Innovation Districts as Drivers of Sustainable Urban Development

An impacts and monitoring framework to drive knowledge economy, urban revitalization, and social inclusion

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Executive Summary

Innovation districts are increasingly influential mechanisms through which cities aim to accelerate economic innovation and investment. A key challenge for policymakers, planners and investors involves ensuring that innovation districts deliver wider benefits to neighbouring communities and the city regions in which they are located. Too often innovation districts create islands of economic growth that are disconnected from the surrounding city. This represents a major lost opportunity. Innovation districts have the potential to drive sustainable urban development through inclusive innovation. This report identifies how innovation districts can contribute to the broader sustainable urban development of city regions.

The first part of the report presents the findings of a rapid literature review and global scan of 165 innovation districts, identifying internationally leading examples that either have or are aiming to generate a wide set of beneficial impacts on the cities and communities. Detailed findings are presented using a logic model of 'input-activity-output-outcome-impact' to identify specific inputs and actions that have been used by innovation districts around the world to generate wider economic, urban and social impacts (Appendix 1).

Two cases are of particular interest in terms of their focus on generating broader benefits and social inclusion: Cortex Innovation Community, St. Louis, USA and Kendall Square, Cambridge, USA. Cortex Innovation Community aimed to create a racially, ethnically and gender inclusive district and has developed a range of entrepreneurial programmes to increase minority, LGBTQ+ and female participation. Kendall Square has implemented activities that focus on developing the knowledge cluster, making an attractive place and increasing social inclusion.

The second part of the report applies the logic model to ID Manchester, a major innovation district currently under development in the city centre of Manchester, UK. ID Manchester has explicit ambitions to contribute to the sustainable and inclusive growth of the city and wider city region. Adjacent to the busiest railway station in Northwest of England, Manchester Piccadilly, ID Manchester sits on one of the most valuable development site in the UK outside of London.

The report presents a monitoring framework for ID Manchester to achieve sustainable and inclusive urban development in Manchester City, Greater Manchester, the North/Northwest of England and the UK. Following the logic model of 'input-activity-output-outcome-impact',

we present a theory of change and identify specific activities that can deliver the intended beneficial economic, urban and social impacts of ID Manchester.

Economic activities to achieve a knowledge-based economy driven by the digital tech sector, life sciences, creative industries, green industries, and advanced manufacturing for boosting the productivity of the local economy and retarding economic disparities regionally. The goals include establishing a self-sustaining innovation ecosystem integrated with the local one, building supply chain hubs, forming partnerships locally and globally, enhancing existing economic assets, supporting start-ups and international researchers, and fostering demand side entrepreneurial initiatives.

Urban activities: To achieve urban revitalization and sustainable urban development through local leadership, long-term partnerships and networks with local people, businesses, and government, and coordination with central and regional governments for urban prosperity, regional resilience, and national competition. The strategy involves integrating policy goals, forming a mission-oriented coalition, establishing multi-level governance partnerships, enhancing connectivity, creating mixed-use accessible public spaces, fostering urban experimentation and opening testing facilities, accommodating talent, increasing green space, and supporting sustainability in infrastructure and businesses.

Social inclusion activities: To achieve neighbourhood vitality and inclusive development through community engagement and bottom-up empowerment for delivering benefits to local communities and residents for succeeding in social inclusion. The approach involves equality, diversity and inclusion, co-design and public engagement, talent pool development through funding and incentives, career training and sectoral-focused skill courses for graduates and residents, and transitioning citizen engagement into entrepreneurship.

Traditional metrics-based monitoring approaches are well suited to capture the immediate outputs of activities, and key metrics are proposed. The report also outlines how qualitative methods, longitudinal data, automated and real time data, and people-led sampling can be used to monitor longer-term impacts of ID Manchester. A monitoring strategy that is responsive and inclusive will support the ambition of ID Manchester to be a genuinely innovative and inclusive place that generates a wide range of benefits. It will also be of interest to cities around the world.

Introduction

Located in central Manchester, ID Manchester aims to be a world-leading innovation district (ID). Its ambition is to be a world-class innovation platform for growth, an exemplar of urban regeneration, a place for collaboration, innovation and commercialisation, a driver of inclusivity, diversity and creativity, a world leader for net zero carbon, and a distinctive place for global talent and creating opportunities for local people (Bruntwood SciTech and The University of Manchester, 2023). This vision builds on ID Manchester's strong developmental potential offered by economic assets like the universities and existing innovation clusters, physical assets including the proximity and connectivity of transport and location, and existing heritage buildings, and networking assets covering collaborations between the University and private enterprises. ID Manchester is one of the most valuable development site in the UK, adjacent to Manchester Piccadilly railway station and the city centre, but is also adjacent to neighbourhoods that are among the most deprived in the UK. ID Manchester promises ambitious contributions towards inclusive and sustainable development to communities within the city of Manchester, as well as the wider Greater Manchester region, the North/Northwest of England, and the UK.

IDs are an emerging intervention tool of place-based economic re/development, rooted in place-making or place-branding agendas (Kayanan, 2022) and a new-type spatial form to address urban challenges such as economic hardship, national austerity, local fiscal crises, extensive sprawl urban revitalization, political instability, global competition, environmental degradation and social inequality (Spirou, 2021). However, there is little agreement on the definition of IDs (Taecharungroj and Millington, 2023). The earliest common definition from Brookings described that "these districts are geographic areas where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators and accelerators" (Katz and Wagner, 2014). Although early ID models happened across the US cities, European IDs mentioned the 'Smart (Specialisation) Strategy' at the local scale (Monardo, 2018), where IDs could combine the concept of the smart city into place-making strategies (Heaphy and Wiig, 2020). The recent IDs start to focus on regenerating brownfields

in city centres rather than science parks in the suburbs and rebuilding mixed-use, compact, and walkable neighbourhoods rather than single-function communities, both of which benefit their residents and absorb younger and more skilled workers from outside regions (Katz and Wagner, 2014). In other words, the built form of IDs caters to the 'live-work-play' goals with creation of new housing and infrastructure for the 'creative class', such as walking routes, public realms and other targeted amenities.

IDs are not simply economic and innovation strategies to promote the agglomeration of innovative industries in places. Rather, they present a knowledge-based, place-based, and community-based economic, urban and social strategy that aims to take a holistic and integrated approach. IDs represent a strategic urban project (Kalliomäki et al., 2023) to cultivate knowledge-based development for urban transformation (Morisson and Bevilacqua, 2019a). This urban transformation is led by knowledge generation and innovation, rather than just real estate development through its various typologies, for example, high-technology-intensive ID, creativity-intensive ID and knowledge-intensive ID (Yigitcanlar et al., 2020). IDs aspire to attract younger talents, promising new lifestyles and a self-fulfilling agglomeration economy of productivity and creativity in a mixed-used and crowded urban district (Heaphy and Wiig, 2020). Through dense mixed-use development IDs aspire to redevelop 'left-behind' places with packed resources for their stakeholders and residents to become emerging urban socio-spatial hubs (Hamilton, 2016, Morisson, 2020, Esmaeilpoorarabi et al., 2020b).

The increasing use of IDs in cities challenges us to understand how they can drive sustainable urban development. Rather than creating islands of innovation and wealth, IDs need to connect with broader neighbourhoods, cities and regions and help deliver broader policy goals. Early studies on the impacts of IDs have highlighted a noticeable shift to privatised modes of development and governance mechanisms, and increasing gentrification around peripheries, despite aspirations of inclusivity (Kayanan, 2022, Kayanan et al., 2022). However, we need to acknowledge that research into the impacts of IDs is limited because most IDs are at an early stage of development (Fernandez and Bentley, 2022, Kayanan et al., 2022).

This report aims to identify the long-term and broader potential impacts of IDs systematically and holistically. It focuses on the role of IDs in driving a knowledge economy, urban revitalization, and social inclusion. The report relates these findings to the case of ID Manchester to identify how it can help achieve sustainable urban development and present

a framework for monitoring the broader impacts of ID Manchester on the city, city-region, region and nation as well as benefits to the adjacent communities and residents.

Scope and Approach

ID Manchester is a regeneration initiative backed by a major UK University and the next phase of the thriving Manchester Oxford Road Corridor development. The report was commissioned to support the goals of the ID Manchester Joint Venture partnership to realise the potential of ID Manchester to benefit the city region and inform strategy. The research aimed to:

- Understand the range of potential positive impacts of ID Manchester on Greater Manchester, the North/Northwest of England and the UK.
- Identify pathways and activities to achieve these impacts.
- Present a framework to monitor these impacts.

The research design consisted of three stages: a rapid review of the existing literature on IDs and specifically their impacts; an international survey; and a single case study. In the first stage, the rapid review provides a snapshot of cutting edge thinking about IDs and their roles in driving both innovation and wider impacts in city-regions. The second stage of the research builds upon the findings of the rapid review to evaluate and distinguish the impacts of international IDs according to the 'input-activity-output-outcome-impact' logic model through a qualitative evidence-based assessment. The logic model, shown in Figure 1, analysed inputs (What resources go into IDs?), activities (What do IDs do?), outputs (What do IDs deliver?), outcomes (What do IDs wish to achieve?), and impacts (What do IDs aim to change?). The impact evaluation encompassed the entire process of ID development such as decision-making, plan-making, project implementation, and project operation. The mechanism discusses a recombination of resources (inputs), a series of innovative activities in place (activities), short-term results of innovative activities (outputs), and long-term results of innovative activities (outcomes), which give rise to ID-driven transformation (impacts).

The international survey identified 165 international IDs as the database from academic papers, online reports and websites covering three types of IDs outlined by Katz and Wagner

(2014): 'anchor-plus' model (urban redevelopment by major anchor institution and its related firms, entrepreneurs and spin-off companies), 're-imaged urban area' model (urban regeneration in traditional waterfront, industries district and warehouse district), and 'urbanized science park' model (urban regeneration in suburban and exurban science park). Appendix 1 lists six IDs with indications constructed on the 'input-activity-output-outcome-impact' logic.

Considering ID Manchester is an 'anchor-plus' model, two successful North American IDs of the 'anchor-plus' model category have been described: Cortex Innovation Community developed through private-led initiatives and Kendall Square developed through public-driven initiatives. These two detailed examples present their developmental histories, mechanisms, approaches and impacts to provide more in depth inspiration for ID Manchester.

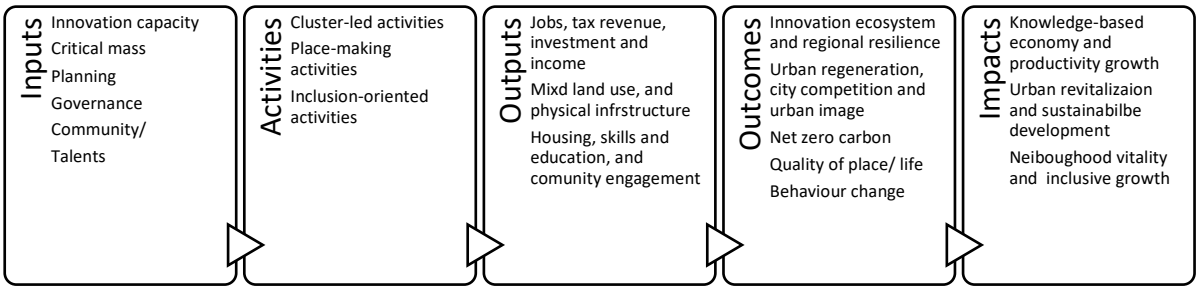

Figure 1 The 'input-activity-output-outcome-impact' logic model. (Source: authors).

The final stage of the research translated these findings into the context of ID Manchester. We adopted a qualitative research design containing two methods for data collection: documentation and semi-structured interviews. The documents relating to ID Manchester contained governmental policies at the national, regional and local levels and grey reports from think tanks, consulting companies and non-profit organizations. The semi-structured interviews were conducted with six key local stakeholders from the government, the private sector, the University and non-profit organizations, including Manchester City Council, Bruntwood SciTech, Oxford Road Corridor and The University of Manchester. We analysed the challenges and opportunities of ID Manchester and the expected impacts to develop a theory of change for monitoring the impact framework. This helps to understand the potential mechanisms, actions and impacts of ID Manchester in the economic, urban and social realms.

Innovation Districts: Rapid Review

The UK Innovation Strategy states that "IDs are networks of organizations in major cities that produce and commercialise knowledge" (Department for Business Energy and Industrial Strategy, 2021). The challenge remains whether IDs will succeed in bringing an innovation-led productivity economy, interactive place-based design and inclusive growth (Lawrence et al., 2019, ARUP, 2018). Key questions relate to the kinds of innovation being sought (Fastenrath et al., 2023) and how these innovation processes will be governed (Davidson et al., 2023). In other word, ID development requires continuous interaction and iteration in the entire development process of local innovation in a productive, inclusive and sustainable way (Katz and Wagner, 2014, Kayanan, 2022, Drucker and Kayanan, 2023).

Reviewing the literature reveals three broad domains of impact: economic transformation, urban transformation and social transformation. Because IDs are focused on knowledge-based economic renewal, urban renewal through place-making, and inclusivity-oriented neighbourhood renewal, this tripartite of impacts can be identified across much of the literature on IDs (Rapetti et al., 2022a). For example, 22@Barcelona displayed commercial and economic transformation, infrastructure and urban transformation, and talent and social transformation (Pique et al., 2021, Rapetti et al., 2022a). MIND in Milan represents a major ID project with an explicit aim to regenerate part of the city and deliver economic, social, and environmental benefits (Plusvalue and Polytecnico di Milano, 2022). However, systematic empirical evidence does not yet exist regarding how IDs impact economic vitality, urban development, and foster inclusive neighbourhoods (Monardo, 2018, Fastenrath et al., 2023). Some scholars have looked at the impacts on economic growth and urban revitalization (Battaglia and Tremblay, 2011, Drucker and Kayanan, 2023, Hamilton, 2016), while others highlighted the deficiency of the impacts on surrounding neighbourhoods and even society as a whole (Esmaeilpoorarabi et al., 2020b, Krueger et al., 2022, Kayanan et al., 2022, Arenas et al., 2020, Morisson and Bevilacqua, 2019a). But IDs may also fail to realise these wider social and urban benefits and even exacerbate existing inequalities (Monardo, 2018, Morisson and Bevilacqua, 2019a, Leon, 2008). Below, we highlight aspects of economic, urban and social impacts briefly using examples.

Regarding economic impact, Drucker et al. (2019) discussed agglomeration, entrepreneurial ecosystems, and labour, where ID produced a cluster economy between entrepreneurial and innovative firms and knowledge-producing institutions. Many scholars and cases demonstrated the role of ID to foster a local innovation-oriented economy and drive regional economic development through knowledge generation (Drucker and Kayanan, 2023, Katz and Wagner, 2014, Davis, 2015, Clark et al., 2010). For example, 22@ in Barcelona was planned to transform an old industrial area into an ID to grow the local economy and increase competitiveness (Battaglia and Tremblay, 2011, Leon, 2008). Contrarily, Andes et al. (2017) reviewed that Pittsburgh's ID has not yet realised broad-based economic growth through its technology assets.

Concerning urban impact, IDs address urban challenges and seek to drive knowledge-based urban transformation (Fastenrath et al., 2023) through the integration of strategy, investment, technology and governance (del Cerro Santamaría, 2022). Innovation implies searching for new solutions, new practices, and services to deal with existing place-based problems, and in this way place-based urban innovation can help drive the prosperity of IDs towards urban transformation and sustainable development such as urban resilience, built environment, and climate adaptation. Furthermore, IDs are a tool of local authorities for urban revitalization (Morawska et al., 2021, Pique et al., 2019). For example, the I.D.E.A. District, as an intervention tool of innovation-oriented urban regeneration, constituted an urban growth strategy in San Diego, US (Parisi and Biancuzzo, 2021). Hamidi and Zandiatashbar (2019) suggest walkability, mixed uses and transit access for compact development can stimulate networking, learning, and collaborating in an active place that specifically absorbs knowledge-based small businesses. Additionally, Morisson (2019) highlighted the role of emerging places combined with co-living, co-working and comingling spaces, such as Station F in Paris, for social interactions and networks. Moreover, scholars noticed generally satisfactory outcomes for IDs in the aspects of the quality of place (Esmaeilpoorarabi et al., 2020a, Esmaeilpoorarabi et al., 2018). And del Cerro Santamaría (2022) discussed governance of sustainability in IDs to reduce environmental pollution and encourage sustainable transportation needs.

Social impact is an emerging concern beyond economic and urban impact, responding to public values and the social responsibilities of IDs to tackle societal challenges through the

empowering of residents and communities, thus contributing to inclusive development (Angelidou and Psaltoglou, 2017). However, Arenas et al. (2020) critiqued the harmful social effects of the Medellinnovation District in Colombia, where they noted socioeconomic polarisation, gentrification, non-community participation and a missing neighbourhood identity. On the contrary, Morisson and Bevilacqua (2019b) believed the strategy adopted by the Medellinnovation District might mitigate these negative effects. Furthermore, Morisson and Bevilacqua (2019a) critiqued not only the issue of gentrification leading to the displacement of residents, users and companies, but also how Chattanooga's innovation district balanced gentrification placed-based and knowledge-based urban strategies and governance mechanisms. While IDs have shown lack of success in local community engagement (Esmaeilpoorarabi et al., 2020a), One-north in Singapore provided evidence that activity-based integration might improve interactions between different income groups in the mix-used and smaller place (Gao and Lim, 2023). Kayanan et al. (2022) have underlined the disadvantages to long-term residents and the affordable housing crisis along with increasing housing prices and expensive amenities. Therefore, social factors need much attention when considering the impacts of IDs.

Given the limited development of most IDs, and the challenges of evaluating the impacts of IDs, our study adopted a qualitative approach for evidence-based impact evaluation (Mohr, 1999). First, this research adopted an 'input-activity-output-outcome-impact' logic model to examine three impact mechanisms through international case studies, where the question was how effective are IDs in optimizing economic, urban and social impacts? Second, according to the findings from the logic model, the research developed the theory of change that provided a conceptual foundation of the changes to answer how to maximize economic, urban and social impacts of ID Manchester for its surrounding communities, Manchester city centre, Greater Manchester, the North/Northwest of England and the UK. The theory of change is chosen as "an approach to planning, learning, reflection and documentation of the change we make and explained why we think certain actions (a project, program and/or an organisational strategy) likely will lead to the desired change"(O'Flynn and Sonderskov, 2015).

International ID districts

Summary of global survey

The section summarizes the inputs, activities, outputs, and outcomes of evidence-based practices of international IDs towards their economic, urban and social impacts. The evidence-based findings have been manifested through 1) inputs: the resources put into the IDs, 2) activities: the initiatives carried out in the IDs, 3) outputs: the short-term results provided along with IDs' implementation; 4) outcomes: the long-term achievements the IDs presented; and 5) impacts: the transformation that happened in conjunction with IDs development.

Inputs

Appendix 2 illustrates the inputs of IDs including five categories: critical mass, innovation capacity, planning, governance and community/ talent from economic, urban and social aspects. Economic inputs contain critical mass and innovation capacity for building a sustaining local innovation ecosystem and delivering entrepreneurial activities. Urban inputs focus on the planning of place-making, such as holistic strategy and design on the ground floor; governance, such as leadership and coalition; and organizational structure and real estate investment. Social inputs consider 1) diversity, equity, and inclusion, 2) investment of education and training and 3) culture of communities/ talents.

Activities

In general, the activities of IDs fall into three main categories: cluster-oriented activities, place-making activities and inclusion-oriented activities for economic, urban and social development by events, programmes, and policy instruments. For example, the Porto Digital Case described specific activities based on the lifecycle from the social, economic, and urban dimensions (Rapetti et al., 2022b), with the same seen for 22@ in Barcelona (Pique et al., 2021, Gianoli and Palazzolo Henkes, 2020). Regarding the economic dimension, cluster-oriented activities have four themes: money, training, policy and commercialization. First, IDs require ongoing programmes through funding, investment and venture capital to support clusters, small companies, start-ups, incubators and innovators. Second, IDs require training

programmes to assist small businesses and innovators at the early stage. Third, IDs require policy support for local businesses such as public procurement. Concerning the urban dimension, place-making activities focus on infrastructure updating for working, living, learning, playing and cyber, and policy incentives through tax tools. Inclusive-oriented activities established commitment, training, money, policy and co-creation around the concept of social inclusion. First, IDs need to set a collective goal about equality, diversity and inclusion. Second, IDs offer programmes of training and funding support to talents, students, graduates and residents. Third, the lifecycle of IDs requires the involvement of residents and communities through co-creation activities.

Outputs

ID outputs are the short-term results that come with the implementation of IDs' activities. Concerning outputs in the economic dimension, IDs have generated new patents, products, services, and processes and enhanced local innovation capacities, which resulted in plenty of opportunities and high-value jobs. IDs have blossomed and that has attracted second-round investment and tax revenue. For instance, Boston's IDs created more than 200 start-ups in the area and hundreds of new jobs, which contributed to the city's reputation as a hotbed for tech-driven entrepreneurship and becoming the top destination for venture capital investments in the United States (Rissola et al., 2019). Regarding urban outputs, IDs produced a new urban hub for controlling urban sprawl. Furthermore, attempts are made to regenerate land use and infrastructure along a 'work-live-play-learn-cyber' agenda. Increasing land prices is one of the drawbacks, leading to gentrification. The outputs of the studied cases stressed that developing infrastructure and amenities will expand co-working spaces, open spaces, green spaces, mixed-used spaces, digital network and physical network for everyone around IDs. Relating to social outputs, IDs generated incomes for residents, affordable housing, a series of training and educational programmes, and community engagement. 22@ in Barcelona increased household disposable income because of the growing population of residents from foreign countries and the internationalization of businesses (Rapetti et al., 2022a). However, the same effect led to tension over affordable housing for residents in Chattanooga ID (Hamilton, 2016, Morisson and Bevilacqua, 2019a). To meet Boston 2030 goals, Boston's ID involved more than 15,000 citizens through a variety of citizen engagement tools and instruments (Trillo, 2021). The primary output is to strengthen the

skills and education of residents, graduates, and students by supporting training programmes, events and courses, in order to develop a local talent pool.

Outcomes

Here we consider the long-term achievements in economic, urban and social terms. As for economic outcomes, IDs not only help build a sustainable local innovation ecosystem, shape a place-based new economy, and build long-term and local-driven supply chains, but also help balance the regional economy and contribute to improved regional resilience. The innovation ecosystem is the core component, where each ID requires persistent efforts to make a sustaining and healthy ecosystem. Most innovation ecosystems depend on their own advantages and integrate into city-level, and regional-level innovation ecosystems. For instance, Rissola et al. (2019) discussed the significance of the Boston-Cambridge innovation ecosystem, and Pensacola and Chattanooga created their local innovation ecosystem (Spirou, 2021). Furthermore, many cases such as Boston's ID, Cortex Innovation Community, Medellinnovation District and so on stimulate regional economic development and competition.

As for urban outcomes, IDs are seen as a successful mode of urban regeneration, helping establish a new urban image of the city and improving the competitiveness of the city. The Silicon Docks ID in Dublin provides an example of this (Kayanan, 2019). The Chattanooga ID stimulated the tourism economy and changed the city reputation. Furthermore, whether the result of primarily top-down planning or largely driven by bottom-up initiatives, all IDs are focused on upgrading the quality of place by improving physical, digital and green infrastructures toward a green, connected, accessible, walkable, safe and sustainable place. Milan ID (MIND) delivered local sustainable goals by integrating with technology in water, energy, and solar power, to help firms meet carbon emissions goals.

From a social perspective, IDs aspire to enhance quality of life and place identity, reduce deprivation and change people's behaviour or lifestyle to a certain degree. Although there is not enough evidence to affirm these claims, we have looked for empirical research that particularly emphasized the importance of social outcomes. For example, Esmaeilpoorarabi et al. (2018) believed behaviour or lifestyle change only happened in the students, graduates, or younger people in Kelvin Grove Urban Village, rather than long-term residents.

Medellinnovation District and Brisbane's knowledge precincts exhibited a lack of place identity and community-based values from the residents' view (Esmaeilpoorarabi et al., 2018, Arenas et al., 2020, Gonçalves et al., 2022). However, despite the risk of gentrification, IDs contribute to redevelopment of the deprived or 'left behind' places through urban regeneration projects in brownfield sites leading to longer-term socio-spatial outcomes.

Impacts

International experiences reflect the role of IDs in driving economic, urban and social transformations that include, on the one hand, not only the district itself but also its city, region and country, on the other hand, the surrounding communities and its residents. In economic terms, IDs accelerate cluster agglomeration and entrepreneurial activities in biomedicine, information technology, and advanced manufacturing sectors which foster productivity in the local economy and stimulate regional economic growth. IDs can help drive an economic transition towards a new knowledge-based economy. For example, the Skolkovo innovation ecosystem in Moscow, Russia, produced evidence of economic transition by technology clusters (Chekanov, 2022). Using the examples of Seaport ID (Boston), Detroit ID, Cortex Innovation Community and I.D.E.A District, Drucker and Kayanan (2023) discussed the capacity of IDs to reach the goals of the regional economy through innovation and entrepreneurship. In the dimension of urban impact, IDs are a form of urban regeneration (Testa et al., 2023) that focuses on city centre locations, contributing to downtown revival and urban prosperity. Studies have highlighted that IDs facilitate transformation and urban revitalization from a post-industrial, or shrinking, city to an innovative city or a dynamic city (Arenas et al., 2020, Leon, 2008). For instance, Boston displayed waterfront urban renewal, 22@Barcelona presented urban redevelopment from textile industries, and St. Louis offered urban regeneration from an old industrial area (Blakely and Hu, 2019).

Moreover, IDs contribute to local sustainable development combined with city, regional and national strategy through a place-making approach. Social transformation pays more attention to social inclusion and neighbourhood vitality where IDs aim at achieving community transformation from a 'left behind' area. As an illustration of social integration, an inclusive innovation strategy was adopted by Pittsburgh ID, Chattanooga ID and

Medellinnovation District (Lee, 2020, Lee, 2023, Morisson and Bevilacqua, 2019a, Arenas et al., 2020).

Two successful examples

Below we take two successful innovation districts (Cortex Innovation Community and Kendall Square) from the USA and describe some aspects of their developmental trajectories and long-term impacts. These two districts are close to universities, driven by high technology, and involve lasting innovations. Cortex Innovation Community represented an example of development by a not-for-profit organization to plan district strategies and to design innovation activities through a private-led and bottom-up approach. On the contrary, Kendall Square's growth has largely relied on a series of neighbourhood-level plans announced by the city government through a public-driven and top-down approach – although supported by the locational choices of companies over decades.

Case One: Cortex Innovation Community, St. Louis, USA

Cortex Innovation Community is driven by a technology-enabled and innovation-led ecosystem, which contributes to the regional innovation economy through technology-oriented innovation industries in St. Louis (TEConomy Partners LLC, 2019). Cortex Innovation Community is a successful innovation and entrepreneurship hub towards inclusive growth by maximizing the innovation potential and creating equitable economic impacts (Katz and Black, 2020, Cortex Innovation Community, 2022). The Cortex was founded as the Centre for Research Technology and Entrepreneurial Exchange in 2002 from an industrial area and rebranded as Cortex Innovation Community led by the 501c(3) not-for-profit organization including 5 anchor institutions: Washington University in St. Louis, BJC HealthCare, Saint Louis University, Missouri Botanical Garden and the University of Missouri-St. Louis in 2010 (Read, 2016). "Cortex now anchors a growing regional system of more than 400 companies and 6,000 employees across 200-acre space with near-zero vacancy and transforms from a technology-infused life and plant sciences district into an entrepreneurially-charged live-work-play-learn community" (HOK). The Cortex shows how the anchors create economic growth in a dynamic mix-used ID (Katz and Black, 2020) and "how the community catalyses innovation that brings

together big-thinking problem solvers with state-of-the-art resources, facilities, and innovative programming to inspire and drive collaboration" (Cortex Innovation Community).

Cortex Innovation Community aims to achieve technology-based economic development through a holistic innovation ecosystem (Figure 2) with a series of activities (Appendix 3) including 1) innovation and technology development, 2) venture development and business services and supports, 3) capital for pre-seed, seed venture capital rounds and expansion capital, 4) place-making in infrastructure, building and facilities development, transportation infrastructure and community space, 5) education, training and workforce development, and 6) community, networking, interaction facilitation and events (TEConomy Partners LLC, 2019). Meanwhile, Tax Increment Financing will help to drive investment in buildings and infrastructure. Tax abatements will freeze taxes at a base rate with no increase over a predetermined period.

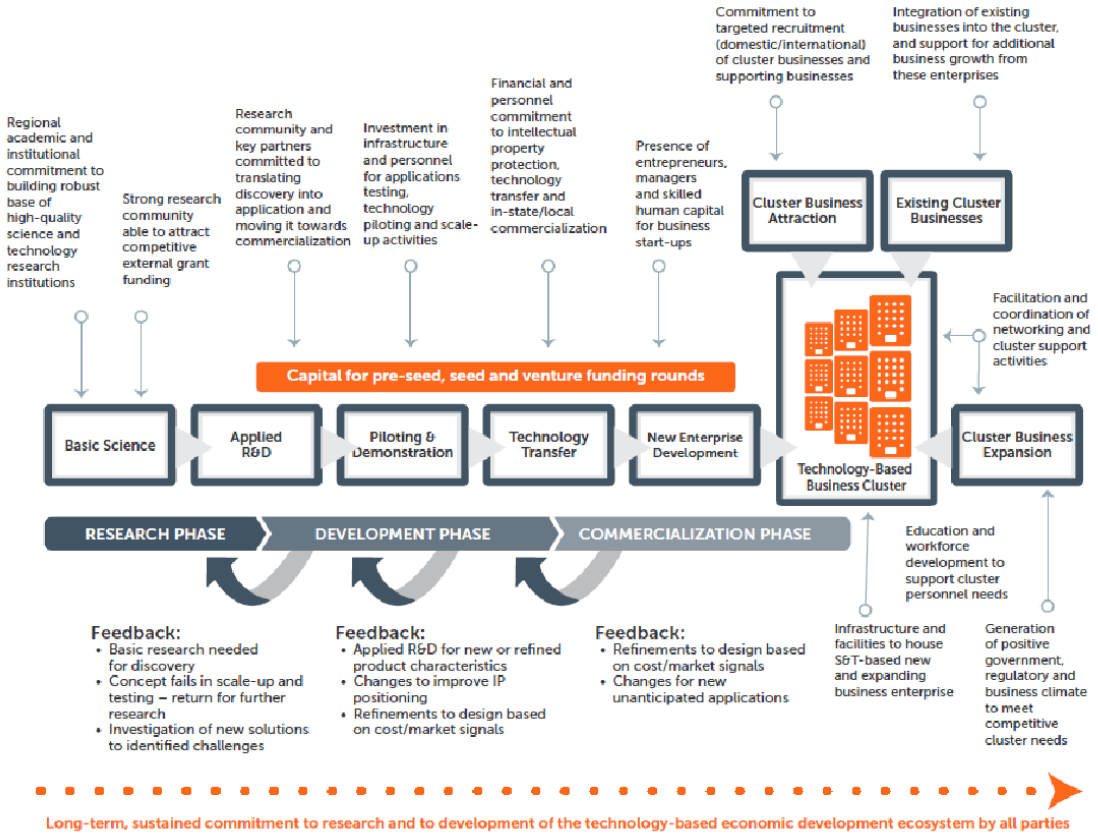

Figure 2 The innovation ecosystem of Cortex Innovation Community. (Source: TEConomy Partners LLC, 2019).

The Cortex Innovation Community is still on the way to exploring how the district successfully impacts adjacent neighbourhoods and improves equity for St. Louis City and Missouri Region. The goal of Cortex was restressed to build "the most racially, ethnically and gender inclusive

district in the country" in 2017, which included six steps to achieve inclusive growth: 1) to increase high minority and woman-owned company participation; 2) to increase diversity on the broad; 3) to promote inclusive access to programming and events; 4) to train and engage young people of colour in STEM disciplines; 5) to provide funding training for entrepreneurs; and 6) to provide affordable lab spaces by Washington University partnership (Katz and Black, 2020). Especially after the pandemic, the Cortex aims to improve equity and inclusion through entrepreneurship programs, where under-represented communities including minorities, women, people of colour, and LGBTQ individuals could engage (Letscher, 2022). Moreover, the Cortex worked on LEED-certified buildings, solar roofs, storm water capture systems, and refurbished heritage buildings to meet the space needs of technology firms towards environmental sustainability (Read, 2016).

The Cortex contributed to the city and the region as an economic engine, for instance, $2 billion in regional economic outputs, 425 companies and 6000 new employees, $84 million in state and local tax revenues, and $950 million for neighbourhood investment in retail and residential development (Cortex Innovation Community, 2022). Cortex Innovation Community brings economic, urban and societal benefits through: 1) emerging disruptive technologies, new business models and convergence; 2) industry cluster growth and diversification of the regional economy; 3) a connected community for capturing convergence and partnering opportunities; 4) employment growth and associated personal and family incomes; 5) attracting investment; 6) growth in taxation for local government; 7) city competition improvement in a global innovation-based economy; 8) graduate jobs growth; 9) balanced supply and demand relationship for skill workers; 10) improved liveability, community aesthetics, and quality of place; neighbourhood revitalization and inclusion opportunities; 11) improved national and international urban image for St. Louis region and Missouri; and 12) regional planning and strategic and economic development (TEConomy Partners LLC, 2019).

Case Two: Kendall Square, Cambridge, USA

Kendall Square is an internationally recognized ID close to MIT (Massachusetts Institute of Technology) and a centre of the Cambridge innovation economy in the city of Cambridge,

USA. Kendall Square has a long history of development from a factory boomtown to urban renewal (1800-1980), from digital and artificial intelligence industries to biotechnological industries (since 1980) and continues to grow by innovation convergence. The success of the ID makes it one of the exemplar cases of a university-driven ID. Kendall Square has benefited from the close proximity of MIT as an anchor institution, developed through public-driven plan-making and generating an open, dynamic and entrepreneurial ecosystem with increasing innovation firms and clients from home to abroad (Trillo, 2021, Gwynne, 2013). Moreover, it is home to some famous enterprises, for example, technology companies (such as Amazon, Google, and Microsoft), biotechnology companies (such as Genzyme, Biogen and Millennium) and pharmaceutical companies (such as Pfizer, Sanofi and Novartis) (Budden and Murray, 2015).

The transformation of Kendall Square was based on a neighbourhood-level plan toward a liveable mixed-use district in housing affordability, open spaces and transportation accessibility by the Cambridge Redevelopment Authority (Bevilacqua and Pizzimenti, 2018). The vision of the Kendall Square (K2) Plan (Table 1) included nurturing Kendall's existing innovation culture, place-making, promoting environmental sustainability and mixing living, working and playing (Cambridge Community Development Department, 2013b). Furthermore, Kendall Square published design guidelines including environmental quality, walkability, accessibility, build form, ground floor design and academic building (Cambridge Community Development Department, 2013a). Kendall Square reflected the significant role of planning for designing a place-based innovation ecosystem in the district (Budden and Murray, 2015).

Table 1 Kendall Square Central Square Planning Study

Type	***Activities***
Cluster-led activities	• Expand opportunities for Kendall Square's knowledge economy to continue to grow • Foster a strong connection between the MIT campus and the rest of Kendall Square. Enable MIT to develop in a manner consistent with its academic and research mission, so that it continues to be a magnet attracting innovative businesses to the area • Support a vibrant environment for creative interaction • Support the central theme of nurturing Kendall's innovation culture • Continue to support city and state economic development
Place-based activities	• Support open space and recreation needs of a growing neighbourhood • Create lively, walkable streets • Expand convenient, affordable transportation and access choices • Enhance streets as public places

	• Create a healthier natural environment • Reduce resource consumption, waste emissions • Leverage the environmental and economic benefits of compact development • Public place improvements
Inclusion-oriented activities	• Expand opportunities for Kendall's diverse community to interact • Leverage community and innovation benefits of mixed-use environment • Minimize development pressures on traditional neighbourhoods

(Source: Cambridge Community Development Department, 2013, Bevilacqua and Pizzimenti, 2018)

Cambridge Innovation Centre is the key to the success of Kendall Square. Founded in 1991, the nature of Cambridge Innovation Centre is an innovative co-working place for convening, working and growing through renting office spaces to start-ups, researchers, and any other innovators (Budden and Murray, 2015). "Cambridge Innovation Centre offered flexible and high-quality spaces including stocked kitchens, conference rooms, internet, printing and copying, telephones, high-end furniture, operational and technical support and concierge in a reasonable cost from US$425 to US$1,500/person/month (Trillo, 2021)". Cambridge Innovation Centre contains over 700 companies and about 500 of which are start-ups from Kendall Square and Boston Downtown, where the companies are mixed across the floors and not clustered by sector (Trillo, 2021). The Centre provides a space for making informal decisions, exchanging cross-clustering knowledge and achieving cross-fertilization of innovative ideas (Trillo, 2021). And it also offers temporary office space to companies such as Google before they make final decisions about office locations (Trillo, 2021).

Framework for ID Impacts

ID Manchester: context

This section of the report presents a detailed look at the case of ID Manchester, and uses the findings from the rapid review and international case study analysis to map out a set of potential impacts that Manchester ID can aspire to. It also identifies activities to achieve theses impacts based on international good practice, and finally presents some principles for how such impacts might be monitored.

ID Manchester is the next phase of Oxford Road Corridor expansion and a commercially-focused innovation neighbourhood (Oxford Road Corridor Partnership, 2021). ID Manchester aspires to be a world-leading applied innovation district for new ideas and disruptive technologies and a world-class innovation platform capable of driving inclusive and sustainable economic growth for the city region and beyond. It also aims to build a green and vibrant new neighbourhood (Bruntwood SciTech and The University of Manchester, 2023). According to the Manchester Digital Strategy, ID Manchester will be embedded in place-based urban regeneration programmes such as a network of smart places and digital neighbourhoods to ensure everyone has accessible, affordable and equitable access to the digital world (Manchester City Council). Furthermore, great emphasis is placed on "setting and raising its standards to develop the infrastructure to attract world-class knowledge workers to work, relax and live within the area" (Corridor Manchester, 2015). Manchester City is Britain's core city to achieve well-connected, innovative hubs of high-value activity (HM Treasury, 2021). It is also important to note that Greater Manchester is one of three Innovation Accelerator regions in the UK (Department for Levelling Up and Communities, 2022). Table 2 summarises the strengths, weaknesses and threats, opportunities, and challenges to develop ID Manchester.

Table 2 The potential of ID Manchester

Strengths	***Opportunities***
• Location in the city centre • Joint Venture Investor and Developer Partner (Bruntwood SciTech) • Full advantages of public transport infrastructure (Piccadilly train station and Northern Powerhouse Rail) • Single ownership of ID Manchester property • The rich assets along Oxford Road Corridor: higher education, health, culture and commercialisation assets • The developing ecosystems around Circle Square, Enterprise City and ID Manchester • Rich talents	• Greater Manchester is selected as one of the eight functional economic areas in the Investment Zones • ID Manchester is chosen as one of the priority approaches in the Manchester Economic Recovery Plan. • City Centre Transport Strategy 2040 (CCTS) for improving the accessibility (walking and cycling) to public spaces, attractions and facilities in the Oxford Road Corridor area • Northern P owerhouse for digital and technological investment • The agglomeration of economic activities and innovation cluster (health and advanced materials) • Economic geography location outside the London and largest office market • Ongoing urban regeneration
Weaknesses/ Threats	***Challenges***
• Manchester in low productivity growth • Housing shortage in Manchester • Economic disparities and regional imbalance in Greater Manchester	• Open dialogue and a shared vision with all stakeholders from the outset • Leadership for the long-term development • Digital neighbourhood: how everyone has accessible, affordable and equitable access to the digital world.

• Skills shortages of the residents and the high rate of worklessness in Manchester • Deprivation in Manchester • Too many students leads to local community pressure	• How ID Manchester's innovation ecosystem is embedded in the existing local innovation ecosystem • How ID Manchester links to surrounding communities and the long-term residents

(Source: summary from stakeholder interviews and government documents)

Theory of change for ID Manchester

Figure 3 presents a theory of change to understand how ID Manchester can drive the knowledge-based economy and productivity growth, urban revitalisation, sustainable development and neighbourhood vitality and inclusive growth. ID Manchester will 1) as a catalyst, enable an economic transition towards a knowledge-based economy in Manchester City, Greater Manchester, the North/Northwest of England and the UK; 2) as a driver, succeed in a new period of urban revitalization through bottom-up, people-powered and experimental regeneration; and 3) as a platform, contribute to social inclusion and neighbourhood vitality through public engagement and empowerment. Five aspects of resources will be put into ID Manchester containing economic inputs (critical mass and innovation capacity), urban inputs (planning, and governance) and social inputs (communities and talents). To achieve the desired impacts, a series of initiatives and programmes will be designed, which can be categorised into three types: cluster-led activities, place-making activities, and inclusion-oriented activities. Cluster-led activities will increase job opportunities and tax revenue, absorb next-round investment, and create new patents, products, services and processes. Additionally, ID Manchester will update the quality of the place such as, mixed land use, open space, connectivity and accessibility in physical and digital infrastructure, green infrastructure, and a safe environment through targeted place-based activities. ID Manchester will provide homes to the city, improve the skills of talent, workers, and residents and support engagement for the surrounding communities. In terms of long-term development, ID Manchester will not only build a sustaining innovation ecosystem but also embed in local, urban, and regional innovation ecosystems. ID Manchester will develop its sustainable supply chains from research to commercialization. These will lead to the productivity growth of the local economy and decrease economic disparities. As a successful brownfield regeneration project, ID Manchester will become a new urban hub in the city

centre that raises the national and global profile of the city. Along with the infrastructure renewal, ID Manchester will improve the quality of place and help firms in the district to address sustainable development such as net zero carbon and energy efficiency. ID Manchester highlights the significance of inclusive development to undertake social responsibilities and meet public values, which will improve the quality of urban life and place identity, change the behaviour or lifestyle and slow down deprivation.

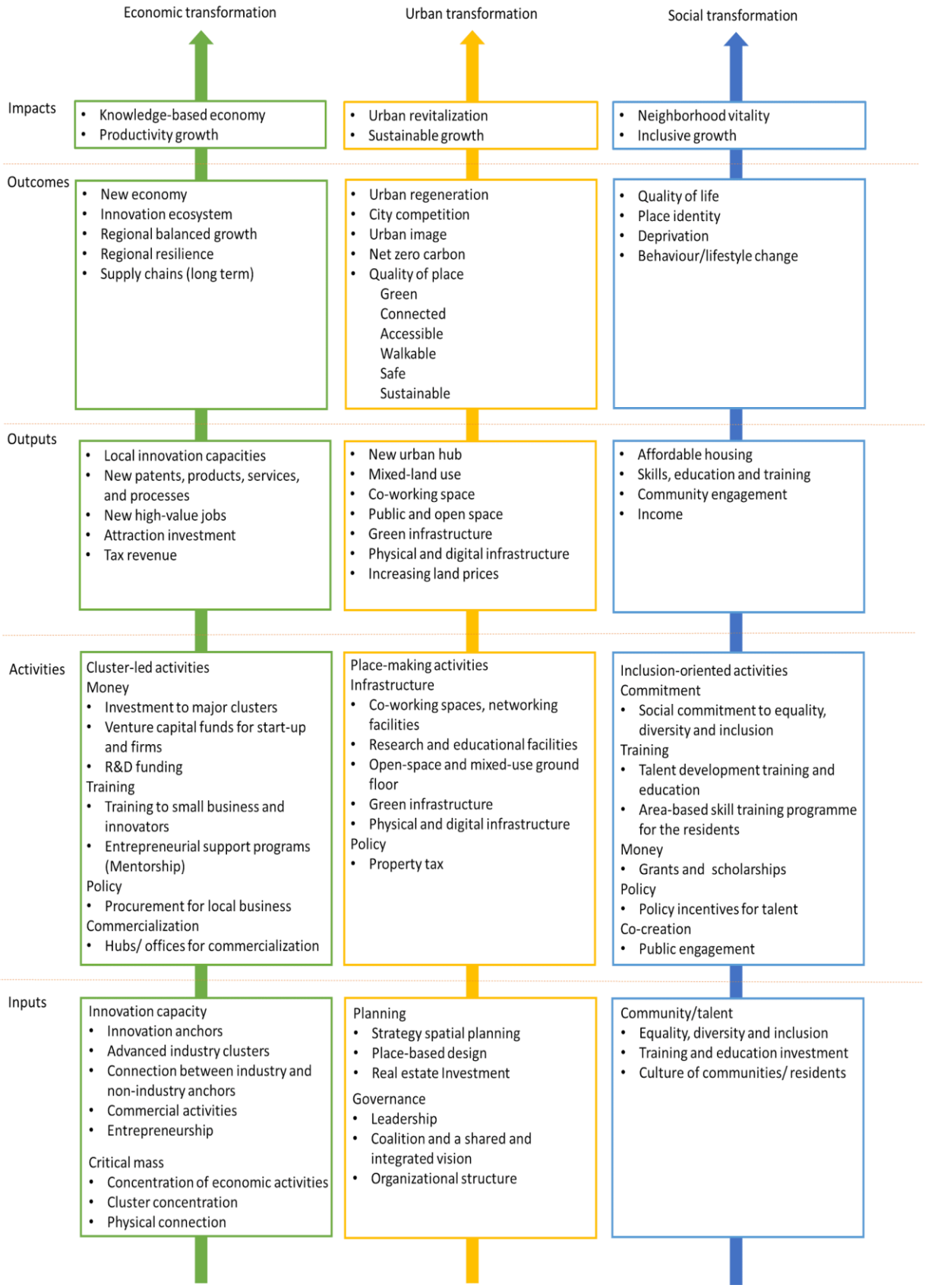

Figure 3 Theory of Change for ID Manchester. (Source: authors).

Recommendations: impact and monitoring strategies for ID Manchester

Activities to generate broader impacts

The theory of change indicates a set of key activities relating to economic, urban and social impact that ID Manchester should focus on in order to generate wider sustainable urban development, urban revitalisation and social inclusion. Table 3 summarises key activities.

Table 3 Recommended activities for ID Manchester

Economic activities	***Urban revitalisation activities***	***Social inclusion activities***
Building an effective and self-sustaining innovation ecosystem of ID Manchester embedded in the existing local innovation ecosystem (Oxford Road Corridor, Manchester, and Greater Manchester) including governments, R&D-performing organizations, finance providers, funders, international and domestic partners, businesses, and others	Developing a holistic development strategy that could integrate multi-level policy goals where ID could embed in a wider urban and city-regional geography. Offering the spaces for living and playing to talents, skilled workers, and graduates and developing an inclusive public realm.	Social commitment to equality, diversity and inclusion.
Building hubs for developing supply chains from R&D, to development, to commercialization.	Identifying the leadership with a clear and coordinating role and establishing a mission-focused coalition for holistic development across the political, business, and institutional spectrum. Increasing inclusive and accessible green spaces to improve the quality of place and urban life.	Co-design and public engagement to achieve the social missions at the early stage of plan-making.
Creating partnerships within the local innovation ecosystem, developing domestic and international networks between industries and non-industries and cultivating local businesses and their network.	Creating multi-level governance structure through long-term partnership (formal and informal), networking and well-organized interaction, for instance, strengthening coordination with local, city-region, and national government, collaboration with multi-level industries and non-industries, corporations within local innovation ecosystem as well as broader partners. Constructing the infrastructures and helping firms to meet national and international sustainability targets with net-zero emissions and energy-saving.	Deeping a talent pool by funding support and policy incentives.
Providing support conditions, funding, training and policies to start-ups and inventors at the early stage and to visitors, foreign companies	Developing coworking, meeting and mixed-use public spaces for everyone who works and lives in the district for knowledge-sharing and development	Developing citizen engagement programmes into entrepreneurial activities

and international researchers for the establishment.		
Developing demand-side entrepreneurial initiatives.	Developing urban experimentation and opening testing facilities and laboratories.	Leverage existing schemes from key partners that place long term unemployed from neighbouring areas into jobs.
Maximizing the value of existing economic assets and reinforcing innovation cluster.	Achieving connectivity and accessibility through physical and digital networks. Developing a holistic development strategy that could integrate multi-level policy goals where ID could embed in a wider urban and city-regional geography.	Providing career training and sectoral-focused skills courses to graduates, and residents to meet recruitment requirements from high technology industries.

(Source: authors)

Monitoring outputs

In terms of the logic model of 'input-activity-output-outcome-impact', any stage of the process can be monitored. Impacts by definition take time to emerge from inputs and activities. Returning to the theory of change represented in Figure 3, it is easier to monitor outputs that are directly related to activities, such as the amount of training provided to businesses than outcomes and impacts like more resilient local supply chains and increased productivity. Table 4 identifies metrics the global review of IDs that have been used to monitor economic, urban and social outputs:

Table 4 Monitoring outputs

Economic outputs	***Urban outputs***	***Social outputs***
Increasing national and international ranking of anchors' research and commercialization	Creating a holistic vision and mission-oriented initiatives	Increasing number of living spaces
Increasing number of headquarters	Building a clear leadership and governance structure	Increasing presence in the talent pool from minorities
Increasing number of companies from advanced industry clusters	Increasing number of networking opportunities between industries and non-industries, between inside and outside local innovation ecosystem, and between domestic and global partners	Increasing education and training for skilled workers, graduates and residents from minorities
Increasing number of small and mid-sized companies, and start-ups	Increasing co-working space	Increasing procurement policy and technical and financial assistance for local businesses from minorities
Increasing number of incubators, and accelerators	Increasing public realm and accessible open space	Increasing public engagement from scratch
Increasing number of local businesses	Increasing connectivity in walking, cycling and driving networks and free WiFi network	
Increasing number of academics, researchers, staff and students participating in the incubators and accelerators		
Increasing industry R&D expenditures		
Increasing funding to small businesses and innovators		
Increasing funding to visitors, foreign companies and international researchers for the establishment		

(Source: authors)

Monitoring outcomes and impacts

Outcome and impacts are harder to monitor as they only emerge over longer timescales and are harder to attribute to specific activities. Attributing changes in regional productivity to an SME training scheme 5-10 years previously is challenging. Positive social impacts such as improved sense of wellbeing among local residents are hard to attribute to the effects of being near or in an innovation district. There is no doubt that these kinds of impacts are important to realise the full potential of IDs to contribute to sustainable urban development. A number of approaches can help address this challenge:

- *Qualitative methods.* Surveys with local residents, users of and visitors to ID Manchester to assess their interactions with the development and self-reported impacts. Surveys can be digital or in real life, administered or self-administered, and incorporated into buildings and feedback touchpoints. This kind of data can also be used to be responsive to emergent types of impact that the development may be having.
- *Longitudinal data.* Repeating surveys with individuals over time can build up a rich picture of how specific activities generate longer-term impacts on the lives and livelihoods of people. This kind of monitoring can produce powerful and personal stories of change.
- *Automated and real time data*. IoT sensors offer cheap and reliable ways to understand the use of the ID Manchester space and its impact on key environmental variables that influence liveability and human health. Sensors to count people and identify the different uses of space over time by people can be paired with environmental sensors to monitor long-term changes in temperature, humidity, air quality and so forth.
- *People-led*. ID Manchester provides new outdoor space, but it also provides new indoor spaces. Understanding the use and environmental quality of these spaces is key as most people will spend their time inside. While the outside spaces are essential to monitor for accessibility, inside spaces should be part of an inclusive public realm where possible. Similarly, ID Manchester will need to physically connect to the neighbouring communities and city. Monitoring these connecting corridors will generate insights about how well the development is integrating with surrounding neighbourhoods.

Partnerships for monitoring

The lack of robust evidence concerning the impacts of IDs, and arguably urban regeneration schemes in general, reflects the challenges of identifying pathways to impact and collecting relevant data to evidence them over time. IDs are often based on partnership models of governance, bringing developers, municipalities and Higher Education Institutions together to unlock the power of the knowledge economy to generate inclusive economic growth. The

opportunities to generate broad beneficial impacts and the challenge of monitoring these should be approached as part of this commitment to long-term partnership (Paskaleva et al., 2021).

ID Manchester has many of the pieces of this jigsaw in place already. It is underpinned by a civic commitment by the partner institutions to deliver benefits to the surrounding neighbourhoods, city and city region over the long term. ID Manchester is led by one of the leading universities in the UK, which can provide intellectual and human resources to develop an internationally leading approach to impacts and monitoring. This topic has research as well as civic relevance. The question of how the knowledge economy can drive sustainable urban development, urban revitalisation and social inclusion is significant to current policy agendas, from levelling up to net zero. Approaches to evidence broader impacts from urban development can also help to unlock ESG investment.

Often research funding cycles are too slow to address the immediacy of real-world challenges. Monitoring impacts lends itself to longer research schemes like centres or PhD projects. It requires a multidisciplinary approach that can capture impacts across the economic, urban and social domains and deploy a range of qualitative and quantitative methodologies (Bannan et al., 2022).

Finally, monitoring in partnership provides a route to ensure that ID Manchester is responsive to the needs of the city in which it lives. Feedback loops provide an opportunity to improve the connection between stakeholder communities and ID Manchester and demonstrate the positive difference it makes.

A monitoring strategy that is responsive and inclusive will support the ambition of ID Manchester to be a genuinely innovative and inclusive place that generates a wide range of benefits. It will also be of interest to cities around the world.

Appendix 1 International examples of innovation districts

Name ***City (Country)*** ***Time*** ***Type***	***Input***	***Activity***	***Output***	***Outcome***	***Impact***
Chattanooga Innovation District Chattanooga (US) 2017 Anchor-plus	• A new framework plan for Chattanooga's Innovation District (2018) • Developed through the university (downtown campus) plan • The strategy of downtown redevelopment • The Technology, Gig, and Entrepreneurship Task Force • Mayoral leadership • Partnership with nonprofit entities and for- profit enterprises	• Edney Innovation Centre (Online-learning hub) including Co:Lab (a highly successful business accelerator); Enterprise Centre (TGH) (a nonprofit formed to support innovation and the digital economy), and Society of Work (a membership-based, shared office space group) • Gig City initiative • A citywide internet network • Creating an urban lab to produce economic opportunities for local residents • Underground telecommunications fibre (Martin Luther King Corridor) for smart city outdoor laboratory • MetroLab (a network that encourages universities and cities to engage in joint research) • A lively, mixed-use and densely developed urban core • 'Satellite office' for recruitment • Payment-in-lieu-of-taxes program or PILOT (affordable housing)	• Housed 671 businesses and employed 14,000 individuals • New business investment and private investment • New residents • Taxes on hotels and motels and the sale of publicly owned properties • Empowering participation through a sense of ownership	• Gentrification in downtown from low-income households to middle-/high-income households • Reducing affordable housing • The highest levels of economic disparities • A new urban image by the visitor economy • The city transforms into a regional tourist centre • Providing a quality and recreational	• Downtown revival and urban transformation • Local economy growth • Brought considerably social unsettling, greatly contributing to the decline, that is "a deepening of income and racial inequities in the midst of metropolitan progress".

		• Tech Goes Home Chattanooga (Digital Inclusion) • CreateHere (a collective of programs, projects, incentive funding, and individuals working for creative economic and cultural development) • A plethora of year-round activities: festivals, concerts, theatre productions, symphony and opera performances, wine tastings, fireworks, art exhibits, and farmers markets		infrastructure for existing residents	
Philadelphia Innovation District Philadelphia (US) 2015 Anchor-plus	• Collaborative leadership and new types of organizational structures (bring key regional actors to the table to jointly develop and implement the kinds of strategies) • City-wide organizations	• Support entrepreneurship • Increase seed funding • Industry collaboration • Physical infrastructure	• More and better-paying jobs • Higher gross metropolitan product • Increased revenues	• Advance the district's innovation ecosystem • Improve the competitive position of the Philadelphia region • Reinvested in cities and their citizens	
Boston's Innovation District (Including five sub-districts: Fort Point, Seaport, Port, Convention Center, and 100-Acres)	• Capital investments • Concentration of higher education institutions, research and manufacturing capabilities, and venture capital firms	• Tech Goes Home (TGH) (Digital inclusion program) • Breeding additional cross-sector activities and partnerships • Attracting both established companies and emerging entrepreneurs, and developing	• More than 200 startups • Creating 5000 new jobs • The city's reputation as a hotbed for tech-driven entrepreneurship • Boston was the top destination for venture	• New challenges of accessibility, affordability, and identity • The city's ability to promote	• Entrepreneurial neighbourhood

Boston (US) 2010 Reimaged urban area Government-led	• MONUM Office (the Mayor's Office of New Urban Mechanics 2010) aimed at exploring and tackling experiments and prototypes that cover a range of topics • Imagine Boston 2030 (The City of Boston spatial framework) • South Boston Waterfront Sustainable Transportation Plan (2014)	infrastructure and amenities to holistically support work-life opportunities • District Hall (First public innovation centre) • Future streets and mobility • Education and youth employment • Storytelling and engagement • Housing for all • Welcoming and resilient place • The world's largest start-up accelerator 'MassChallenge' and 'Factory 63' • A tax agreement	capital investments in the United States • Affordable rents helped the neighbourhood continue to grow • MassChallenge Boston startups raise an average of $75,000 during the program • District Hall hosted over 900 events and over 95,000 visitors and invested one million dollars in the community in sponsored event spaces	dynamic economic growth	
One-North Singapore (Singapore) 2001 Urbanized science park Government-led initiative	• Develop Biomedical cluster (Biopolis), Physical Sciences/Engineering and ICT cluster (Fusionpolis), and Digital Media (Mediapolis) • One-north Master Plan including Mixed Use space (work or industry spaces and live or residential spaces); Connectivity (IT, transport,	• Test bedding of new products: CNG car, Segway and IMTS (Intelligent Modal Transport System) • Promoting private sector participation: government-private partnership and tendering land out to private developers • The government for high-risk and non-profit development (library/ museum) • NTU City Campus (higher educational space for adult continuing education and an Alumni Clubhouse of National Technology University of Singapore, a business	• Biomedical cluster (Biopolis) with over 260,000 square metres of space • Physical Sciences/Engineering and ICT cluster (Fusionpolis) over 120,000 square metres of space • Digital Media (Mediapolis) by shared facilities such as soundstages, advanced digital screen studios, motion capture studios, and broadcast facilities.	• Work-live-play-learn innovation hubs	• Innovation based economy

	pedestrian, social and business network); Rejuvenation (land use zoning); and Unique identity • Governance: E-21 Ministerial Committee, One-north Steering Committee, One-north Resource Advisory Panel, One-north Review Committee and One-north Software Remaking Committee	incubation centre, theme park swimming pool, outdoor spa retreat, book café, preschool, bowling alley, wine bar, theatres and function rooms) • INSEAD expansion (French business school) • Wessex Estate and condominium at Slim Barracks (Residential development) • Hotel and South Park Quadrant (hotel, apartments, office, retail space and civic institutions-library) • Rochester Heritage cluster (F&B outlets) • Buona Vista Park (public recreation space for the community) • New programs catering (the evolving needs of the growing communities) • Bent grid system (for visitors and the community) • Tree planting • Roof carpet • Conversation and adaption reuse of existing old buildings and road • Arts integration into public space	• Housing 400 leading companies and global institutions in high-tech and knowledge-intensive industries, 16 public research institutes, 6 institutes of higher learning and corporate universities, and 50 incubators with approximately 800 startups • Having 3,900 residents. • Having a working population of about 50,000 • Providing a unique social node for the increasing one-north community • The site is also 2 degrees cooler than other parts of Singapore because of the lush canopies of the mature trees. • Promoting distinctive spatial forms for urban activities in the sky (Roof carpet)		
Medellinnovation District Medellin (Colombia) 2012 Anchor-plus	• Led by Ruta N Corporation • Masterplan (Science, Technology and Innovation (STI))	• The soft-landing program for attracting knowledge-intensive international startups (ICT, health, and energy) such as rent space • Co-creation with its residents in the planning process including	• 197 companies from 27 countries landed, generating more than 4,216 jobs • 2178 houses were registered throughout the	• The quality of life of its population • Urban fragmentation and conflicts	• Knowledge city • The sustainable growth of the future country (attractive and competitive for

	with a long-term vision • Listed as Municipal Development Plan (with municipal government support through public policy) • City invested 2.14% of its economy ($408 million) in science, technology and innovation activities • Governance: an association between public entities, non-profit, of common utility and social interest (University-Company-State Committee) • Support by Colombian law • EPM-UNE (public multi-utility and communications company) as the investor, the institutional incubator for Ruta N's mission and model, and	interviews, observations, focus groups, innovation bazaars, creative lunches, census, co-creation activities, and conferences through four approaches approaching the community, co-creating with the community, communicating with the community, and including the community in the development of the innovation district • The DistritoLab program involved the participation of local high school students • Open House (build a connection between city and entrepreneurship, provide mentoring and training, and learn about the work of Ruta N) • Open kitchen program for existing restaurants and bars • A Living Lab for local residents to test prototypes and new services • Generation N (a project for teachers from educational institutions that seeks to transform the experience of students through project-based learning) • STI Observatory (a tool for monitoring global trends in science and technology in the markets of health, information and communication technologies, energy, and biotechnology for the agricultural sector)	district, where a total of 2261 households are located, for an average of 1.04 households per house • Attracting businesses and talents • Supported more than 500 projects and attracted more than 150 domestic and foreign businesses to settle on its premises within less than 10 years • (Generation N) Benefit about 1,500 students in education between 3rd-11th grades in areas of science, technology, engineering and mathematics (STEM) by working directly with their teachers • (Investmeter) Investments were $31.5 million benefiting 25 companies, with $8.7 million from Private Capital Funds, $1.7 million from the Angel Investor Network and $21 million from other investment channels	with the surrounding community (Residents' feeling of being instrumentalised, Residents' sense of uncertainty, and Residents' fear of expulsion)	investors and other large governments)

	programmes and structures	• Investmeter (a tool implemented to measure the dynamism of active investors in the city) • Tax breaks such as the property taxes and industry and commerce taxes for companies of the following clusters that are located in the district: ICT, energy, health, textile, construction, design, and tourism			

@22 Barcelona (Spain) 2000 Reimaged urban area Government-led (at the beginning)	• A regeneration plan • Modification of the General Metropolitan Plan (MPGM) • Around €180 million of total investment in infrastructure investment	• Encouraging new-generation activities related to and requiring education, creativity and innovation • 'Repensem el 22@' (a citizen participation movement) with will develop, through an open and inclusive methodology that guarantees real participation of citizens, shared diagnosis of challenges and needs and a strategic proposal to rethink 22@ • Balancing the creation of new employment • Provision for housing and social amenities. For example, 1) mixed residential development including social housing, live-work spaces, and relocation of universities, and 2) the development of leisure facilities, new green spaces, and rapid transportation systems both within the district as well as between it and the rest of the city, 3) the development of heating and air-conditioning, electricity distribution, pneumatic waste disposal, telecommunications infrastructure	• Four industry clusters: ICT, Media, Bio-Medical, and Energy • Creating around 25,000 jobs and over 1400 new firms and institutions • Around 20% to 25% of the workforce in these new firms and knowledge-based industries could be from the international community • 4614 existing homes and the construction of around 4000 new subsidised units • 114 000 m^2 of green-area land	• A new international heart of the city Barcelona as a global hub of innovation for knowledge-based industries and providing new international market opportunities for existing firms. • A well-educated, mobile international community for high-quality housing and services to support the lifestyle • Promotion of the district image and branding • An international community	A leading knowledge society

(Source: summarized by authors)

Appendix 2: ID inputs

Input	*Category*	*Elements*	*Description*
Economic inputs	Critical mass	Concentration of economic activities	• Employment density • Working commuting • Residential density • Concentration of existing buildings for adaptive reuse
		Cluster concentration	• Concentration of anchor institution (university, medical centre, and large anchor companies) • Concentration of small and mid-sized companies, and start-ups • Concentration of innovation intermediaries (incubators, accelerators, coworking spaces, etc.) • Industry sectors concentration • Talented workers concentration
		Physical connection	• Connection to domestic and international transits • Connection to the rest of the region • Physical barriers for accessing to surrounding areas
	Innovation capacity	Innovation anchors	• Strengths of non-industry institution (R&D funding, STEM graduates, publications, research labs, university ranking and major academic departments) • Strengths of firms (Patents, STEM and IT workers, corporate research centres, Headquarter companies, industry-weighted R&D expenditures, and technology experts by industry) • Specific research strengths (Rankings of academic departments, star faculty, subject R&D funding, research-specific centres and prestigious, and location quotients by subjects)
		Advanced industry clusters	• Strengths of advanced industry cluster (for jobs, output and productivity) • Strengths of relative cluster

			• Cluster opportunities (Supply chain, job, growth trends and connection with adject industries)
		Connection between industry and non-industry anchors	• Formal connections (cross-discipline patents, sponsored research by industry, joint publications, and joint degrees) • Informal connections (internships and students, hiring of recent graduates and staff, proximity of research centre)
		Commercial activities of anchors	• Formal commercialization (license agreements, patents, and start-up by institution, sharing R&D expenditures, and translational and applied research awards) • Informal commercialization (master agreements, informal partnership with industry, Faculty on scientific boards, local alumni spinoffs, approach of tech transfer office, and faculty-related spinoffs)
		Entrepreneurship	• Start-up (new high-growth firms, new firms by sectors, and new job by new firms) • Recourses (coworking spaces and accelerator programs, total venture capital, mentorship programme, management-level recruitment) • Supports by region (External funding such as relocation, post-seed funding for start-ups, funding for innovators, local venture capital, serial entrepreneurs and total IPOs and acquisitions, size of deals and retention of founders)
Urban inputs	Planning	Strategy spatial planning and place-based design	• Connectivity Walkable street network Accessibility to surroundings (infrastructure, open space, and large space uses) Sidewalks and pedestrian in safety Accessibility by foot (Active ground floor) Digital connection • Proximity Sufficient employment and residential densities Publicly accessible mix-used ground floors (shops, cafes, bars, restaurants, maker spaces, parks, squares, cultural spaces, etc.) Public and private innovation spaces for events (accelerators, innovation centres, co-working spaces and public innovation halls) • Property ownership

			• Public engagement in the design, planning and management of public space
		Real estate Investment	
	Governance	Leadership	• Support innovation and entrepreneurship • Enhance connectivity and quality of place • Promote diversity and inclusion
		Coalitions (for early stage)	• Collective goals/vision setting • Stakeholder diversity
		Structure	• Formal governance structure by existing organization • New organization (values, capitals, powers, and responsibilities)

Social inputs	Community/ talents	Diversity	• Diversity in district workers, researchers and students (ethnicity/ gender) • Diversity in surrounding residents and communities (race/gender/foreign-born) • Diversity in ownership of district businesses (minority-/woman-owned)
		Equity	• Equity in the entry requirements for occupations • Well-paying and accessible occupations • Economic disparities (wage by race)
		Inclusion	• Workforce from surrounding residents • Socioeconomic status of residents (poverty/median household income/education/unemployment and labor force participation) • Community engagement
		Research and education investment	
		Culture of communities/ residents	

(Source: modified by Anne and Bass, 2018)

Appendix 3: Activities of Cortex Innovation Community

Activities	*Pathway*	*Actions*	*Description*
Cluster-led activities	Innovation and technology development	Patents held by companies STTR (The Small Business Technology Transfer) program and SBIR (The Small Business Innovation Research) program Access to R&D core facilities	
	Venture development and business services and supports	Ameren Accelerator	12-week accelerator program for companies in energy and sustainability and provide $100,000 in funding, office space, mentorship and engagement
		BioGenerator	BioGenerator invests and mentors' life science companies
		Capital Innovators Accelerator	Capital innovators invests in start-ups and provides them with mentorship, networking, back-office tools and support and other resources
		Fundamentals	Customized one-on-one coaching, mentoring and classes for the founders of life science start-ups
		MedLaunch	A non-profit, biomedical and entrepreneurship incubator
		Sling Health	A student-run biomedical technology incubator providing resources, training and mentoring to teams of students
		SBIR/STTR Training	Workshops, training and coaching for writing successful grant
		Square One Bootcamp	A 10-week program for early-stage entrepreneurs on developing businesses in bioscience, IT, manufacturing or consumer products
		Square One Ignite	A 4-week program for entrepreneurs on validating their business model and providing support organizations and mentors
		Square One Level Next	Investment graduates for mentoring and supporting their business in six months
	Capital for pre-seed, seed venture capital rounds and expansion capital	Ameren Accelerator	Investment for companies selected to participate in accelerator
		BioGenerator	Investment in life science companies
		Capital Innovators	Investment in start-ups companies in IT
		Cultivation Capital	Investment in young companies in life-science group
		iSelect Fund	Investment for early -stage private companies moving from concept to commercialization
		RiverVest Archer Seed Fund	Investment of pre-seed and seed funding early-stage in biopharmaceutical/biomedical companies
		Square One Level Next	Investment graduates for mentoring and supporting their business in six months

Place-making activities	Placemaking in infrastructure, building and facilities development, transportation infrastructure and community space	Duncan Cortex 1 BJC @The Commoms Forest Parks Commons and Streetscape 1 BioGenerator Expansion CIC@CET (Phase 1 and 2) Duncan (Crescent buidling) Custom Streel (Garage) Duncan Avenue Sewer Infrastructure MetroLink Rail Station	
Inclusion-oriented activities	Education, training and workforce development	COLLAB	Cybersecurity graduate program Open, shared space for industry and academic collaboration including talent recruitment, research partnerships and community engagement
		Gateway Higher Education Cybersecurity Consortium	Academic Consortium with the mission of filling cybersecurity jobs and facilitating academic collaboration on research, events and grants
		Start-up Talent Showcase	Organized spring and fall fairs to connect students with start-ups and corporations in a matchmaking-style environment
	Community, networking, interaction facilitation and events	Chess Tournaments	Hosting of 2-3tournaments at each winter
		Cortex Connections Newsletter	A weekly newsletter such as Cortex Commons news, construction updates and entrepreneurship events
		House of Genius	A community event run by volunteers that brings together 20 strangers to help 3 entrepreneurs solve their start-ups problems
		Start-up Talent Showcase	Organized spring and fall fairs to connect students with start-ups and corporations in a matchmaking-style environment
		Innovation Hall and Civic lounge	A fully service event space for the community with catering
		Let's Discuss Sessions	Venture café monthly discussion serious among racial and social equity issues
		Tours	Introducing people from outside to Cortex
		Vision St. Louis	St. Louis annual conference aimed at building an inclusive and diverse innovation community

(Source: TEConomy Partners LLC, 2019)

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