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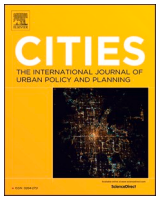
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Cork City, Ireland: A blueprint for transformation in second-tier urban centres

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ABSTRACT

This paper analyses Cork's trajectory towards a sustainable, innovative, and globally connected urban centre. On Ireland's south coast, Cork serves as an exemplar of how second-tier cities can undergo transformation and structural change, emerging as an exemplar of economic success. The paper explores the synergies between policymaking, labour markets, and transportation improvements, specifically in the pharmaceutical and IT sectors, noting their clustering and success in international markets. It explores challenges and opportunities presented by demographic shifts alongside an analysis of Cork's transport system, its port capabilities, and connectivity.

The paper links to the UN SDGs and suggests strategies to promote sustainable growth and boost innovation. These enhance Cork's technological capacities, educational attainment, sustainable urban planning, and transport systems. It offers insights into urban development, focusing on place-based, future-oriented solutions and strategic directions for Cork.

This study extends beyond Cork, offering a roadmap for other second-tier cities grappling with similar challenges and opportunities. It emphasises the need for comprehensive unified approaches to urban planning, aligning with global sustainability objectives, innovative standards, and best practices in city management. Cork not only pioneers its path towards resilience and innovation but also serves as a model for global second-tier cities, showcasing the growth and transformation potential of urban centres.

1. Introduction: Cork City - a paradigm of second-tier urban evolution and economic resilience

This paper unfolds the narrative of Cork City, tracing its remarkable journey from medieval times to its current standing as a pivotal urban and economic hub as Ireland's second largest urban centre after the capital city, Dublin. Delving into the annals of Cork's history, this work highlights the intricate interplay between the city's architectural evolution and its economic development, providing a window into how Cork has blended a rich heritage with modern dynamism to foster resilience and adaptability in the face of changing times.

From its early days as a fortified medieval settlement, Cork's trajectory has been one of significant transformation, shaped by key developments that have closely tied its historical essence to its economic progress. This exploration into Cork's past is not just a recount of its architectural and urban milestones but a critical examination of how these elements have underpinned the city's economic growth, highlighting Cork's capacity to adapt and thrive within an evolving economic landscape.

Shifting focus to the contemporary era, the narrative highlights the instrumental role of Foreign Direct Investment (FDI) in catalysing Cork's economic maturity. With a particular emphasis on the Information and Communications Technology (ICT) and pharmaceutical sectors, the paper explores how Cork's historical landmarks have become the bedrock for economic advancements, showcasing the city's agility in navigating the complexities of a globalised economy. This analysis extends to examine present-day challenges and opportunities - including labour market dynamics and transportation network intricacies, thereby painting a comprehensive picture of strategic positioning, port capabilities, and critical issues of connectivity.

The analyses culminate in a strategic proposition for Cork's ongoing development, advocating for potential to emerge as a prime destination for investment and talent. By synthesising the insights gathered from the historical and economic examination, the paper proposes a forward-

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looking strategy aimed at reinforcing Cork's status as a resilient, innovative, and globally connected urban centre poised for future opportunities. In doing so, the study draws upon seminal works of Brady (2016), O'Connor et al. (2017) and Han (2012), to highlight the critical reassessment needed regarding the role and potential of second-tier cities like Cork in national development strategies.

The ESPON (2016: 2) Policy Brief defines second tier cities as the largest cities in a country, excluding the capital, whose economic and social performances are sufficiently important to affect the performance of the national economy. Second tier cities are often overshadowed and historically overlooked, yet present untapped opportunities for fostering sustainable growth and innovation. With the correct infrastructure, facilities, and powers, they can achieve many of the agglomeration effects of capital cities (ESPON, 2016). Through the lens of Cork City, this paper champions a paradigm shift towards recognising and leveraging the unique contributions of second-tier cities to the broader spectrum of urban development and economic prosperity.

The paper is organised into thematic sections. It begins with an overview of Cork's historical evolution and its strategies for attracting foreign direct investment (FDI), then probes the specifics of its pharmaceutical and ICT sectors, offering strategies that can be replicated by similar cities. Subsequent sections examine Cork's integration of local education and labour policies, its tailored transport and digital strategies, and the broader implications for infrastructure policy in second-tier cities. The conclusion synthesises these insights into a strategic blueprint for sustainable growth and global connectivity, providing a roadmap for other second-tier cities.

2. The development of Cork City and its exemplary role among second-tier cities

The historical and economic evolution of Cork City, nestled in Ireland's southern region, serves as a good example of how second-tier cities can leverage their unique attributes to achieve significant growth and global recognition. Cork's journey from a 7th-century monastic settlement to becoming Ireland's second-largest urban centre is a testament to its strategic geographical advantages, cultural heritage, and adaptive economic policies. With a population of 224,004 in 2022 (CSO, 2023), Cork's development narrative is richly illustrated by its transformation from a medieval trading hub, favoured by its natural harbour and strategic location, to a fortified city marked by significant maritime and industrial advancements.

2.1. Historical foundations and industrial evolution

Cork City's historical foundations, underpinned by its establishment by Saint Finbarre and subsequent strategic importance during Viking and Anglo-Norman periods, laid the groundwork for its maritime heritage and economic resilience. By the late 12th century, the Anglo-Normans had captured and fortified Cork, as depicted in Fig. 1 illustrating the medieval walled city characterised by prominent towers, battlements, and crenellations (Cork City Council, 2023a).

Fig. 1 depicts Cork City's gates, a marine gate, and a central channel designed for ship access, facilitating its transformation into a fortified trading centre. The city's strategic positioning and walled structure fostered an era of prosperity, with trade routes expanding Cork's economic influence across Europe and beyond. The city's adaptation to expanding populations gave rise to new street patterns around the former wall (Cork City Council, 2023a), illustrated in Fig. 2.

Commercial activities in the 17th and 18th centuries also facilitated a shift towards industrialisation, notably in brewing, distilling, and shipbuilding, bolstered by the development of railways and the emergence of iconic establishments like Heineken Murphy's Brewery and the Glen Distillery (Cork City Council, 2023a; Cork City Libraries Cork Past & Present) as depicted in Fig. 3.

2.2. Strategic economic development and FDI attraction

By the 20th century, Cork's economic landscape evolved significantly, aligning with Ireland's broader national economic priorities and global trends towards open markets and free trade. The establishment of Cork Airport in 1961 marked a pivotal development, enhancing the city's connectivity and further positioning it as an attractive location for international business and investment. This era of industrial growth and

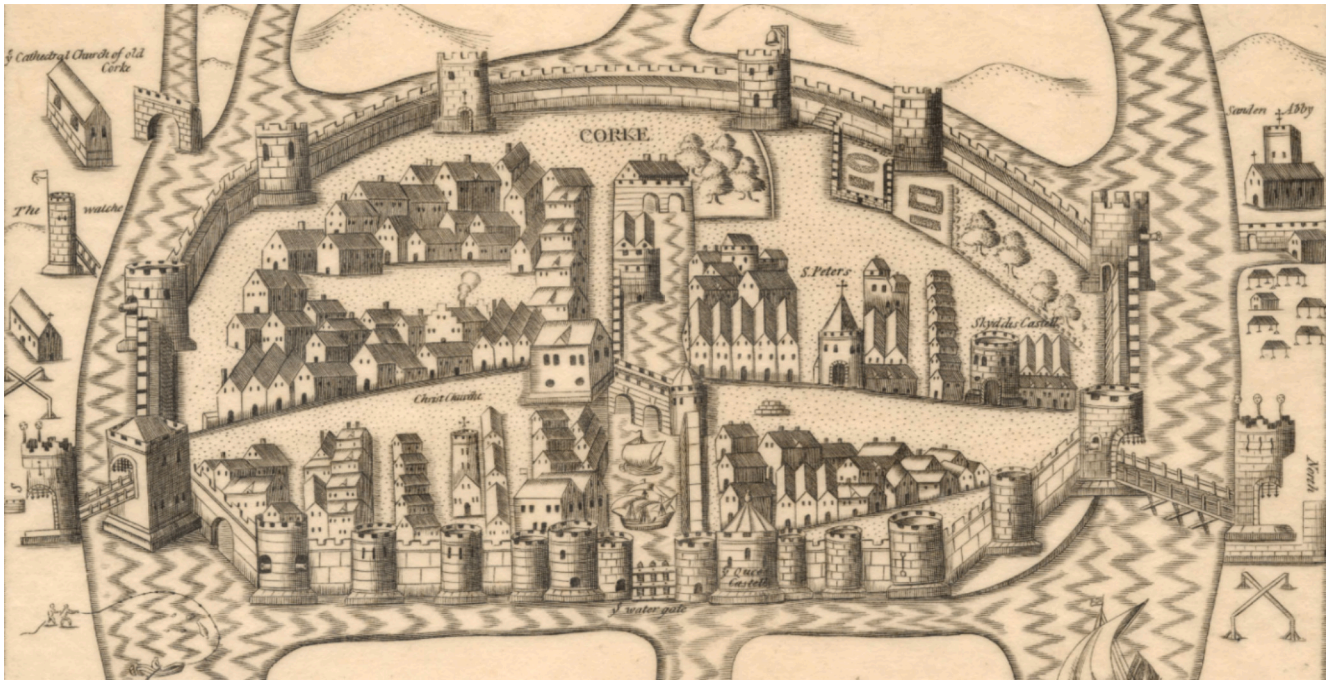


Fig. 1. Late 16th (early 17th) Century Map of Cork, Ireland.
Source: Ortelius, A. (1540). Late 16th (early 17th) century map of Cork. In T. Stafford, Pacata Hibernia 1633 (p. 137). London: Printed by E. Allde for John Partridge.

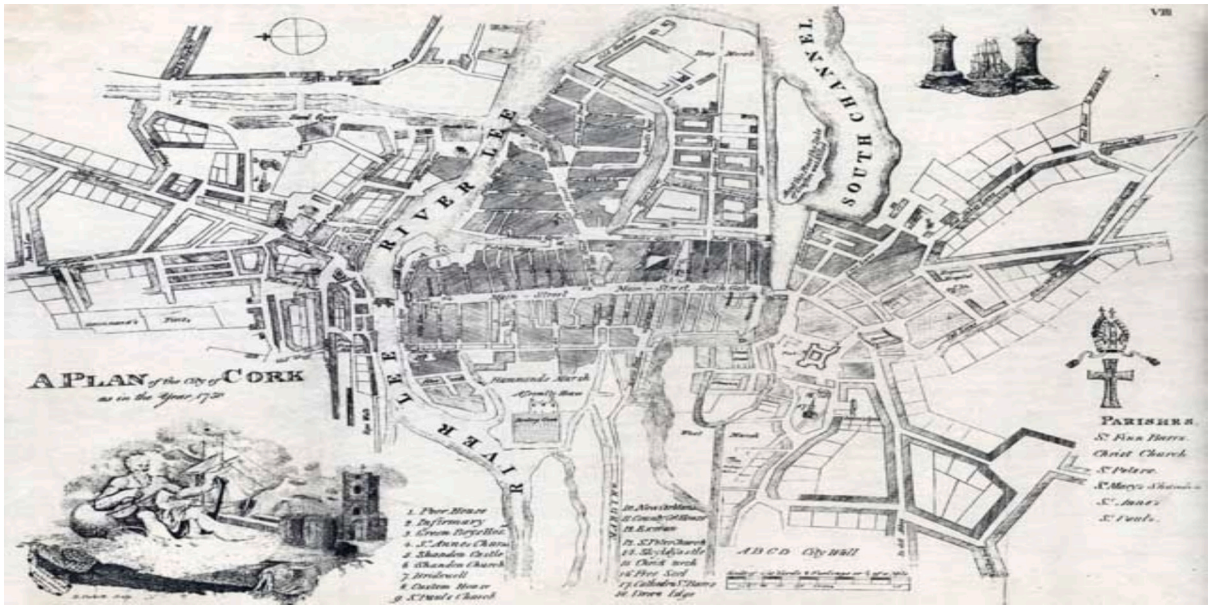


Fig. 2. City of Cork in the 18th century.
Source: Charles Smith, (1750) The ancient state of the city of Cork, Dublin. Copyright Cork City Libraries.

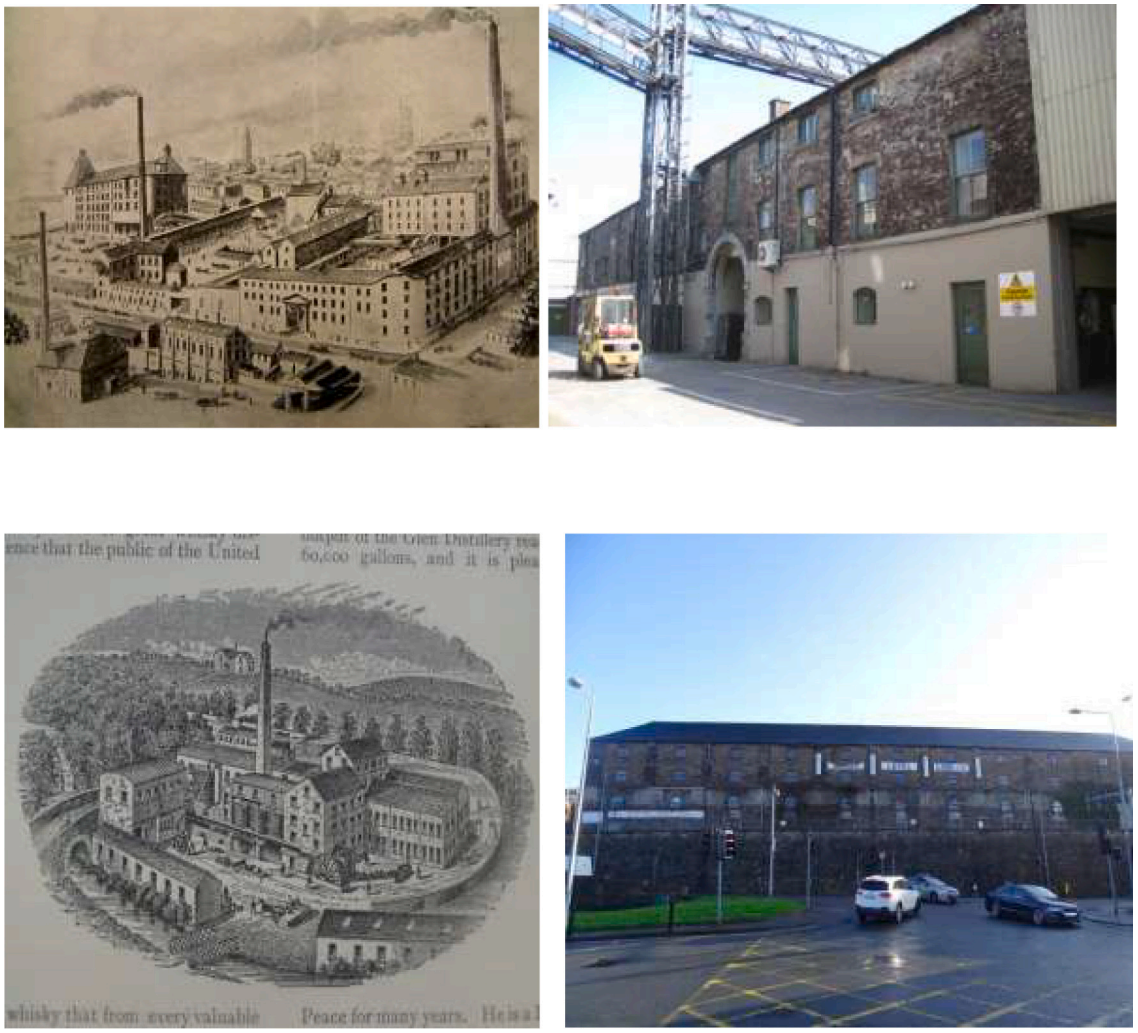


Fig. 3. Heineken and Glen Distillery, 19th century and present day.

diversification saw Cork embracing a surge in Foreign Direct Investment (FDI), particularly benefiting the Pharmaceutical and ICT sectors (Morgenroth, 2018; O'Connor et al., 2017).

Cork's strategic efforts in attracting FDI have been instrumental in its economic development, contributing to the city hosting over 190 multinational firms by 2024 and its significant contribution, 19 %, to Ireland's GDP (Cork City Council, 2023b). The city's recognition as the "No. 1 small European city for economic potential, 2nd Overall and 4th for Business Friendliness" in the Financial Times European Cities of the Future Awards 2022/2023 (Cork City Council, 2023b) highlights its economic vitality and the effectiveness of its business environment (Cork Chamber, 2024; Cork City Council, 2023b).

The evolution of Cork City from a historical trading hub to a modern economic powerhouse encapsulates the dynamic potential of second-tier cities in contributing to national and global economic landscapes. Cork's strategic positioning underwent a significant transformation with the city boundary's expansion in 2019, resulting in a 400 % increase in the city's area and a 40 % rise in population. This expansion, alongside Cork's industrial diversification and its ability to attract foreign direct investment (FDI), highlights the city's resilience, adaptability, and innovative spirit.

The next sections discuss the development of the Pharmaceutical and ICT industries, through FDI, in the city. Strategic considerations for the development of second-tier cities are also presented.

3. The evolution of FDI in Cork: implications for second-tier cities

Cork's journey through industrial diversification and economic integration offers a compelling case study in the evolution of FDI within second-tier cities. Historically, Cork's economy was anchored in *traditional* industries, such as food and drink, textiles, and significant port-related operations, which formed the bedrock of its industrial foundation and socio-economic identity (Power & Brunt, 2007). This diversified industrial base set the stage for Cork's economic evolution, impacted by a significant policy shift in Ireland towards international economic integration post 1960, and especially following Ireland's accession to the European Economic Community in 1973 (Kennedy et al., 1990).

Transition towards open markets and free trade catalysed a period of unprecedented industrial growth and diversification in Cork. The opening of Cork Airport in 1961 was a pivotal development, enhancing the city's connectivity and further positioning Cork as an attractive location for international business and investment (Cork Heritage, 2023). In recent years, Cork has successfully capitalised on this strategic positioning, attracting substantial FDI, particularly in the Pharmaceutical and ICT sectors, showcasing the city's adaptability and readiness to embrace innovation (O'Connor et al., 2017).

3.1. Strategic positioning of Cork's pharma sector: framework of second-tier cities

The evolution of Cork's pharmaceutical sector offers a compelling perspective on strategic economic development via effective harnessing of FDI. Since the 1960s, Cork has transformed into a substantial pharmaceutical centre, benefitting significantly from targeted FDI initiatives. This transformation was catalysed by the Industrial Development Agency (IDA), which played a crucial role in promoting Cork, alongside Ireland, as a prime destination for pharmaceutical investments (Brady et al., 2013; Van Egeraat & Curran, 2013).

Strategic investments by the IDA in the 1970s and 1980s, particularly in Cork's lower harbour area, laid foundational infrastructure for the establishment and growth of pharmaceutical plants. This foresight and strategic planning facilitated Cork's emergence as a key base for European trade in pharmaceuticals, attracting six of the ten new Irish drug substance plants between 1975 and 1986 (van Egeraat & Barry, 2009; Van Egeraat & Curran, 2013). Such developments not only solidified Cork's status within Ireland's pharmaceutical landscape but also highlighted the city's role in the global pharmaceutical industry.

The sector's growth was further accelerated by Ireland's favourable corporate tax regime and the synergistic benefits derived from clustering with other foreign-owned firms, enhancing productivity and innovation within Cork's pharmaceutical landscape (Noonan et al., 2021). By 2003, Cork accounted for 48 % of Ireland's employment in drug substance operations, reflecting the city's internationally competitive business environment (Van Egeraat & Curran, 2013; Gallagher et al., 2002).

Recent developments have seen Cork's pharmaceutical and life sciences sector receiving over €10 billion in investment, with more than thirty companies, including global giants of Janssen, Eli Lilly, and Pfizer, marking the city as a production site for six of the top ten 'blockbuster drugs' (Cork City Council, 2023c; We are Cork, 2023). This reflects Cork's position not just as a national leader but as a significant player on the global pharma stage.

3.1.1. Transformation and trajectory of Cork's ICT sector: lessons for second-tier cities

FDI also played a major role in the development of the city's ICT sector. Cork's ICT sector has undergone a dramatic transformation, particularly highlighted during the challenging de-industrialisation era of the 1980s. The city faced significant economic shifts, marked by the closure of traditional industries such as the Ford assembly plant and Dunlop and Verolme dockyard, with substantial job losses that marked a period of economic uncertainty (Moynihan, 2018; Power & Brunt, 2007). However, this era also signified the beginning of Cork's transition into a burgeoning technology hub, marked by the establishment of Apple's first manufacturing facility in 1980 and the subsequent arrival of other tech giants, catalysing Cork's reputation as a prime location for ICT investment (Apple, 2020).

The 'Celtic Tiger' period of the mid-1990s further accelerated economic growth and the expansion of the ICT sector in Cork, demonstrating the city's capability to attract and sustain significant multinational investment and employment growth within this sector (Kennedy, 2001; Power & Brunt, 2007). Despite facing global economic challenges in the 2000s, Cork's ICT sector showcased resilience and adaptability, supported by the strategic expansions of anchor firms like Apple and EMC, emphasising a shift towards service-oriented functions (Breathnach et al., 2015).

By 2020, Cork had established itself as a vibrant ecosystem for technology companies, hosting a diverse array of ICT businesses that contribute to local, regional, and international markets (Cork City Council, 2023b; Byrne et al., 2021). This evolution reflects Cork's successful transition from a city grappling with industrial decline to a dynamic hub of technological innovation and employment.

3.2. Strategic implications for second-tier cities

The development of Cork's pharmaceutical and ICT sectors offers lessons for other second-tier cities navigating similar economic transitions. It highlights the importance of embracing technological advancements and fostering environments conducive to innovation and investment in emerging industries (Hannon et al., 2011). Cork's journey highlights the potential of second-tier cities to reinvent their economic base, attract global investment, and cultivate sectors that contribute to their resilience and growth in the face of global economic fluctuations. Cork's experience with FDI highlights several strategic implications for other second-tier cities seeking to enhance their economic profiles and attract international investment noted below.

3.2.1. Leveraging industrial diversity while engaging in specialisation

A triad of benefits associated industrial specialisation can be traced back to the seminal work of Marshall (1890). These include access to a pool of labour skilled in the needs of the sector, access to a range of

auxiliary trades and services and the prevalence of knowledge spillovers (Marshall, 1890; Parr, 2002). To achieve economic growth through FDI, focusing on specialised sectors is crucial. This strategy, backed by strategic planning and supportive policy, utilises local advantages to attract global investments. Wang (2015) and Dogaru (2014) stress the role for targeted investment in sectors like biotechnology and pharmaceuticals. In addition, Evans (2016) emphasises the role of effective urban policy and cooperation with regional authorities in this process, while Power and Brunt (2007) highlights how industry associations can advance economic development within these sectors.

However, there are also costs associated with specialisation. If a city is too dependent on one sector, a negative demand shock to that sector may result in a substantial slowdown in economic growth and substantial unemployment (Frenken et al., 2007). By focusing on the development of two different high-tech sectors, Pharmaceuticals and ICT, Cork is reaping the benefits associated with specialisation while also safeguarding the city's economy through diversification.

Cork's evolution into a hub for pharmaceuticals and ICT showcases the benefits of balancing industrial specialisation and diversification in adapting to global market trends and achieving economic growth and resilience. Literature supports this approach; Niu and Su (2023) emphasises the adaptability of tech and pharmaceutical sectors, while Brown et al. (2020) finds that diverse industrial structures bolster resilience during economic shocks. Through balancing specialisation and diversity Cork provides an exemplar for second-tier cities aiming for sustainable growth and international recognition through strategic development and global integration. Strategic policy alignment is needed ensure such a balanced industrial base.

3.2.2. Strategic policy alignment

Cork's strategic approach to attracting foreign direct investment (FDI) emphasises the necessity for second-tier cities to align their economic policies with global trends. Behrman and Rondinelli (1992) highlights the importance of urban development tailored to cultural preferences attractive to global investors. Côté et al. (2020) discusses the role of city diplomacy in fostering FDI, particularly relevant in the context of global trade's service-oriented shift. Furthermore, Wint and Williams (2002) highlights the need for non-discriminatory policy reforms and promotional activities to attract FDI. Together, these perspectives stress the importance of creating a conducive environment for FDI through strategic policy alignment and urban development, highlighting the model provided by Cork for other second-tier cities aiming to enhance their global economic profiles. The significant pivot towards international economic integration highlights the necessity for second-tier cities to align their economic policies with global trends, fostering an environment conducive to attracting FDI.

3.2.3. Infrastructure and connectivity

Availability of critical infrastructure, such as Cork Airport and Cork Port, is indicative of the central role of both physical and digital connectivity in making a city more attractive to foreign investors (Bannò & Redondi, 2014). As highlighted by Lynn et al. (2022), robust infrastructure facilitates not just connectivity but also urban density and coordination of private investment, essential elements for urban development. Collier and Venables (2016) adds that infrastructure enables cities to coordinate private investment effectively. The implication is that second-tier cities must prioritise investments in infrastructures to enhance connectivity, thereby improving their appeal to potential investors and paving the way for sustainable economic growth and development. While improved infrastructure is important, ESPON (2016) caution that improved accessibility alone may not be sufficient for economic and demographic development – it needs to be complemented by further development measures.

3.2.4. Attracting the sectors for your city

The ESPON (2016) Policy Brief identifies that second-tier cities have different characteristics and, as such, tailor-made, place-based policies are required which consider aspects such as national context, location, human capital, accessibility, and governance. Cork's strategic focus on niche sectors like Pharmaceuticals and ICT for attracting foreign direct investment (FDI) offers lessons for other second-tier cities looking to boost their economic profiles. This approach, underpinned by factors such as supportive industry associations (Power & Brunt, 2007), favourable corporate tax rates, skilled labour, and access to larger markets (Van Egeraat, 2012), along with Ireland's targeted strategy for FDI (Cassidy et al., 2009), and resilience during the pandemic (Polyak, 2022), highlights the importance of capitalising on specific competitive advantages. Cork's success demonstrates the effectiveness of specialising in sectors where cities can offer unique value, serving as a model for leveraging niche markets to attract international investment.

3.2.5. Favourable environment

ESPON (2016) note the importance of governance, institutional capacity, and stakeholder cooperation for second tier cities to thrive. Tekulova et al. (2019) identifies the role of environmental management in boosting economic efficiency and attracting foreign operations. Conrad (2005) discusses how stable and strategic environmental policies can support competitiveness and serve as protectionist tools. Tirkkonen (2014) examines China's policy landscape, noting the effects of protective measures on foreign companies and investment attraction.

Furthermore, fostering collaboration across industry, academia, and government is key to creating an innovative and growth-supportive ecosystem. Worrall and O'Leary (2020) advocates for a culture of innovation enabled by policy and effective partnership across sectors. Akçura and Avci (2014) and Vosman et al. (2023) highlight the importance of ICT and an innovation ecosystem approach for addressing broader societal challenges.

The development of the pharmaceutical sector in Cork provides an exemplar of governance and stakeholder collaboration. The IDA, the agency responsible for attracting FDI into Ireland, invested heavily in the Cork Harbour Area in the 1970's, purchasing large amounts of land, and investing in drainage infrastructure required by the pharmaceutical industry (Van Egeraat & Curran, 2013). The local authority, Cork County Council, created the country's largest capacity for processed water in Cork's lower harbour, while the Electricity Supply Board installed the power supply required by the industry (Van Egeraat & Curran, 2013). The area was heavily promoted by the IDA to drug substance plants interested in establishing operations in Ireland (Van Egeraat & Curran, 2013). Cooperation between a variety of stakeholders facilitated the development of an industry within the city - such cooperation across local and state entities is key for developing industry foundations in second tier cities.

3.2.6. Education and workforce development

Investing in education and training that align with the Pharmaceutical and ICT sector's demands ensures a consistent supply of skilled workers. Evans (2016) points towards the importance of higher education institutions in developing talent and stimulating local economies. Wu et al. (2015) notes the digital economy's role in driving regional development, with Reinecke and Donaghey (2021) stressing the importance of aligning industry needs with education for effective workforce development.

ESPON (2016) discuss the importance of improving education in second tier cities to attract young people. More specifically, they suggest that higher education should focus on the *local* economic structure (ESPON, 2016). Initially, when the pharmaceutical industry entered Cork, there was a limited amount of related educational courses offered in the city. However, there was a substantial growth in graduates in pharmaceutical-related sciences from University College Cork since the 1970s (Van Egeraat & Curran, 2013). Many companies interacted with local third-level institutions to shape programme development and course content and found that the interaction has a positive effect on the

numbers of graduates and the skillsets of local graduates (Van Egeraat & Curran, 2013) This again highlights the importance of stakeholder engagement and provides an insight for other second tier cities as how education can be tailored to meet the requirements of local industry.

Strategic positioning, policy alignment with international trends, industrial diversification, and investments in connectivity are key factors in enhancing a city's appeal to foreign investors (Collins & Grimes, 2008). However, the quality of FDI is also crucial, with some projects more beneficial than others (Alfaro & Charlton, 2013). The role of FDI in regional development is often underestimated, and a place-sensitive regional policy that integrates the connectivity dimension is needed (Iammarino, 2018). Cork demonstrates how second-tier cities can capitalise on their unique advantages, such as favourable geographical locations, created assets and existing industrial bases, to attract global investments and foster economic growth.

4. Cork's strategic positioning for future FDI: second-tier cities context

Cork's emergence as a destination for premier FDI is a narrative that not only highlights its strengths as Ireland's second-largest urban centre but also exemplifies the broader potential of second-tier cities in attracting global investments. The city's urbanisation economies, which significantly enhance the productivity of foreign-owned businesses are manifest in Cork's well-developed infrastructure, comprehensive municipal services, and robust labour pool (Noonan et al., 2021; Parr, 2002). These attributes, alongside an extensive transportation and communication network, present Cork as a suitable locality for business operations, thereby attracting a substantial volume of inward FDI.

The growth trajectory of FDI direct employment in Cork, as depicted in Fig. 4, showcases notable increases in job creation within the city - and county - from 2010 to 2020.

This upward trend not only highlights Cork's capacity to attract and retain foreign investments but also signifies the broader economic contributions of second-tier cities to national development through FDI.

However, Cork's allure for future FDI is contingent upon addressing several critical challenges. Foremost among these is the need to bolster human capital, ensuring a steady supply of skilled labour to meet the demands of foreign businesses. This entails not only nurturing local talent through education and training initiatives but also attracting skilled workers from other regions and countries. Additionally, enhancing Cork's transportation infrastructure is essential for facilitating ease of access and movement, further augmenting its attractiveness to potential investors.

These challenges, while significant, present an opportunity for Cork, and other second-tier cities, to redefine their strategies for economic development. By leveraging their unique strengths and addressing existing gaps, cities like Cork can maintain their competitive edge, fostering sustainable growth and innovation. The experiences and strategies employed by Cork can serve as a blueprint for other second-tier cities aiming to attract FDI, demonstrating the importance of strategic planning, investment in human capital, and infrastructure development in securing a favourable position within the global investment landscape.

This analysis highlights the necessity for strategic interventions in areas such as human capital development and infrastructure enhancement, essential components in crafting an attractive environment for FDI. As second-tier cities continue to navigate the complexities of global investment dynamics, Cork's approach offers insights into strategies that can support success.

5. Cork's human capital: workforce dynamics challenges in second-tier cities

Cork City demonstrates evolving dynamics of human capital in second-tier urban centres through its ranking on the European Commission (2023) Human Capital and Education index for small to medium-sized cities, as shown in Table 1.

Cork showcases a vibrant academic scene and a knowledge-based economy crucial for attracting inward investment. The city's educational institutions, including University College Cork and Munster Technological University host over 36,000 higher education students annually.

However, Cork faces demographic challenges that mirror broader trends affecting second-tier cities globally particularly in terms of fertility patterns, posing new challenges to the city's human capital. From a high of four births per woman aged 15–44 in 1965, the fertility rate fell to 1.75 births in Ireland by 2018, well below the population

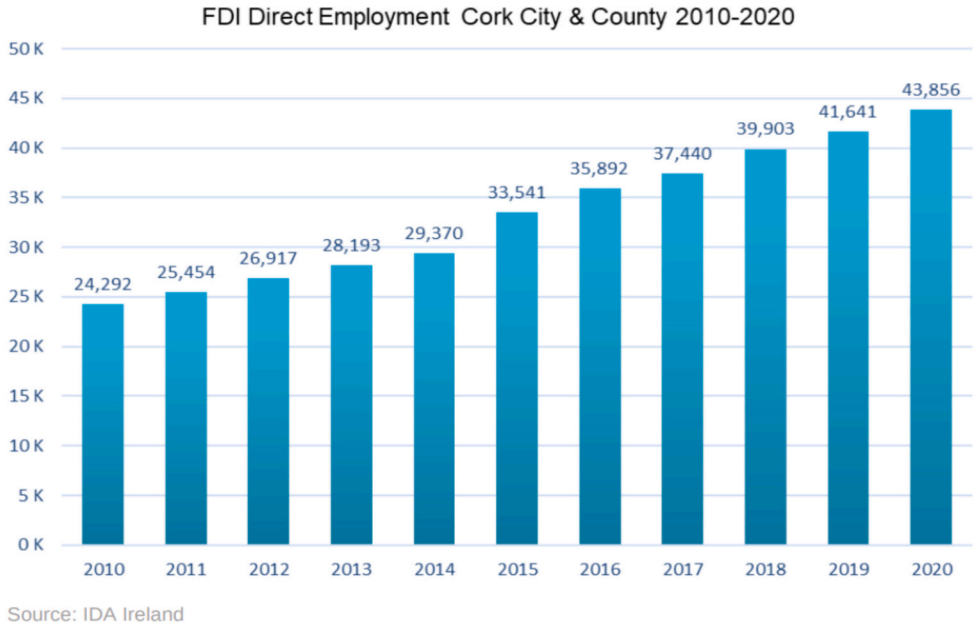


Fig. 4. FDI employment in Cork City and county 2010–2020.
Source: Economic Monitor: Cork City, County and Southwest Region 2021 https://www.corkcity.ie/corkcityco/en/doing-business-in-cork/economic-profile/economic-monitor.

Table 1
The top five ranked small to medium sized European cities (50,000–250,000 inhabitants) for human capital & education 2015–2019.

	2015	2017	2019
1	Heidelberg	Leuven	Limerick
2	Cork	Limerick	Galway
3	Weimer	Galway	Cork
4	Leuven	Cork	Leuven
5	Bern	Heidelberg	Kortrijk

Note 1: 79, 77 and 76 cities were included in the small to medium sized category in 2015, 2017 and 2019 respectively.
Note 2: See European Commission (2023) for details on the criteria required to be included in the Cultural and Creative Cities Monitor.
Note 3: See European Commission (2023) for further details on the variable rankings.
Source: European Commission (2023) Cultural and Creative Cities Monitor.

replacement rate of 2.1, required for population stability (RTE, 2021).

A declining fertility rate signals potential labour supply issues, evidenced in Fig. 5, highlighting the need for strategic policy interventions to sustain economic growth and support an aging population.

Moreover, Cork's labour market dynamics reveal gender disparities shaped by historical, cultural, and educational factors (CSO, 2023; Bercholz & FitzGerald, 2016) and a notable divide in employment and domestic responsibilities between genders, reflecting deep-seated cultural norms and historical constraints on women's workforce participation.

Table 2 illustrates marked differences in roles of home and family care, with 11 % of females engaged compared to 1 % of males.

The employment data highlights this divide, with 60 % of males employed compared to 50 % of females (CSO, 2023). These challenges highlight the complex socio-economic landscape in which contemporary second-tier cities operate. They necessitate a multifaceted approach to policymaking, aiming to enhance educational opportunities, address labour market disparities, and promote inclusive economic advancement.

Local programs and initiatives play a crucial role in adapting to such demographic shifts, particularly in enhancing women's labour market presence and addressing youth unemployment rates. Recent educational attainments of women have seen significant rise between 2011 and 2022 (see Fig. 6), which gradually enhances their economic opportunities and results in more inclusive labour market presence (CSO, 2023; Bercholz & FitzGerald, 2016).

This shift is not just indicative of Cork's changing educational landscape but also signifies the potential for increased female labour force participation.

The dominance of higher labour force participation rates among men

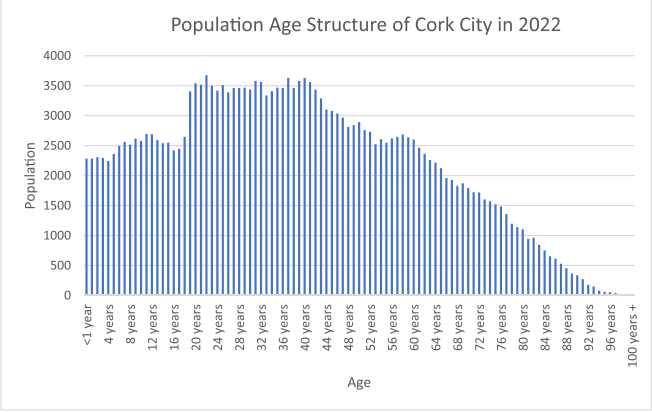


Fig. 5. Population age structure of Cork City in 2022.
Source: CSO (2023)

Table 2
Cork City population aged 15+ by principal economic status 2022.

Status	Total	Male	Female
Persons at work	103,249 (55.23 %)	54,915 (60.40 %)	48,334 (50.34 %)
Unemployed (looking for first job)	1556 (0.83 %)	881 (0.97 %)	675 (0.70 %)
Unemployed (lost job)	7435 (3.98 %)	4116 (4.53 %)	3319 (3.46 %)
Student or pupil	23,339 (12.48 %)	11,088 (12.20 %)	12,251 (12.76 %)
Home/family care	11,542 (6.17 %)	1037 (1.14 %)	10,505 (10.94 %)
Retired	28,327 (15.15 %)	13,596 (14.95 %)	14,731 (15.34 %)
Permanent sickness/ disability	10,312 (5.52 %)	4824 (5.31 %)	5488 (5.72 %)
Others not in labour force	1179 (0.63 %)	462 (0.51 %)	717 (0.75 %)
Total	**186,939 (100 %)**	**90,919 (100 %)**	**96,020 (100 %)**

Source: CSO (2023)

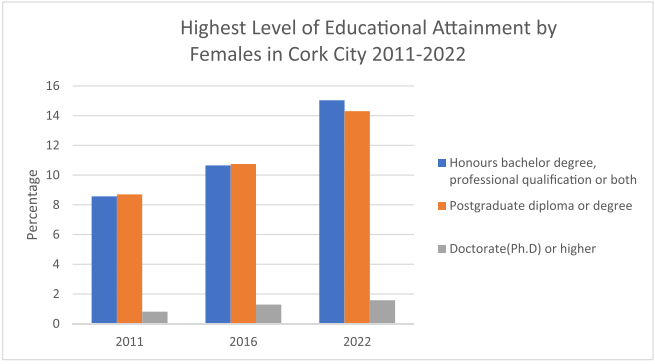


Fig. 6. Highest level of educational attainment by females in Cork City 2011–2022.
Source CSO (2023)

in all age brackets in Cork, as revealed in Fig. 7 is notable.

This trend indicates potential hurdles in the employment landscape, particularly for women, despite educational advancements.

The upward trajectory in educational attainment among women is crucial, especially considering the city's demographic structure. It signifies a shift towards greater gender parity in professional and academic fields, suggesting a potential for changing societal norms and increasing female participation in the labour force. The situation in Cork highlights the critical role of second-tier cities in the global urban system. These cities, often overshadowed by larger metropolises, possess unique potential for innovation, resilience, and growth. Cork's human capital

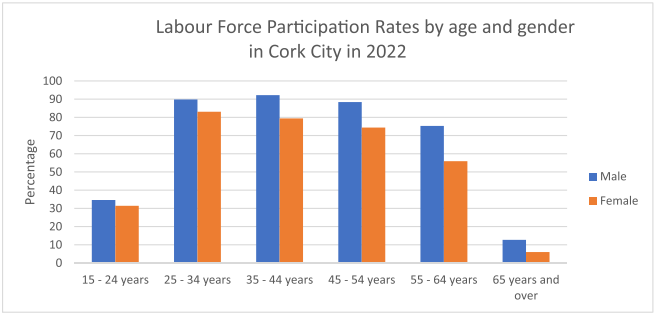


Fig. 7. Labour force participation rates by age and gender in Cork City in 2022.
Source: CSO (2023)

challenge, coupled with its strategic positioning and rich educational landscape, exemplifies the nuanced dynamics of workforce development in second-tier cities. It calls for a re-evaluation of urban development strategies, emphasising the need for targeted policies that leverage the unique contributions and address the specific needs of these urban centres.

Cork exemplifies how second-tier cities can synergise educational achievements with labour market needs to cultivate an inclusive, vibrant workforce. This approach not only encourages their appeal to investors and talent but also solidifies their roles as vital hubs of innovation and economic growth. Cork's actions in addressing its human capital challenge reflect on the broader narrative of urban development, offering key insights for policymakers and urban planners aiming for sustainable growth and economic resilience in similar urban settings.

The city's proactive strategies in human capital development, gender equality in the workforce, and educational alignment with job market requirements serve as useful lessons for other cities. Cork's blend of historical heritage and economic vitality highlighting the significant impact second-tier cities have, highlighting their capability to drive innovation and foster connectivity in an evolving urban landscape.

6. Integrating local educational and labour policies within the framework of second-tier cities: the case of Cork

Cork's approach to integrating local educational policies and labour market strategies offers a blueprint for second-tier cities aiming to enhance their socio-economic landscapes. The *Cork City Profile (2018)*[1] and *Cork (2050)*[2] highlight a forward-thinking commitment to creating an accessible and inclusive learning environment. Recognition as a UNESCO Learning City in 2015 and the annual Cork Lifelong Learning Festival exemplify Cork's dedication to fostering a pervasive culture of learning that accommodates diverse ages, interests, and abilities.

Central to Cork's educational strategy is the *Learning Neighbourhoods* initiative, which surpasses the traditional confines of education by facilitating community-wide engagement and addressing educational and social disadvantages in a collaborative manner. This initiative, alongside the emphasis on Delivering Equality of Opportunity in Schools (DEIS) and Revitalising Areas by Planning, Investment, and Development (RAPID) programs, seeks to ensure equitable educational opportunities across the community. Furthermore, the Cork, 2050 plan aligns educational objectives with regional economic needs, identifying education as a key enabler of economic growth and resilience. Examples are provided in Fig. 8.

The integration of education into Cork's broader community development strategy highlights the city's holistic approach to fostering a lived experience of learning, further amplified by the leveraging of technology and innovation in teaching methodologies.

6.1. Implications for second-tier cities

Cork's initiatives in education and labour force development offer insights for second-tier cities, emphasising the necessity of a holistic approach to workforce development and educational advancement. A range of key strategies indicate the related projects contributing to these developments.

Fostering Community-Wide Learning Initiatives: Cork's Learning Neighbourhoods exemplify the impact of collaborative education projects on societal and economic challenges. This initiative, rooted in partnerships between the City Council, University College Cork, and the Cork Education and Training Board, showcases the importance of lifelong learning and social inclusion. This model advocates for universities to deepen their community engagement and social service roles. Similarly, Gamble and Bates (2011) highlights the value of community-based learning and research in Dublin Institute of Technology's Programme for Students Learning with Communities, offering an alternative to traditional industrial work placements.

Aligning Educational Programs with Economic Objectives: Cork's strategy to align education with regional economic needs is validated by Legcevic (2014), who emphasises the importance of synchronising educational outcomes with labour market demands for regional development and global competitiveness. This alignment, McKoy et al. (2011) suggests, can be fostered by linking education and planning policies at the local level, while Tvaronavičienė et al. (2018) notes the critical role of educational systems in boosting economic and innovative potentials. Universities, as Muresan and Gogu (2010) points out, can drive regional innovation culture and competitiveness.

Leveraging Technological and Digital Education: Emphasising digital tools and online learning, as Cork does, aligns with Gabriel et al. (2022) findings on the potential of digital technologies to bridge educational divides and prepare students for the digital economy. Kumi-Yeboah et al. (2020) highlights the importance of digital tools for diverse learners, while Sadiku et al. (2022) calls attention to the need for teacher training and support in these technologies.

Promoting Lifelong Learning: The Cork Lifelong Learning Festival highlights the importance of fostering a culture of continuous learning, regarding the adaptability to economic and technological changes. Hammer (2019) stresses the role of universities and cities in promoting lifelong learning, while Lee et al. (2014) points to the opportunities such initiatives provide for societal adaptation.

These strategies not only enrich Cork's socio-economic landscape but also serve as a guide for second-tier cities to foster sustainable growth. Aligning educational pathways with economic goals, embracing digital education, and promoting lifelong learning are foundational steps towards enhancing the resilience and attractiveness of cities in the global urban network. Cork's approach, grounded in a rich tapestry of literature and best practices, offers a roadmap for second-tier cities aiming for sustainable development and socio-economic prosperity.

6.2. Bridging educational & workforce gaps in second-tier cities: lessons from Cork

Cork City's progressive efforts in refining its educational policies and workforce integration underscore a productive strategy for second-tier cities looking to enhance economic growth and innovation. Recognising the importance of closing gender disparities and integrating underrepresented groups, such as the elderly, Cork adopts a comprehensive approach to develop a diverse and inclusive human capital base. This strategy is pivotal for driving economic growth and fostering a culture of innovation.

Strategic Initiatives for Comprehensive Growth: Cork's action plan includes targeted initiatives to elevate the participation of women and the elderly in key sectors like ICT and pharmaceuticals, reflecting a proactive move towards economic inclusivity:

Empowerment Programs for Women: Initiatives such as mentorship, career advancement workshops, and networking events, specifically designed for women, aim to bridge the gender gap in crucial industries. These efforts resonate with Baltov et al. (2023) recommendation for boosting women's visibility in pharmaceutical sciences, advocating for e-mentoring platforms to empower women.

[1] Part of the Healthy Cities project: https://corkhealthycities.com/publications/cork-city-profile-2018/.

[2] Cork councils submission to the National Planning Framework, 2017: https://www.corkcity.ie/en/media-folder/planning/170322_npf-submission-main-report-reduced.pdf.

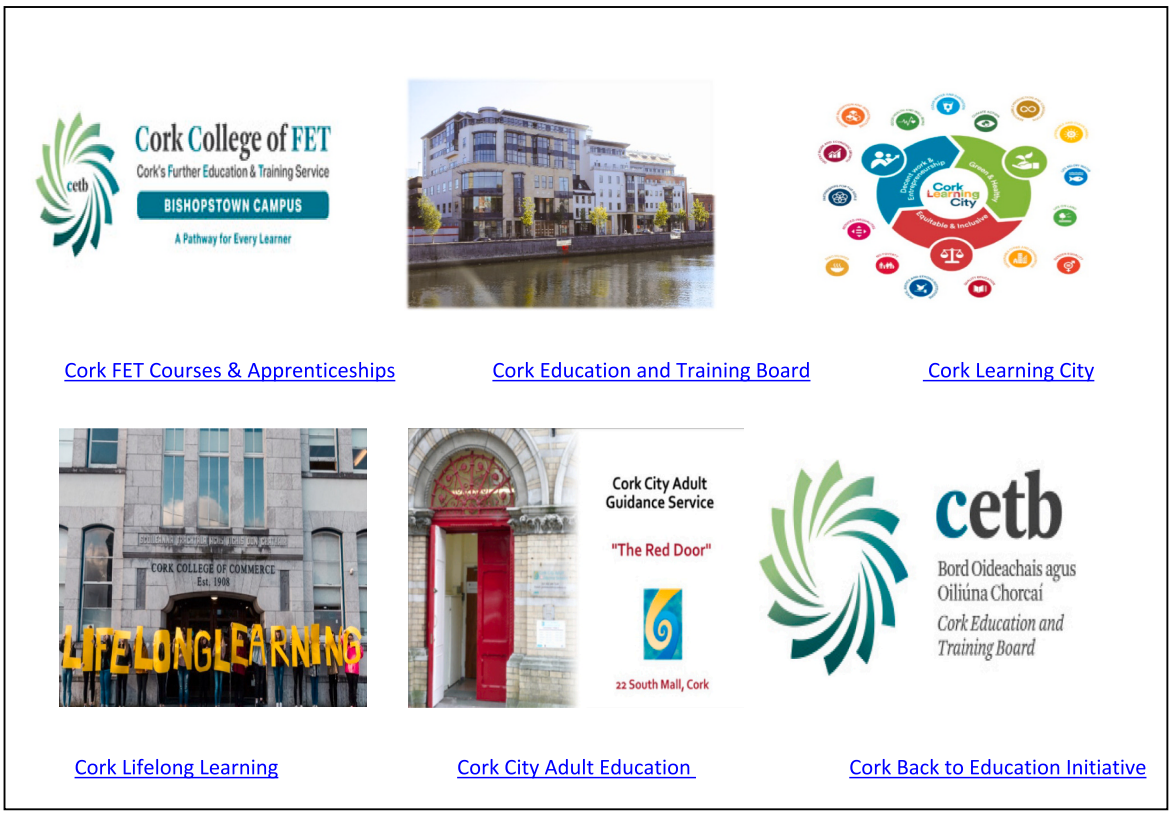


Fig. 8. Examples of local education supports in Cork.
Source: Authors own. Photos and working links sourced from public websites.

Inclusive Training for the Aged: Following Wu et al. (2015), Cork offers specialised training programs tailored for the elderly, focusing on the latest industry trends and technologies in ICT and pharmaceuticals, to bridge the technological divide.
Workplace Inclusivity Programs: Echoing Sakitri's (2015) emphasis, Cork's ICT and pharmaceutical sectors are encouraged to implement inclusivity programs, creating a welcoming environment for women, the elderly, and other underrepresented groups. This includes diversity training, flexible working arrangements, and work-life balance policies.
Childcare/Caring Solutions: Recognising the role of accessible childcare in enhancing labour participation, Cork looks to models proposed by Moussié et al. (2021) for public provision and subsidies to support working parents, particularly women.
Customised Programs for Diversity: Drawing from Manoharan et al. (2024) Cork develops tailored programs addressing the unique needs of migrants, women, and the aged, enhancing the diversity of the talent base in the ICT and pharmaceutical industries.
Digital and Scientific Literacy Projects: Inspired by Silva and Heaton's (2017) study, Cork initiates specific literacy programs aimed at boosting community engagement and inclusion, especially among the underrepresented and elderly.

6.2.1. Implications for second-tier cities

By adopting targeted policies and programs that promote inclusivity, diversity, and lifelong learning, cities can bolster their human capital, attract investment, and enable economic resilience. Collaborative efforts among local authorities, educational institutions, corporate entities, and community organisations are crucial for fostering an ecosystem that supports continuous skill development and workforce integration.

Cork's dedication to bridging educational and workforce gaps through a range of strategic initiatives sets a precedent for second-tier cities aiming to bolster their economic competitiveness and innovation capabilities. Cork's comprehensive and inclusive approach provides a roadmap for sustainable growth and development in second-tier urban centres, navigating the complexities of human capital development with strategic foresight and collaborative engagement.

7. Navigating transport challenges in second-tier cities: insights from Cork

Cork City's transport infrastructure, while boasting significant strengths such as its port facilities, faces challenges that highlight the complex interplay between local ambitions and national policies crucial for sustainable urban growth and attracting FDI. Challenges particularly in air and ground transport offer critical lessons for second-tier cities worldwide on the importance of developing robust, integrated transport systems to enhance global connectivity and economic competitiveness.

7.1. Strategic asset and connectivity challenges

Cork's port, recognised as the world's second-largest natural harbour, exemplifies the strategic advantages that can be leveraged by second-tier cities to enhance their economic vitality and global trade connections. The Port of Cork's versatility in handling diverse shipping modes and its significant role in European trading highlight the potential of strategic infrastructure in bolstering economic growth and attracting international business and investment.

However, the contrast between the port's capabilities and the limitations in air and ground transport connectivity highlights a broader challenge faced by second-tier cities: developing a comprehensive transport infrastructure that supports not just regional but also global connectivity. The constraints at Cork Airport, particularly its limited direct international flight options, and the inefficiencies in regional road and rail links, pose significant hurdles to enhancing Cork's

attractiveness for FDI and its integration with other economic centres.

Reflective of these transport infrastructure deficiencies, Cork's standing in comparison to small to medium-sized European cities for local and international connections is concerning. According to the European Commission (2023) detailed in Table 3, Cork's rankings have consistently lagged, placing 76th, 74th, and 73rd in 2015, 2017, and 2019, respectively.

7.2. Implementing tailored transport & digital strategies in second-tier cities: a model from Cork

The comprehensive approach undertaken by Cork City, as outlined in the Project Ireland 2040 The National Planning Framework and echoed in local strategies, demonstrates an advanced blueprint for second-tier cities to enhance their transport infrastructure and digital connectivity. This section examines the tailored policies aimed at addressing the unique transport infrastructure challenges faced by Cork, offering a paradigm that could be replicated by second-tier cities globally to foster urban development, enhance regional connectivity, and drive economic growth.

Strategic Framework for Transport Development: Cork's commitment to developing customised local strategies in transport infrastructure signifies a departure from one-size-fits-all solutions, recognising the importance of city-specific strategies that consider unique geographical, economic, and social dynamics. Initiatives like the Cork Metropolitan Area Transport Strategy (CMATS) 2040 and the Cork City Centre Movement Strategy embody this approach, aiming to create a sustainable, integrated transport system responsive to anticipated population growth and the imperative for decarbonisation.

The BusConnects Cork program represents a transformative venture set to revolutionise Cork's public transport system, with significant enhancements planned for bus services. This initiative is indicative of the broader strategy to optimise citywide traffic flows, improve public transport systems, and enhance the quality of life for Cork's residents.

Digital Connectivity as a Catalyst for Urban Development: Parallel to its transport initiatives, Cork's investment in digital infrastructure, exemplified by the National Broadband Plan and the expansion of high-speed fiber networks by Open Eir, highlights the integrated role of digital connectivity in modern urban development. Cork's comprehensive three-year Digital Strategy aims to harness enhanced digital connectivity to elevate the quality of life for its citizens and stimulate economic growth, setting a precedent for how second-tier cities can leverage technology to become more connected and forward-thinking urban areas.

Table 3
Rankings for small to medium sized European cities (50,000–250,000 inhabitants) for local & international connections 2015–2019.

	2015	2017	2019
1	Lleida	Lleida	Lleida
2	Tilburg	Tilburg	Tilburg
3	s-Hertogenbosch	s-Hertogenbosch	s-Hertogenbosch
4	Eindhoven	Amersfoort	Amersfoort
5	Amersfoort	Heidelberg	Heidelberg
Cork	76	74	73

Note 1: 98, 96 and 95 cities were included in the small to medium sized category in 2015, 2017 and 2019 respectively.
Note 2: See European Commission (2023) for details on the criteria required to be included in the Cultural and Creative Cities Monitor.
Note 3: Local and international connections rankings are based on passenger flights, potential road accessibility and direct trains to other cities. See European Commission (2023) for further details.

While the projects outlined above are broadly commendable, more needs to be done to improve the city's infrastructure. The next section proposes a series of projects that policymakers should consider enhancing economic growth within the city.

7.3. Bridging infrastructure policy gaps in second-tier cities: insights & innovations

The strategic initiatives and current landscape of Cork provide a blueprint for addressing the nuanced challenges and opportunities within transport and infrastructure policies in second-tier cities. By developing comprehensive strategies that not only meet immediate needs but also aim for long-term sustainable growth, inclusivity, and technological advancement, cities like Cork can enhance their urban fabric and economic vitality. This section explores potential initiatives that could bridge these policy gaps, drawing on Cork's experiences and proposing strategies that second-tier cities can adopt to foster a dynamic and inclusive urban environment.

7.3.1. Strategies for infrastructure enhancement

Expanding Air Connectivity: Developing airport infrastructure to support direct international flights, crucial for fostering global business relationships and attracting FDI. This might involve runway expansion, upgrading facilities, and negotiating with airlines to introduce new routes.
Innovating in Transport Technology: Encouraging investment in innovative transport technologies, such as autonomous vehicles and advanced traffic management systems, can revolutionise urban mobility. Cork's potential exploration of these technologies suggests a path forward for second-tier cities to become leaders in transport innovation, enhancing efficiency and sustainability. Collaborations with tech companies and academic institutions for pilot projects could serve as a catalyst for developing smart transport solutions, reflecting a commitment to future-proofing city infrastructure.
Optimising Freight and Logistics: The strategic importance of port activities in Cork highlights the need for an efficient logistics sector. Developing logistics centres and employing digital platforms for freight management can streamline operations, reduce costs, and enhance the competitiveness of local industries. This approach is essential for cities with significant commercial port activities, facilitating their integration into global supply chains.
Leveraging Transport for Economic Diversification: Cork's focus on connecting business districts, innovation hubs, and educational institutions through transport infrastructure emphasises the role of mobility in economic diversification. By facilitating easier access to key economic sones, second-tier cities can stimulate growth, attract investments, and foster a culture of innovation. This strategy aligns with global trends where transport infrastructure acts as a backbone for urban renewal and economic development.

7.3.2. Implications for second-tier cities

The policy gaps and strategic responses identified in Cork offer context and exemplars for second-tier cities worldwide. By prioritising innovation in transport technology, optimising freight and logistics operations, and leveraging transport infrastructure for economic diversification, cities can address critical infrastructure challenges and position themselves for future growth. These strategies highlight the importance of a proactive, integrated approach to urban planning that considers the unique needs and potential of second-tier cities.

Addressing infrastructure policy gaps is crucial for the sustainable development of second-tier cities like Cork. By adopting innovative strategies that focus on technological advancement, efficiency in logistics, and economic diversification through transport infrastructure, cities can enhance their urban environments and economic resilience. Cork's ongoing efforts to tackle these challenges offer a roadmap for

other second-tier cities, emphasising the need for tailored, forward-looking policies that cater to the specific dynamics of urban growth and development. In doing so, second-tier cities can not only meet the immediate needs of their citizens and businesses but also lay the foundation for a prosperous, inclusive, and sustainable future.

8. Future directions: a blueprint for second-tier cities from Cork's strategic roadmap

Consequences of growth and sustainability are common challenges of success that can blur boundaries between a city's strategic planning focus and the objectives of its citizens, communities and businesses. Here, we frame the city's challenges in human capital and transportation infrastructure around the Sustainable Development Goals (SDGs), to offer a speculative, but place-based-informed set of goals appropriate for second-tier cities aiming for transformative urban development. By combining Cork's targeted investment areas and drawing inspiration from global benchmarks, this roadmap outlines a path for second-tier cities to foster innovation, inclusivity, and sustainable growth.

8.1. Strategic investment areas and global benchmarks

1. *Innovation and Technology:* Cork's ambition to become a tech hub aligns with SDG 9 (Industry, Innovation, and Infrastructure), as it aims to support tech startups and SMEs through incentives and incubation programs (Jesemann, 2020). This approach mirrors the successful tech ecosystem in Tel Aviv (Berry & Wasserteil, 2014), where government policy initiatives (Savina & Karpova, 2021), sociocultural factors, institutional, educational influences (Kon et al., 2014), and venture capital initiatives (Chirchietti, 2017; Berry & Wasserteil, 2014) have spurred significant economic growth (Frenkel et al., 2003). For second-tier cities, fostering a supportive environment for technological innovation can drive economic development and position them as attractive locations for high-tech industries.
2. *Education and Workforce Development:* Investing in education, particularly in STEM fields, to develop a skilled workforce and reduce gender disparities reflects Cork's commitment to SDGs 4 (Quality Education) and 5 (Gender Equality). For example, the Helsinki's education model, emphasising quality and gender equality, offers insights for Cork in STEM and workforce development (Holgado et al., 2022). Its focus on Education for Sustainable Development (ESD) and systems thinking aligning with UN Sustainable Development Goal 4 for inclusive education serves as a model for how second-tier cities can enhance their human capital to meet the demands of modern economies.
3. *Transport Infrastructure:* Cork's plans to improve connectivity through airport expansion and public transport enhancements are guided by SDGs 9 and 11 (Sustainable Cities and Communities). Singapore's integrated public transport system, which has successfully encouraged public transport use and reduced car travel with policies focusing on sustainability and smart solutions (Haque et al., 2013), and as well initiatives for system improvement (Ibrahim, 2003), sets a standard in sustainable transport and land use integration (Lee & Palliyani, 2017) providing a blueprint for second-tier cities to develop sustainable and efficient transport networks that support urban growth and reduce environmental impact.
4. *Healthcare and Life Sciences:* Leveraging the pharmaceuticals and life sciences sectors by promoting research and talent acquisition aims to strengthen Cork's position in these industries, aligned with SDG 3 (Good Health and Well-being). The biotech ecosystems in Boston and San Diego illustrate the potential benefits of such a focus for second-tier cities (Mayer, 2011), highlighting the importance of partnerships between industry, academia, and healthcare institutions for innovation and economic growth (Harrison et al., 2012).
5. *International Connectivity and Collaboration:* Enhancing global connections, digital infrastructure, and establishing direct international flight routes are critical for Cork to boost its international presence, in line with SDG 17 (Partnerships for the Goals). Focusing on enhancing global connections, digital infrastructure, and establishing international flights, to boost its international presence and networks (Burghouwt, 2017), Dubai's success in attracting foreign investment and developing advanced logistics offers a blueprint for second tier cities to become a significant, globally connected, competitive, logistics hub (Sundarakani, 2017).
6. *Inclusivity and Quality of Life:* Committing to inclusive urban development and investing in public amenities are central to improving living standards and addressing urban exclusion, reflecting Cork's dedication to SDGs 10 (Reduced Inequalities) and 3 (Good Health and Well-being). Vienna's urban planning, focusing on enhancing well-being through active travel, public transport, and inclusive public spaces (Mouratidis, 2021), alongside its social housing model promoting social cohesion (Friesenecker & Kazepov, 2021), offers valuable lessons for second tier cities.
7. *Sustainable Urban Development:* Cork's commitment to sustainability, including green buildings and renewable energy, aligns with SDG 11 (Sustainable Cities and Communities). Copenhagen's pursuit of carbon neutrality through sustainable initiatives like green buildings and renewable energy (Damsø et al., 2017) serves as an inspiring model for second-tier cities to integrate sustainability into urban planning and development efforts deemed essential for achieving climate goals (Alkhani, 2020).

By embracing innovation, focusing on education and workforce development, enhancing transport infrastructure, leveraging key industry sectors, and committing to inclusivity and sustainability, second-tier cities can navigate their unique challenges and opportunities. This approach not only positions them for economic growth and resilience but also contributes to the broader goals of sustainable urban development and global connectivity.

9. Conclusion: charting paths for second-tier cities through Cork's experience

This analysis encapsulates Cork City's evolutionary journey from its historical roots to becoming an emblematic figure of regional and global economic success, spotlighting its pivotal sectors of Information and Communications Technology (ICT) and pharmaceuticals. Cork's story is a testament to the potent combination of strategic policymaking, fostering an inclusive labour market, and prioritising advanced transportation infrastructure to navigate and surmount contemporary urban challenges.

Cork's prominence in the pharmaceutical and ICT domains highlights the city's ability to lead and innovate within these critical industries. However, the city's progress and diversification also bring to light the necessity for adaptive labour policies, particularly in response to evolving demographic trends and the imperative for a skilled workforce. Additionally, the examination of Cork's infrastructural capabilities and limitations, especially in transportation, underlines the crucial role such infrastructure plays in strengthening the city's stature in the global market.

In alignment with the United Nations Sustainable Development Goals (SDGs), this paper identifies a series of strategic recommendations designed to support technological innovation, strengthen educational systems, champion sustainable urban development, and foster a culture of inclusivity. These strategies are not just blueprints for Cork's sustained growth and resilience but also serve as guiding principles for second-tier cities worldwide facing similar trajectories and challenges.

The Cork City model provides a valuable roadmap for second-tier cities seeking to enhance their global connectivity and competitive edge while navigating the intricacies of urban development in the 21st century. It illustrates that through concerted effort in policy refinement, investment in human capital, and infrastructure development, cities can

transform into thriving, progressive urban.

By adopting Cork's approach to tackling demographic shifts, enhancing labour market inclusivity, and upgrading transport systems, second-tier cities can harness their unique potentials and overcome the constraints typically associated with their size and historical development patterns. Furthermore, the strategic emphasis on aligning urban development goals with global benchmarks and best practices offers a pragmatic framework for these cities to aspire towards sustainable growth, innovation, and enhanced quality of life for their inhabitants. This paper not only highlights Cork City's strategic pivot towards a more resilient, innovative, and globally connected urban centre but also posits Cork as an illustrative example for second-tier cities aiming for similar transformative growth. The insights gleaned from Cork's journey highlight the importance of adaptive strategies, inclusive policies, and robust infrastructure development in achieving sustainable urban evolution. As such, Cork's narrative extends a beacon of inspiration and a practical guide for second-tier cities worldwide to chart their courses towards sustainable, inclusive, and dynamic urban futures, firmly rooted in the global urban fabric.

Finally, this analysis advocates for a re-evaluation of the narratives surrounding second-tier cities, urging a greater appreciation for their unique contributions to the global urban system. The Cork City model demonstrates that, with strategic planning and a holistic approach to development, second-tier cities can overcome traditional constraints and emerge as vital players in the international economy, offering valuable lessons in resilience, innovation, and sustainability.

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CRediT authorship contribution statement

Marie Ryan: Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Lisa Noonan:** Writing – review & editing, Conceptualization. **Eleanor Doyle:** Writing – review & editing. **Denis Linehan:** Conceptualization.

Declaration of competing interest

There are no conflicts of interest to declare by any of the authors.

Data availability

No data was used for the research described in the article.

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