control, though learning and negotiation are ongoing.
Community	Scepticism about transparency and true involvement in decision-making
Experts	Play advisory role, providing knowledge and scenario analyses. Highlight challenges in communication and alignment, noting sustainability as a complex and sometimes vague concept.

Table 6 Stakeholders' perspective 'Stakeholder Dynamics and Power Relations'

5.4. Market Forces and Economic Pressures

Within the area development, conscious efforts are made to design plans that are resilient to market fluctuations. The area development of KnoopXL spans approximately 25 years. A stable financial foundation is therefore essential. The province and municipalities have received substantial funding from the national government, including through the Housing Construction Incentive (Woningbouwimpuls) and acceleration funds. The latter are broader than housing alone, they also include mobility measures. This ensures that new housing is accessible and can be realised more quickly.

Infrastructure projects such as MMK are only possible due to financial agreements between the national government, the province, and the municipality. These involve multi-billion-euro investments, partly financed through the Brainport and Beethoven deals and MIRT explorations. One of the national government's conditions was that housing developments must take place in proximity to the junction. Sustainable mobility requires large-scale thinking and long-term investment. MMK and KnoopXL are core components of Project Beethoven, which focuses on facilitating regional growth through investments in infrastructure, housing, and amenities.

A Social Cost-Benefit Analysis (MKBA) was also conducted as part of the MIRT exploration. Initial calculations point to the financial infeasibility of the complete plan. Alternatives are now being explored without compromising on quality. Movares is drafting an "objective achievement memorandum" in which all alternatives are assessed on criteria such as sustainability, environmental impact, transport value, spatial quality, and with financial feasibility as a key factor. Financial considerations weigh heavily because the commissioning authority, the Municipality of Eindhoven, has limited resources. As a result, the best option must be found within the available budget. The goal is to identify a solution that contributes as effectively as possible to all objectives within financial constraints.

The private limited company carries out the area development for Fellenoord within established financial parameters. In the case of financial setbacks or windfalls, this is discussed with the shareholders, the province and the municipality. Ways to incentivise developers are being explored. Although the development company does not build itself, it does make agreements with private parties. A requirement of 85% affordable housing reduces land value, as developers are then able to realise less profit. The province compensates for this difference in order to make the affordability ambition feasible. The business case must be balanced. Deficits are shared by the shareholders, and financial risks are calculated and recorded in advance. This is done according to strict accounting standards: determining when risks must be activated, how large the reserves must be, and how rising costs are to be absorbed. The financial consequences of risks projected over, for example, 20 years, must already be available today in the reserve. Market parties also bear financial risks, particularly in relation to bank financing.

Project developers have to sold 70% of the homes before construction can begin. In an unfavourable economic climate, such as in 2023, this proved difficult. The Ministry's Housing Construction Incentive provided a solution in such cases. "And that was actually an important factor in being able to start."[32] – respondent 8. The subsidy is intended to revive housing projects

[32] ''En dat is ook wel een belangrijk puntje geweest om van start te kunnen.'' – respondent 8

that are at risk of being halted due to changing economic conditions. The challenge of maintaining housing affordable demands flexibility in housing strategies. It is likely that primarily rental housing will be realised in KnoopXL. This is because developers must sell 70% in pre-sales, after which it still takes several years before the homes are actually built. “People don’t want to wait that long.”[33] – Respondent 11. Housing associations can contribute to lasting affordability, as they are not required to sell homes at a profit. Still, not all rental housing can be considered affordable. “I would argue that a lot of rental housing is simply not affordable.”[34] – Respondent 15.

Another financial instrument for developers is the “green compensation system” applied by the municipality. If developers do not meet the green ambitions, a penalty of €230 is imposed per square meter of missing greenery. “It now looks like one development may have to compensate financially for up to two hundred thousand euros. “Then you have to recalculate your entire plan.”[35] – respondent 13. This money must then be used by the municipality to finance additional greenery, not to fund measures already planned.

The tension between public interest and financial feasibility also arises in relation to the water board. Although they do not pursue profit, their requirements, such as spatial claims for water retention, can reduce buildable volume, which means that developers can construct fewer homes. Ideas are emerging for a local purification system per building. However, the system entails maintenance costs, which would have to be distributed among the residents. This makes housing somewhat more expensive.

The Dutch Mountains project currently appears financially feasible, due to high rental prices, which cover construction costs. However, if the market shifts, due to war, for instance, or falling rents, the project could still become financially unviable. In the design phase, optimisations were sought, such as reducing the amount of glass and applying modular construction, in order to keep costs under control.

The long-term effects of sustainable construction are often underweighted due to diverging interests. Project developers primarily focus on initial investments and derive no benefit from lower maintenance costs in the long term if the homes are sold. Housing associations, on the other hand, do take this into account. The affordability requirement is only assessed at the outset, without any long-term guarantees. Especially in the case of owner-occupied homes, the value often rises faster than incomes, making affordable housing inaccessible to the target groups for whom the homes were originally intended. Over time, the value of these homes increases along with general market developments, independent of the original price or the sustainable nature of the building. This underlines the importance of ongoing regulation or ownership by housing associations as a tool for safeguarding long-term affordability.

An expert also points out that the affordability bottleneck often lies in the stacking of profit margins. Developers, lenders, contractors, and other stakeholders in a construction project all

[33] ''Daar willen mensen niet op wachten.'' – respondent 11
[34] ''Ik zou zelf beweren, heel veel huur is niet betaalbaar.'' – respondent 15
[35] ''Het ziet er bijvoorbeeld naar uit dat één ontwikkeling voor misschien wel twee ton financieel moet compenseren. Dan moet je weer helemaal je plan opnieuw gaan doorrekenen.'' – respondent 13

seek a return. “All those small margins really add up.”[36] – respondent 15. This drives up prices, even though affordability is often the starting point.

In addition, there are discussions about the potential need for a new unit of calculation, in which primary valuation is based on “carbon equivalents” rather than euros. This concept is already being experimented with at TU/e.

Stakeholder group	Perspective ‘Market Forces and Economic Pressures’
Government	Provides substantial funding and financial guarantees (e.g. Woningbouwimpuls, acceleration funds). Balances ambitions with budget constraints. Uses financial instruments like green compensation. Strong role in risk sharing and subsidy provision to stimulate development despite market fluctuations.
Private sector	Faces strong market pressures, requires 70% pre-sale to start construction, which can be difficult in weak markets. Profit margins under pressure due to affordability requirements and green ambitions. Developers bear financial risks linked to financing and market conditions.
Fellenoord development manager	Manages development within fixed financial frameworks. Explores incentives for developers. Must ensure financial feasibility while pursuing public goals.
Community	Rental homes are more common but not always truly affordable. Rising housing values make ownership inaccessible for target groups. Maintenance costs of sustainable systems can increase expenses for residents.
Experts	Highlight the complexity of balancing financial feasibility with sustainability and affordability. Point out hidden cost layers (“stacking of margins”) that drive up prices. Explore innovative valuation methods (e.g. carbon equivalents) to better align economic and environmental goals. Emphasize need for long-term perspectives in financing.

Table 7 Stakeholders’ perspective ‘Market Forces and Economic Pressures’

[36] ''Al die kleine marges tellen behoorlijk op.'' – respondent 15

5.5. Technological and Design Innovations

The rapid pace of technological development presents a constant challenge. Should one wait for the next innovation or proceed decisively? Although Eindhoven is known as a frontrunner in high-tech innovation, striking technological applications and design innovations within the KnoopXL project are still largely absent at this stage. “That is indeed the ambition. But it has not yet been realised.”[37] – respondent 7.

The location within the Brainport region accelerates processes and increases the national impact of the project. At the same time, innovative challenges arise due to complex contextual conditions. For instance, the traffic circulation plan focuses on a low-traffic city centre that prioritises space for cyclists and pedestrians. The underground bus station poses technical challenges due to the wet subsoil but simultaneously creates opportunities for real estate development, urban greening, and a high-quality public realm. High-rise buildings up to 150 metres are necessary due to the limited space, resulting in an entirely new urban skyline within twenty years. “How ‘Eindhoven’ will it be? What makes something truly Eindhoven?”[38] – respondent 4. High-rise development also brings wind-related issues. Therefore, at the Social Hub, the use of a PowerNest is being planned, an Eindhoven-based innovation that combines solar and wind energy to generate sustainable power.

Significant sustainability measures are being implemented to realise MMK. Eindhoven Station is one of the sixt largest stations in the Netherlands. Much concrete is still visible in the area. As a result, new sustainable plans are being developed. “That a plane could land there. That’s honestly kind of bizarre.”[39] – respondent 16. The decision to construct an underground bus station was based on considerations of safety, traffic flow, and spatial quality. Three alternatives were investigated: at ground level, underground at the current location, and fully underground and even beneath the railway tracks. The ground-level alternative proved infeasible due to 200–300 buses per hour and potential conflicts with pedestrians. The underground alternative provides better distribution of bus traffic through tunnels and aligns more closely with the ambition for a high-quality MMK. Thanks to national Brainport and Beethoven agreements, the underground version is financially viable.

The Dommel currently represents a bottleneck due to a narrow tunnel beneath the railway. The city is visually and physically divided. “The city is split in two by the railway.”[40] – respondent 16. With the vision of a wider, green passage, daylight via skylights, and a new station entrance, efforts are underway to restore the urban connection. Sustainability can also be used smartly in this context. Water from the underground bus station can be naturally discharged via the Dommel Valley, while impervious surfaces are reduced as much as possible and bioswales are implemented. “So many homes and so much concrete are being added to this small part of the city. Serious investment is needed in this green lung.”[41] – respondent 16. Technological innovation can also be explored in design details, such as in the Dommel Passage. Here, green

[37] “Dat is wel de ambitie. Maar hij is nog niet waargemaakt.” – respondent 7
[38] “Hoe Eindhovens wordt het? Wat maakt iets dan Eindhoven?” – respondent 4
[39] ''Dat daar een vliegtuig kan landen. Is eigenlijk natuurlijk super bizar.'' - respondent 16
[40] “De stad is in tweeën gedeeld door het spoor.” – respondent 16
[41] ''Er worden zoveel woningen en zoveel beton eigenlijk toegevoegd aan dit kleine stukje stad. Je moet gewoon echt investeren in deze groene long die daar loopt.'' - respondent 16

banks could be created in low-light conditions using special LED lighting that simulates daylight, potentially in collaboration with local tech companies. Although not yet implemented, this technology has already been used successfully in Eindhoven, including at Eindhoven Station, an illustrative example of how technology and design can go hand in hand in this Brainport city.

An example of a smart yet simple innovation can be found at The Dutch Mountains. Instead of complex ventilation systems, natural ventilation is preferred. “People should simply be able to open a window.”[42] – respondent 5. A typical Eindhoven innovation is the carrier-infill system, which enables modular construction and ensures buildings remain adaptable. The original ambition for circular construction at The Dutch Mountains proved infeasible, but there is still significant emphasis on biobased construction and natural principles, such as the chimney effect within the timber atrium. This provides energy-efficient airflow and a healthy indoor climate without heavy installations. Additionally, semi-transparent solar panels are being considered, the indoor garden will be irrigated with reused rainwater, a mobility system with charging points will be developed, and a large bicycle parking facility is being planned. “A bicycle parking facility from here to Tokyo.”[43] – respondent 5. EDGE implements smart energy concepts such as a central serra ventilation system and a shared aquifer thermal energy storage (ATES) installation, leading to efficient heat recovery. The residential and office buildings also share a parking garage, saving both space and materials. Lightyards combines energy performance with social quality. Through the use of lightweight partition walls, apartments remain flexibly adaptable. The project meets Nearly Zero Energy Building (BENG) standards but places more emphasis on energy conservation than on generation. With an ATES system, heat recovery, and excellent insulation, developer AM prioritises user comfort and sustainability. AM places greater emphasis on social quality and resident comfort than on maximising technical sustainability indicators. “It’s always about finding a balance.”[44] – respondent 8. There has been technical progress on the construction side, partly driven by regulations such as the Environmental and Building Decree (Besluit Bouwwerken Leefomgeving). Developers like EDGE aim for high sustainability ratings, such as BREEAM++++.

In the MMK project, few innovations are currently visible as the plan is still in its early stages. Innovation here primarily concerns material choices and the execution phase. “A part of that innovation lies simply in making the right choices early on.”[45] – respondent 10. At the outset, research was conducted into which materials could be reused. Although reuse within the site proved difficult, materials have been reused elsewhere. An energy analysis was also conducted, which included energy demand, generation, and storage, including space for a battery.

In the absence of formal policy for nature-inclusive building, the municipality stimulates solutions that combine greenery and water through climate challenge calculation tool. At this point, most inspiration comes from the municipal green department. Points are awarded for elements such as nesting boxes, and the tool rewards solutions that combine green and water with additional points. Expansion towards biodiversity measures is currently in preparation.

[42] “Mensen moeten gewoon een raam kunnen openzetten.” – respondent 5
[43] “Een fietsenstalling van hier tot Tokio.” – respondent 5
[44] “Het is altijd zoeken naar een balans.” – respondent 8
[45] “Een deel van dat innovatieve zit gewoon in vroeg een goede keuze maken.” – respondent 10

At the same time, tensions emerge between different sustainability goals. Vertical forests and residential towers with trees contribute to biodiversity and mental health but lead to CO2 emissions because of the concrete use. The same applies to the underground bus station. It comes with high environmental costs due to the use of concrete but it provides long-term benefits through sustainable mobility.

Stakeholder group	Perspective 'Technological and Design Innovations'
Government	Encourages sustainable innovations and climate adaptation tools. Supports nature-inclusive building and greening initiatives. Balances trade-offs between environmental impact and urban development (e.g., underground bus station vs. concrete use). Drives projects that improve public space, connectivity, and sustainability in line with Brainport ambitions.
Private sector	Adopts advanced sustainability standards. Focuses on flexible, efficient designs such as shared parking, smart ventilation, and energy use optimization. Balances innovation with financial viability and resident comfort. Explores modular and biobased construction while managing regulatory demands
Community	Technology shapes Eindhoven's identity.
Experts	Highlight complexity in choosing innovations given technical, environmental, and financial constraints. Stress early decisions on materials and energy analysis. Emphasize innovative combinations of technology and design and the need to balance competing sustainability goals.

Table 8 Stakeholders' perspective 'Technological and Design Innovations'

5.6. Communication and Transparency

In the development of KnoopXL, communication and transparency play an essential role. Engaging the right stakeholders at the right time and with clear information has proven to be a practical challenge. The participation processes vary across subareas. For example, the procedures surrounding Fellenoord progressed relatively smoothly, partly due to the limited presence of conflicting interests. On the southern side, however, there was more resistance from the local environment, resulting in a greater number of formal objections. People can stay informed by following the latest updates published on the 'KnoopXL' website. Interested parties can also subscribe to a newsletter. Additionally, the 'OpenEindhoven' website presents how the planning area is divided, which projects are part of it, and what these projects entail.

A recurring signal is the desire for earlier and broader participation. Residents and other stakeholders would prefer to be involved before plans are too far advanced. This means that participation in future cluster passports must be structurally integrated and more robustly organised. Placemaking efforts are increasingly seeking conscious ways to engage residents. Initially, this was still too limited. The municipality is progressive in the field of participation, but even here it remains a learning process. “They are really afraid of risks, or of making commitments, or whatever it is.”[46] – respondent 6. Transparency about what has been fixed and where there is still room for influence remains a sensitive issue.

During participation events, expectation management is crucial. Participants must understand what has already been decided and on which aspects their input can still make a difference. The development vision is already established and forms the framework within which new plans are elaborated. Aspects such as building height or location are usually fixed unless there are compelling new insights. Participation is a chance to contribute to the elaboration and detailing of plans. At the same time, the municipal participation process is still under development. A communication team will be set up to take responsibility for shaping the participation process. However, this participation process is still in a testing and developmental phase.

A major challenge is reaching the right audience. Currently, only around 200 people live in the Fellenoord area, which is expected to increase to approximately 15,000. Many future residents are currently unknown or have not even been born yet. There is active involvement from businesses, offices, educational institutions, and banks. Nevertheless, engaging the broader environment is crucial, as the project will have an impact on a large part of the city. During the implementation phase, there will be disturbances, such as roadworks, detours, and noise pollution. Clear communication will then be essential, not only for residents but also for entrepreneurs and road users. For instance, detours can change visitor flows, which may negatively affect businesses. During the development process, objections can be filed. In the past, this has already caused delays to several projects, such as Lightyards and EDGE. “We had the honour of appearing before the Council of State, we weren’t happy about that.”[47] – respondent 8. The procedure against EDGE even lasted more than three years, which led to rising construction costs. “As a result, the project came under even more pressure.”[48] –

[46] “Dan zijn ze heel bang voor risico’s of toezeggingen of weet ik veel wat.” – respondent 6.
[47] “Wij hadden de eer om naar de Raad van State te mogen, daar zijn we niet blij mee.” – respondent 8
[48] “Waardoor het project eigenlijk nog meer onder druk kwam te staan.” – respondent 14

respondent 14. Some objections have little legal merit, but are nevertheless intended to delay the plans. Often, the complainants have no legal case, but do everything to cause maximum delay.

Sometimes, participation begins too late, because developers have already made significant design progress, signed agreements with financiers, and left little room for public input. This makes it difficult to take residents' contributions seriously. The COVID-19 pandemic also had an impact because information meetings were cancelled. The alternative for one developer was an online meeting, which was a complete failure. "We had planned it on a large scale, but in the end, only three people called in."[49] – respondent 14. Another issue is that participation processes are difficult to sustain in long-term area developments. People lose motivation when they do not see tangible results.

Various stakeholders, such as residents, businesses, travelers, and organisations, were involved in the MMK participation process. ProRail conducted a survey, and participation events were organised for the broader area surrounding the station. AM Concepts sought input from real estate agents and the local community about their vision for the project. EHVXL, an association committed to spatial quality, was also involved in the participation process. Together with other parties, they reflected on documents of the municipality. "And we gave a fairly serious response."[50] – respondent 6. The municipality then indicated how their feedback was addressed. Nevertheless, there was also criticism. Meetings were often organised during the day, which posed difficulties for working people and students. The participant was limited to a small group, and there was a desire to also include other parties. The volunteers who participated in the process felt disappointed, as they invested a great deal of time and energy in providing feedback but felt that their feedback was no longer taken seriously. As a result, EHVXL decided to organise their own participation process, separate from the municipality. "As long as you have a strong enough base, and especially on social media, we have enormous reach."[51] – respondent 6. Thanks to their connections with city council members, they were still able to exert influence during council meetings.

The process of KnoopXL illustrates the importance of a timely, clear, and inclusive approach to communication and participation. Only then can objections be avoided, support be increased, and plans made truly future-proof.

Stakeholder group	Perspective 'Communication and Transparency'
Government	Desire to a timely, clear, and inclusive communication, embed structural participation early, improve expectation management and broaden stakeholder reach.
Private sector	Sensitive to objections causing project delays.
Community	Desire earlier and broader involvement, criticize limited influence
Experts	Stress importance of early and meaningful participation.

Table 9 Stakeholders' perspective 'Communication and Transparency'

[49] "We hadden het heel groot opgezet maar er waren uiteindelijk maar drie mensen die hebben ingebeld." – respondent 14
[50] "En daar hebben we een vrij serieuze reactie op gegeven." – respondent 6
[51] "Als je maar genoeg achterban hebt en zeker op sociale media hebben we een enorme uitstraling." – respondent 6

5.7. Influence of factors on the relation between greenwashing and balance

5.7.1. Relation between greenwashing and the balance between sustainability and affordable housing

There is a tension between building affordable housing and aiming for ambitious sustainability goals. This tension increases the risk of greenwashing. These two goals are closely linked because strict affordability requirements can limit the feasibility of truly sustainable measures. As a result, developers may resort to symbolic "green" solutions that have little real impact.

This issue becomes particularly visible in Eindhoven's KnoopXL area development. The city's ambition to create a future-proof, sustainable urban environment, with attention to green spaces, water management, mobility, and energy, clashes with political goals that demand 85% of the housing be affordable. For developers it is financially challenging to realise this combination, which puts real sustainability at risk of becoming more of a façade than a fact. Renderings and visualisations often show a greener picture than what is actually delivered, fuelling concerns around greenwashing.

To address this, the municipality of Eindhoven tries to anchor sustainability in a measurable way, by including KPIs in permit requirements, for example through the cluster passports for the Fellenoord area. Similarly, the MMK project explores preferred sustainable alternatives using concrete, measurable indicators. However, the compensation mechanism for developers still exists as a potential loophole, meaning that the door to greenwashing is not fully closed yet.

5.7.2. Influence Stakeholder Dynamics and Power Relations

Residents and potential users are only marginally involved in the KnoopXL development, whereas public and private stakeholders have substantial control over the project's course. This leads to conflicts because affordability and inclusive interests are marginalised while sustainability can occasionally become a prestige tool. This raises the possibility of greenwashing. The variety of stakeholders involved also brings diverging interests to the table, making the decision-making process even more complex. In addition, the City of Eindhoven has made a political commitment to keep 85% of its housing stock affordable. This means that while it is still a significant challenge to keep this balance in practice, the project aims to achieve a happy equality between the inherent need for affordable housing and green and sustainable aspirations.

5.7.3. Influence Market Forces and Economic Pressures

High land prices, profit-driven expectations, and rising construction costs are significant barriers to the development of affordable housing. Sustainability is frequently positioned as a value-add sales pitch, as sustainable practices are still often perceived to be a cost burden. No doubt sustainability objectives remain important for branding purposes and public opinion, but developers sometimes limit their efforts to a few sustainability aspects to save costs. Some projects are branded "green" even when most of the sustainability features implemented are

only documented or symbolic. This does not appear to be the case in KnoopXL because of strict requirements from the municipality.

5.7.4. Influence Technological and Design Innovations

Although Eindhoven actively fosters technological innovation as a Brainport city, the KnoopXL development does not yet fully reflect this goal. Sustainability could become more intelligent and possibly more economical with the help of innovations. Many of these technologies are still experimental or relatively costly, increasing the challenge of affordability, and in addition, they may also be technically challenging or not scalable, meaning that the main objective of these is to promote the project rather than actually do anything.

5.7.5. Influence Communication and Transparency

Although there is currently a desire to better organise the participation process in future projects, participation in the KnoopXL project has been fragmented and frequently started too late. It is more difficult to gain support for important decisions pertaining to affordability and sustainability when residents are only involved late in the process. In order to promote understanding and ensure a fairer balance between disparate interests, transparent communication is essential. Glossy green images can contribute to the perception of greenwashing if the process is unclear and untrustworthy, particularly when it is unclear how sustainable particular decisions are.

5.8. Discussion

The KnoopXL case confirms the theoretical insights on the challenges of sustainable urban development, as described in the literature (Elkington, 1998; Delgado-Baena & Sianes, 2024). The project clearly shows the tensions between sustainability and affordability. Although ambitious sustainability KPIs have been set (through cluster passports), financial feasibility often takes the lead. This supports the criticism that the Triple Bottom Line principle is not fully applied in practice (Harvard Business Review, 2018). The factor ‘Market Forces and Economic Pressures’ was strongly supported. It creates financial constraints, high land prices and construction costs limit developers’ ability to implement deep sustainability, often leading to symbolic or superficial “green” measures to balance costs and branding.

KnoopXL also highlights the risk of greenwashing, where sustainability becomes a vague, multifunctional term without a clear definition. This relates to the warnings of Lupinu and Machura-Urbaniak (2024), who argue that unclear sustainability goals can actually hold back progress. The political push for affordability (85%), although socially motivated, acted as a structural constraint on achieving deep sustainability goals, highlighting how policy goals themselves can inadvertently drive greenwashing behaviour.

In terms of governance, KnoopXL reflects the complex power dynamics and division of roles between the municipality, developers, and other stakeholders, as described by Ba (2021) and

Delgado-Baena & Sianes (2024). The creation of Fellenoord B.V. as a public-public partnership is an innovative step to bring implementation closer to political control. However, the influence of major landowners remains a challenge when it comes to making the process more inclusive. Collaboration with other public bodies, such as the regional water authority, shows how important integrated governance is (Mersal, 2016), but also reveals how difficult coordination becomes when different interests collide. The factor 'Stakeholder Dynamics and Power Relations' was clearly supported. It shows a power imbalance where public and private actors dominate decision-making, marginalising residents and affordable housing interests, which increases the tension between sustainability ambitions and affordability, increasing greenwashing risks.

Technological and design tools, like the cluster passports, MMK and Dommel Passage, play a role in making sustainability goals more concrete but it was still limited in the project of KnoopXL. This aligns with the work of Al-Emran & Griffy-Brown (2023), who emphasise that successful technology adoption requires understanding user needs, overcoming barriers, and ensuring acceptance to truly enhance sustainability. The factor 'Technological and Design Innovations' was partly supported. It was recognised but not fully realised in KnoopXL. Innovations remain costly or experimental, limiting their role in bridging affordability and sustainability despite Eindhoven's high-tech identity.

Wang & Chan (2019) emphasise the importance of involving residents early in the planning process through clear communication and education to foster meaningful participation. However, the factor 'Communication and Transparency' was strongly supported. Yet it remains insufficient. Participation often starts late and is fragmented which reduces stakeholders' influence and fosters mistrust.

In conclusion, the case study clearly demonstrates the importance of political continuity and commitment to sustainability targets. When political processes change at a city council level it can influence ambition and introduce a tension into sustainability goals (Elkington, 2018).

In general, KnoopXL displays many of the challenges that have been seen in the literature but also illustrates how new ways of governing and working closely together lowers or eliminates barriers to use the challenges to achieve urban sustainability. It is evident that clearly articulated roles, transparency and regular involvement of all key actors are essential to achieve meaningful urban sustainability.

6. Conclusion

6.1. Answering the research question

6.1.1. Sub question 1

'How do stakeholder dynamics and power relations shape the balance between sustainability and affordable housing in the KnoopXL project?'

The interactions between stakeholders play an important role in determining the outcome of the balance between sustainability and affordable housing in the KnoopXL project. Stakeholders, the municipal council and project developers, representatives from the province, civil society organisations and consultants, all have different motives or interests, priorities and degrees of influence, which continually create negotiating spaces and trade-offs.

The municipal council mostly plays a framing and supervisory role and clearly kept a distance from the execution of the project. As a result, their direct influence on aspects like housing quality or sustainability requirements is somewhat limited. However, the council can still exert pressure, for example, by taking a stance on cluster passports or by steering through area-wide KPIs. At the same time, some decisions, like the adoption of the area vision in a previous council term, were made quite quickly. This limits room for adjustment now, especially as political preferences evolve.

What also stands out is the strong role of developers, such as AM and EDGE, in shaping and realising the plans. Even though they work closely with the municipality, they still operate within the boundaries of financial feasibility. This means that ambitions around (social) sustainability, like affordable housing and sustainable measures, often come under pressure. A good example is the shift seen in Lightyards and EDGE Eindhoven. Both were initially designed as office developments, only later partially converted into residential projects in response to the housing crisis. This reflects how market logic and project history often lead the process, with policy interventions arriving afterward.

Sometimes stakeholders also observe conflicting priorities within the different departments of the municipality. This makes it hard to create a fully integrated, future-proof urban design. The creation of Fellenoord B.V., a public-public collaboration between the municipality and the province, is seen as a step toward gaining more control over implementation and protecting the story behind the area's development. Still, it is an ongoing learning process where alignment, consistency, and governance remain crucial.

Civil society actors, such as TGE, are vocal critics of how social-sustainable goals are being embedded in the project. They argue that economic interests still dominate the conversation. TGE calls for stronger commitments to things like climate adaptation, circularity, and nature-inclusive building. Their critique supports the idea that sustainability is not just technical or spatial, but also social in the sense that we maintain healthy, inclusive, and accessible living environments.

A second major consideration is the constantly shifting legal and policy environment. There will always be some new legislation which may create potential opportunities. However, with a

change in regulations it will continually add difficulty to keep the focus on long-term goals that are in an ever-moving context. Elections can lead to policy shifts and require continuous renegotiation to determine the balance between sustainability and affordability.

There is also a clear tension between ambition and feasibility. Even though the parties involved in the MMK framework are aiming high, with minimum and maximum targets on themes like water, materials, energy, and health, in reality, not everyone operates at the same level. Some stakeholders push for extra efforts, while others prefer to stick to the minimum. This difference in ambition often leads to delays or renegotiation, which in turn affects how affordable and sustainable the MMK actually becomes.

Finally, scale matters. KnoopXL is a compact area with competing demands for every square meter. Space and budget restrictions force stakeholders to make trade-offs. So more housing means less green space, and vice versa. The intersection of sustainability and affordability is often subject to continuous revisiting and negotiation in practice.

In short, the dynamic between stakeholders substantially affects the search for balance in sustainability and affordability. There are moments when collaboration, heightened political motivation, and changing paradigms, allow for opportunities not previously considered. Yet, on the other side, power dynamics, competing interests, and pragmatic constraints, require trade-offs to be made. The process is complex and not a binary decision making. It is an ongoing process of negotiation, exploring, and sometimes even creativity. All aimed at creating a liveable, accessible, and sustainable urban district remains within reach.

6.1.2. Sub question 2

'How do stakeholders perceive the influence of market forces and economic pressures on the KnoopXL project's balance between sustainability and affordable housing, given the risk greenwashing?'

Within the KnoopXL project, there are clear sustainability ambitions in place. These are not just symbolic, they are actively enforced through financial incentives. For example, developers face a fine of €230 per square meter if there is not enough green space. This kind of measure shows that sustainability here is not optional. It is tied to concrete conditions.

The nature of the construction industry means that developers have little incentive to invest in things like durable materials that could save costs in the longer term. It makes the idea of isolating sustainability for the long-term truly difficult. This makes it difficult to integrate a long-term approach to sustainability.

There is ongoing exploration of alternative valuation systems at the TU/e, for instance, using CO_2 equivalents instead of euros as a unit of measurement. While still in the experimental phase, this does signal a desire to work with a broader sustainability framework, one that better includes social aspects. But for now, the system remains financially driven, leaving limited space to fully incorporate social sustainability.

When it comes to affordable housing, ambitious goals have been set. However, enforcing affordability puts downward pressure on land value, meaning that both the province and municipality often need to provide financial support to keep the project viable.[1] This illustrates how social sustainability, in this case affordability, does not come about naturally in a market-based system. The public sector has to step in to make it happen.

The central issue is that affordability is only considered at the inception of a project with no long-term guarantees. Purchase prices tend to escalate rapidly, making homes unaffordable for the targeted group in a short period of time. As a result, social goals often become temporary effects rather than lasting solutions. Housing associations are really the only actors with a more stable role here, as they are not profit-driven, but their presence in KnoopXL seems to be limited, which puts long-term affordability at risk.

Stakeholders also note that many so-called "affordable" rental units in practice are still out of reach for a large segment of the population. Being called "affordable" does not necessarily make it socially just, and that is an important part of what social sustainability is about.

All in all, there is a persistent tension between public values and financial feasibility. With economic uncertainties, rising construction costs, and stackable profit margins from developers, banks, and contractors all contributing pressure to achieve social goals. There is constant negotiation between ambition and feasibility, but it should be noted that public funds and public policy tools are crucial to focus on sustainability.

6.1.3. Sub question 3

‘How do stakeholders perceive the role of technological and design innovations in balancing environmental sustainability with affordability in the KnoopXL project?’

Stakeholders acknowledge that KnoopXL is taking meaningful steps to promote sustainability through technology and design, but they also point to clear limitations and tensions. On the one hand, there is a strong ambition, aligned with the Brainport identity, to use high-tech innovation for environmentally friendly solutions. On the other hand, many feel that these ambitions are only partially visible in current practices.

From the stakeholder perspective, there are some promising examples. In The Dutch Mountains, biobased materials are being used, rainwater is reused, and features like semi-transparent solar panels, natural ventilation, and the chimney effect are integrated to support a healthy indoor climate. Other innovations include PowerNest, combining wind and solar energy, at the Social Hub, energy-saving techniques at Lightyards, and EDGE’s sustainable strategies like shared ATES systems, central ‘serra’ ventilation, and efforts to meet green building labels and wellbeing certifications. National policy, such as the Besluit Bouwwerken Leefomgeving, is also pushing technical progress in construction.

At the same time, many stakeholders also note the complexity of implementing such innovations, especially technical issues, such as addressing water management issues at the underground bus station and wind nuisance around high-rise buildings, needed to find smart solutions that could be problematic in terms of costs. There are also tensions between objectives relating to biodiversity improvement and potentially harmful materials used, like concrete, in implementing a vertical forest and the bus station. These tensions reflect a trade-off between short term problem versus long-term benefits.

Regarding green infrastructure, initiatives include bioswales, removing pavement to make room for green, and a planned ‘green’ Dommel corridor. These are partly guided by the climate challenge calculation tool, which rewards combinations of water and greenery. The municipality plays a stimulating role here, although much of the momentum seems to come from the city’s internal green department rather than formal policy.

Overall, stakeholders share the understanding that Eindhoven has real potential for integrating sustainability through tech and design because of the high-tech identity of the city. Stakeholders also realise that it is still an evolving process, hence the need for structural decisions and longer-term investments in order to realise this ambition of a robust green urban area.

6.1.4. Sub question 4

'How do stakeholders perceive the role of communication and transparency in shaping the balance between sustainability and affordable housing in the KnoopXL project?

The Municipality of Eindhoven is taking steps to initiate public participation within the KnoopXL project earlier and in a more inclusive way. For instance, a dedicated communications team is currently being set up, and the creation of the private limited company for Fellenoord is intended to enable a more structural approach for the northern part of the area. Still, the participation process differs quite a bit between sub-areas. For the southern section and the MMK, several engagement sessions have been organised, led by parties such as ProRail, Movares, the municipality, AM Concepts, and EHVXL.

On the one hand, the municipality is seen as taking a progressive stance toward participation. But at the same time, there is plenty of criticism. Several stakeholders feel the participation in KnoopXL has been rather limited or even lacking. The municipality itself acknowledges that the process has not been ideal and admits that there is room for improvement. Participation is therefore viewed as a learning process, something to build on and improve in future urban development projects.

Overall, the perception of participation in KnoopXL is quite negative. One key issue here is expectation management. Participants need to know in advance what is already decided and where there is still room for input. In some cases, public involvement becomes nearly impossible once designs are already far along in the process, something that has been noted especially in relation to developers.

A recurring challenge is reaching the right target groups, especially future residents. This is a long-term development program, and much of the future residents are unknown, or even not born yet. While interested individuals can subscribe to newsletters or follow project websites, those methods are primarily used for general transparency initiatives. There could definitely be more clarity about the specific status of sub-projects.

The COVID-19 pandemic also caused delays in participation efforts. In-person meetings were cancelled, and digital alternatives did not always prove effective. In addition, some formal objections have been filed by local residents, particularly concerning developments in the southern section, where resistance has been strongest.

6.1.5. Main research question

'Using KnoopXL project as a case study, what mechanisms or factors shape the balance between sustainability and affordable housing in urban area development initiatives to mitigate greenwashing risks from the perspectives of the stakeholders?'

Using the KnoopXL project as a case study, it becomes clear that the balance between sustainability and affordable housing is shaped by a layered interplay of governance structures, financial mechanisms, spatial constraints, and stakeholder dynamics, all of which also determine the project's vulnerability to greenwashing.

At this point, there is no obvious evidence of greenwashing in KnoopXL, primarily because the project is still in the beginning phase. The municipality has provided developers strict sustainability requirements to meet. These projects must comply with before getting the green light to build. This ensures sustainability standards are not just a formality but a real condition for development. However, the existence of a green compensation fund complicates this picture. It allows developers to buy their way out of certain green measures, potentially weakening the overall sustainability ambitions by letting projects bypass direct environmental improvements. This mechanism highlights an ongoing tension between maintaining strict environmental goals and accommodating market flexibility.

In this high-density urban redevelopment, the municipality of Eindhoven attempts to safeguard its ambitions through tools like area-wide KPIs and cluster passports, while also experimenting with innovative governance models such as Fellenoord B.V. This public vehicle is meant to increase executive power and continuity, but tensions remain between long-term policy goals and short-term market logic, especially in a spatial context where every square meter is contested.

A key takeaway from the stakeholder perspectives is that the dynamics between actors act as both an engine and a brake. Close collaboration with developers, public authorities, and technical experts has led to some promising innovations. While differing ambitions, government changes and distributed responsibility often lessen the degree of commitment, critics are necessary to hold the project accountable, demanding binding commitments to climate adaptation, nature-inclusive design, and affordability. Their involvement also proves that in the absence of pressure, there is a threat that sustainability could slip into being a branding exercise, unmoored from any real sense of social or ecological value.

Another striking insight is the gap between participatory ideals and practical implementation. Even though the city aims for early and inclusive participation, in practice the process has often felt fragmented, a bit top-down, and limited, especially in the later design stages. It is also genuinely tricky to involve future residents, many of whom are not even known yet. That makes it harder to say decisions are fully fair or representative.

KnoopXL shows that making urban development truly sustainable means more than just putting a green label on it. True sustainable urban development needs clear rules, a lot of communication, collaboration and negotiation between stakeholders. Courage is also crucial to put people and planet first, even if it means resisting market pressures. It is a difficult but necessary balance.

6.2. Reflection Scientific Relevance

The originality of this research lies in the integration of the concepts of greenwashing, affordability, and sustainability, alongside a stakeholder-based empirical approach that enables the practical observation of these dynamics. It provides a new perspective by integrating three planning concerns that are often considered separately, sustainability, affordability, and the risk of greenwashing, within a coherent analytical framework. These areas are frequently addressed independently in spatial planning literature. By grounding this framework in the perspectives of diverse stakeholders (in)directly engaged in a high-pressure urban development process, the study adds further originality through its empirical approach. It offers new insights into how these tensions are perceived, negotiated, and sometimes strategically communicated in practice. The KnoopXL project demonstrates how the tensions between sustainability, affordability, and green branding manifest in real-world planning practice. It highlights the institutional, financial, and discursive challenges involved in aligning these objectives within a single development initiative.

On paper, sustainability is everywhere. It is in the plans, in the policy goals, and in the ambitions. But once things get to the ground, it becomes clear that what actually gets built depends a lot on power dynamics, financial realities, and how well different actors work together (Van de Meene et al., 2020; Bagheri et al., 2020). Interestingly, greenwashing is not always the result of developers deliberately trying to mislead. As Lupinu and Machura-Urbaniak (2024) note, it often arises from vague or unsubstantiated claims, and sectors like real estate are especially vulnerable. In complex urban environments, this is further driven by systemic pressures, conflicting goals, and the need for compromise. In this sense, this study provides a more comprehensive perspective. Greenwashing can be due to systemic factors instead of bad intentions. This challenges existing academic literature, which suggests that better regulation or better transparency is enough to prevent the risk of greenwashing (Andersson, 2016; Tateishi ,2017). What is really needed, and what projects like KnoopXL are beginning to adopt, are forms of governance that combine collaboration with clear, measurable goals and a capacity to keep learning along the way (Grant et al., 2016; Van de Meene et al., 2020).

Power dynamics, financial interests, and differing timelines often have a stronger influence than stakeholder input. This raises questions about whether participation genuinely shares decision-making power or mainly serves to inform and legitimise decisions (Wang & Chan, 2019).

Theoretically, this research refines the Triple Bottom Line framework by integrating governance and innovation dimensions, enabling a more practical analysis of how greenwashing can emerge in urban development. It also demonstrates how symbolic communication, when not supported by institutional enforcement, can obscure social trade-offs, challenging common assumptions in communicative planning. Finally, by applying this refined framework to stakeholder perspectives, the research offers a methodological contribution that can inform future studies of urban development discourse and practice.

6.3. Reflection Societal Relevance

The societal relevance outlined in the literature highlights the importance of participation, inclusivity, affordability, and reducing inequality within sustainable urban development. In practice, however, these ideals are far from guaranteed. This study of the KnoopXL project shows that there is indeed attention to inclusive and sustainable area development, but resident involvement often remains limited to informing or consulting. Real influence is also limited, because economic and political values can overwhelm social values.

Although partnerships between public, private and civil society actors are often framed as a proactive force for social sustainability, 'working together' is not inherently equitable. The private actors have the advantage in terms of pace, resources, and knowledge, and the public actors do not always have a strong position for negotiation. This raises the question of whether such collaborations truly lead to socially just outcomes, or whether they risk becoming processes in which terms like participation and sustainability sound good but lack enforceable substance.

This study also highlights the tension between affordability and sustainability. While there is a clear ambition to build ‘green,’ the financial model becomes strained when genuinely affordable housing must also meet sustainability standards. As a result, the risk of symbolic sustainability, or greenwashing, is not only an environmental concern, but also a social one. When ‘green’ becomes a marketing tool without a strong social foundation, certain groups risk being systematically excluded. This makes it essential to not only ask what is being developed, but also for whom.

Based on the KnoopXL case, six key recommendations emerge for policymakers aiming to better balance sustainability and affordability while reducing the risk of greenwashing in large urban development projects. First, social sustainability should move beyond policy ambitions and be embedded through legal and financial instruments. This includes applying long-term affordability contracts, involving housing associations at earlier stages, and linking social goals to enforceable frameworks rather than relying solely on key performance indicators. Second, compensation mechanisms such as green funds should be reconsidered, as they often allow developers to avoid delivering actual sustainability. Instead of just setting sustainability goals on paper, these goals should actually be achieved within the project itself. This helps prevent shortcuts that save money but harm the environment. A third suggestion is to set up an independent group or a kind of “sustainability referee” who checks if the plans still meet promises for affordability and sustainability, especially when changes are made. Fourth, innovation should be built into the way projects are planned and approved. This can be done by rewarding business models that focus on long-term CO_2 reduction, social benefits, and incorporate circularity, not just on profit. Fifth, participation should go beyond just informing people. Future residents and local groups should have a real voice in the decisions being made. Lastly, it is important to keep checking the social and environmental impact over time. This helps to adjust plans when needed and ensures that goals for sustainability and affordability actually lead to long-term improvements. If these steps are followed, they can help avoid greenwashing and lead to cities that are fairer, greener, and better prepared for the future.

6.4. Limitations and further research

This study highlights several limitations that should be addressed in future research. First, the development of KnoopXL is shaped by numerous complex preconditions. It may be valuable to examine how the balance between sustainability goals and other interests plays out in less complex development projects, where sustainable measures may be easier to implement. Another limitation is that the involvement of a more representative community group during the interview process would have improved the realism of the findings for the community perspective. However, as it became evident during the participation process, it is difficult to engage individuals who represent future residents. Furthermore, the sensitivity of greenwashing, especially with developers, made it difficult to have open dialogue about sustainability claims, or assess them robustly. So this meant that there was no open discourse about greenwashing which still appears to be a sensitive and taboo topic. Strategies for addressing greenwashing and breaking the taboo surrounding it were beyond the scope of this study, but deserve further exploration. Financial considerations consistently play a dominant role in decision-making, often guiding choices toward short-term feasibility. Future research could explore alternative evaluation frameworks that better integrate social and environmental values alongside financial metrics. Another limitation of this research is the use of the concept of sustainability as a so-called container term within KnoopXL Eindhoven. Because the term is broad and interpreted in various ways by different stakeholders, it is difficult to gain a fully clear and consistent picture of what sustainability actually entails throughout the entire KnoopXL development.

There is also a concern of assessing potential greenwashing. Stakeholders have divergent perspectives on how sustainability is implemented in practice. Some stakeholders feel that developers tend to define sustainability measures as unrealistic or infeasible. Others suggested that developers hardly engage in sustainable practices for altruistic reasons, but rather because of exogenous pressures like reputation, market, or regulation. However, some stakeholders also noted that there has been an apparent shift in the last few years, with more developers appearing to take sustainability seriously when considering sustainability in their practice. The interviewed developers indicated that they pay significant attention to sustainability within their KnoopXL projects. This raises the need for further research to explore in general, not only KnoopXL, developers' motivations in more depth. How much of their sustainability initiatives are motivated by intrinsic values as opposed to external factors, image, social pressure, financial return, or legal obligations?

As KnoopXL is a developing project in the long-term, this study only captures a moment in time, due to shifting political priorities and evolving power dynamics, along with social sustainability ambitions make it hard to fully assess long-term effects and legacy. It requires an ongoing assessment and evaluation over time.

Further research could explore whether terms like "affordable housing" and "inclusivity" are sometimes used in a strategic way, similar to greenwashing. This may point to a broader pattern of "social washing," where social terms are used without real structural change.

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Appendix 1 Interviewguide

Stakeholder Dynamics and Power Relations

- What is your role in the KnoopXL project/sustainable area development? What are your main objectives and responsibilities in relation to the project's development?
- What challenges arise when trying to integrate different stakeholder perspectives in urban planning?
- How is the collaboration between the other parties? Have there been any conflicts between stakeholders due to differing priorities? If so, how were they addressed, and what kinds of negotiations took place?
- Are there any particular power dynamics between stakeholders that influence the planning process?
- How do different stakeholders influence the decision-making in the project?
- How do public authorities use regulatory instruments to influence sustainability and affordability goals?
- To what extent are researchers involved by stakeholders to justify decisions around sustainability and affordable housing in KnoopXL?

Balance between sustainability and affordable housing

- How does KnoopXL aim to balance sustainability and affordability without significantly increasing costs?
- What are the main challenges in achieving this balance?
- Have specific trade-offs been made between sustainability goals and affordability objectives?
- How is long-term sustainability approached? What long-term environmental and livability impacts have been considered in the decision-making process?
- How are economic interests weighed against ecological and social concerns?
- Is there a risk that rising property values around the hub will lead to the displacement of lower-income groups? How is this monitored or prevented?
- How does the rising property value in and around KnoopXL affect the feasibility of including truly affordable housing while still meeting sustainability standards?
- Do stakeholders believe there is sufficient awareness of the trade-offs between sustainability goals and housing affordability among decision-makers and the public?

Market Forces and Economic Pressures

- How do market conditions and economic factors affect affordable housing in KnoopXL?
- Are there specific economic incentives offered to developers or stakeholders to encourage the integration of sustainability with affordable housing? How effective are these incentives?
- What financial rules or agreements are in place that support or restrict balancing sustainability with affordable housing in the KnoopXL project?
- To what extent does government financing contribute to making sustainable and affordable housing feasible in KnoopXL?
- What financial risks do stakeholders face when trying to combine sustainability objectives with affordable housing, and how are these risks managed in KnoopXL?

Technological and Design Innovations

- Which technological or design innovations have been integrated into KnoopXL to promote sustainability?
- How have these innovations impacted the affordability of housing?
- What challenges have emerged when implementing technological or design innovations?
- How do you assess the long-term viability of these innovations in urban development projects?
- Which sustainable innovations are implemented in KnoopXL, and how do they contribute to long-term environmental goals?
- How does KnoopXL ensure that green technologies are not merely symbolic, but also functional and cost-effective?
- What role does smart design play in balancing environmental performance with construction costs?
- How do technological and design choices in KnoopXL reflect Eindhoven's identity as a high-tech and innovative region?

Communication and Transparency

- How are local residents and stakeholders involved in the planning and decision-making processes of KnoopXL?
- Do you believe the communication about long-term plans and strategies in KnoopXL has been transparent and consistent? Why or why not?

- What kinds of concerns or objections have stakeholders or citizens raised regarding sustainability or housing affordability in KnoopXL?

Greenwashing

- How realistic are the current sustainability plans for KnoopXL when it comes to actual implementation on the ground?
- What are the main pitfalls or limitations that could prevent the realisation of these sustainability ambitions?
- Is greenwashing a topic that is openly discussed among stakeholders in the KnoopXL project? Why or why not?
- Do you feel there is sufficient critical reflection within the project team about the risk of sustainability being used mainly for image purposes?
- Are there independent evaluations or monitoring systems in place to verify the sustainability performance of KnoopXL?
- Who is responsible for checking whether sustainability claims made during the planning phase are actually fulfilled during construction and use
- What specific strategies have been put in place in KnoopXL to ensure sustainability efforts are genuine and not just symbolic?
- To what extent do you think green features are being used primarily for branding or marketing purposes in KnoopXL?
- How can the project balance appealing visual design and storytelling with authentic, measurable sustainability outcomes?