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What facilitates innovation in Aerotropolises?

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Abstract

Purpose – Governments and airports worldwide are increasingly interested in promoting innovation growth in their Aerotropolis developments – large-scale, master-planned developments around airports. The mainstream academic concept and industry practices in Aerotropolis planning use a cluster-based model with a sprawling built environment and industry composition that lack considerations in knowledge base and skills-relatedness. This study applies Boschma's Proximity Theory for Innovation to critically assess to what extent these might not be the ideal urban design and industry composition to stimulate innovation effectively.

Design/methodology/approach – A mixed-methods methodology utilising online surveys and interviews was conducted in 2022 with entrepreneurs and staff from ten industries across nine Aerotropolises, asking about their experiences of inter-industry ideas exchange and innovations in their Aerotropolises and evaluations towards what could be improved in the built environment, industry composition and in general, to facilitate inter-industry ideas exchange.

Findings – Results show that an urbanised built environment and a co-location of skills-related industries from a common knowledge base facilitate inter-industry ideas exchange, subsequently promoting innovation. This aligns with the theoretical understanding that geographical and cognitive proximity support innovative processes. Additionally, a genuine community atmosphere inside the Aerotropolis supports innovation.

Originality/value – This study approaches the largely under-researched topic of innovation dynamics in the Aerotropolis context. Insights from this study provoke researchers and governments to rethink the current Aerotropolis urban development model and offer an alternative that fosters innovation.

Keywords Aerotropolis, Innovation, Planning, Economic development, Urban development, Innovation district

Paper type Research article

Introduction

Airports have become powerful business magnets in the 21st century, akin to train stations and seaports in the past (Kasarda, 2015). Many airport operators, governments and private developers have adopted the "Aerotropolis" planning model to build homogeneous-looking cities in their own right around a 30 km/minute radius of airports, composed of numerous specialised business parks or industry clusters allocated along transport corridors extending from the airport core (Kasarda, 2019; Hirsh, 2019). At least 25 operating Aerotropolises worldwide have been identified, including for example, in Amsterdam, Memphis, Dallas Fort Worth, Hong Kong, and 26 more Aerotropolises in development, such as Dubai South or Western Sydney (Kasarda, 2013). Most Aerotropolises do not grow organically similar to typical city districts. Instead, Aerotropolis management entities control the built environment and industry composition through masterplanning (Kasarda and Lindsay, 2011; Appold, 2014; Chang *et al.*, 2020).

The ultimate goal of Aerotropolis development is to drive economic development (Kasarda, 2019). Innovation and promoting entrepreneurship are essential pillars for economic

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development (Pradhan *et al.*, 2020). Innovation refers to products (goods or services), processes, marketing or organisational methods that are either new or significantly improved (OECD, 2004). Innovation is not exclusive to high-tech industries but has been seen across all industries, including retailers, logistics and restaurants (Hospers, 2003). Therefore, the best innovation strategy for various locales is to cultivate a broad innovation-friendly environment that facilitates ideas to be generated, shared and uptaken by all industries (Florida, 2005). The content of ideas is diverse, encompassing technology insights, market trends or the know-how to coordinate organisational resources (Galbreath *et al.*, 2016). Research indicates that the exchange of ideas between industries has not only led to incremental process innovations but has also catalysed radical product innovations (Frenken *et al.*, 2007; Lee and Sohn, 2019). Such exchanges provide inspiration that allows for the transcendence of existing rules and routines, thereby creating a myriad of new and exciting opportunities when integrated into the established frameworks of one's own industry (Jacobs, 1969; Enkel and Gassmann, 2010).

Professor John Kasarda who theorised the Aerotropolis model, outlined during an interview conducted by Arend (2022) that the state-of-the-art agenda of Aerotropolises is to become centres of innovation and knowledge creation. The priority on innovation growth has been clearly stated in the mission statements of many Aerotropolises as well. For instance, Dubai South Aerotropolis states that it aims to become "A hub for innovation with a progressive outlook towards the future" (Dubai South, 2020, paragraph 1). Lake Nona Aerotropolis in Orlando, states that it "is a modern Mecca for technology, innovation, and community" (Lake Nona, 2024; paragraph 1).

However, to the authors' knowledge, studies have not analysed the innovation dynamics in Aerotropolises nor formulated a clear guide that helps Aerotropolises achieve innovation growth. Therefore, with the goal of providing valuable recommendations to Aerotropolis planners seeking to achieve innovation growth, this study investigated:

What facilitates innovation in Aerotropolises?

By answering the following research questions:

(1) To what extent are product and process innovations happening in Aerotropolises?

(2) What is the role of urban design in fostering innovation in Aerotropolises?

(3) What is the role of industries' knowledge base similarity in fostering innovation in Aerotropolises?

Studies in other urban contexts found that innovation can be the outcome of inter-industry tacit knowledge spillovers, contributed by ideas exchange stemming from numerous face-to-face interactions between workers in different industries (Glaeser *et al.*, 1992; Feldman and Kogler, 2010). Professor Boschma (2005) developed the Proximity Theory for Innovation, explaining an optimal level of geographical, cognitive, social, organisational and institutional proximity can lower the scanning costs and acquisition barriers that often limit tacit knowledge spillovers, thus significantly enhancing innovation. Geographical proximity relates to both absolute physical distance and relative travel time distance that separates two organisations. Cognitive proximity reflects the extent to which two organisations share a common knowledge base. Social proximity concerns the friendly relationships among members of the two organisations; organisational proximity denotes the level of shared hierarchical control between them and institutional proximity refers to their operation within the same regime of shared norms, routines and laws (Boschma, 2005).

Boschma's (2005) framework is particularly sound due to its rich explanatory power using the "reducing transactional costs" thesis, grounded in its robust appreciation of geography and organisational management literature, to understand why proximity facilitates the exchange of ideas and innovation. Moreover, the framework has analytical clarity, clarifying various forms of proximity such as geographical and cognitive proximity. Hence, this research applies

Boschma's (2005) Proximity Theory for Innovation into a new context of Aerotropolis. As it theorises that economic actors tend to search for ideas within close absolute geographical proximity to reduce search and execution costs, the theory is well positioned to investigate an urban case such as the Aerotropolis.

The built environment and industry composition are suggested to be central themes in Aerotropolis masterplanning (Appold, 2014; Chang *et al.*, 2020). Therefore, this study investigates the innovation impact of relative geographical proximity in the form of the built environment in the Aerotropolis model and cognitive proximity in the form of the industry mix that is most conducive to innovation. The results presented in this paper are from original survey and interviews conducted in Aerotropolises in 2022.

The next section comprises the literature review of business and economic studies that looked at the causality between inter-industry ideas exchange, the built environment and industry composition factors that facilitate innovation. After describing the methodology, the fourth section presents and discusses the survey and interview results, followed by a discussion of innovation in Aerotropolises. The fifth section highlights contributions to theory and practice, before the paper concludes by summarising key findings, acknowledging limitations and suggesting directions for future research.

Literature review

Innovation and inter-industry ideas exchange

Innovation, generating new products and processes, is a goal of many Aerotropolises (Arend, 2022). Boschma's (2005) Proximity Theory for Innovation, alongside Fallah and Ibrahim (2004) and Wicaksono and Ririh (2022), explains that in innovation, many ideas are tacit, existing in the form of experience and practical attainment that are difficult to formalise into documents. These ideas flow from one industry or company to another through casual interactions between their workers. Empirical evidence confirms that ideas exchange occurs in workers' interactions in events and even random face-to-face encounters. Interviews by Balle *et al.* (2019) and an ethnographic study by Harvey *et al.* (2012) recorded technical and managerial ideas exchange during business and social events. By regressing the patent citations between companies in different industries in Silicon Valley against the random face-to-face encounters of their workers tracked by numerous smartphone location pings, Atkin *et al.* (2022) confirmed inter-industry ideas exchange occurs during workers' random face-to-face encounters.

Feldman and Audretsch's (1999) seminal regression study using 5,946 city-industry observations in the USA found a significant negative relationship between industry specialisation and innovative activity. They suggest that cities with diverse industries promote idea exchange, leading to increased innovation, as evidenced by new product announcements in the Small Business Administration's Innovation Data Base.

Becoming globally competitive requires industries in manufacturing and service sectors to have immediate connectivity to their distant suppliers and markets; therefore, many companies choose a location accessible to an airport. Consequently, Aerotropolises, both existing and those in development, have attracted a diverse range of industries, such as information and communication technology, wellness and medical, logistics, biomedical and pharmaceuticals [1] (Kasarda and Appold, 2014; Kasarda, 2022; Zandiatashbar and Hamidi, 2022). However, to the authors' knowledge, no studies have investigated ideas exchange between these industries and innovation in Aerotropolises. Existing studies such as those by Mokhele (2016) and Ke (2020) conducted surveys and interviews to investigate the business linkages within Aerotropolises in South Africa and Australia. They found approximately 70% of Aerotropolis-locating companies in many industries, including airlines, logistics, commercial and knowledge-intensive services and manufacturing, have clients or suppliers within the Aerotropolises due to geographical proximity. However, Mokhele (2016) and Ke (2020) did not examine the linkages in the form of ideas exchanged between workers in

different industries and their potential impact on innovation. This study applies Boschma's (2005) Proximity Theory to gain insights into the innovation dynamics in Aerotropolises addressing the first research question:

RQ1. To what extent are product and process innovations happening in Aerotropolises?

Urbanised built environment facilitates innovation

Boschma's (2005) Proximity Theory for Innovation states that geographical proximity not only has an absolute dimension measured by metric distance, but a relative dimension measured in travel time and costs as well, which the built environment can manipulate (Torre and Rallet, 2005; Micek, 2018). Froy (2021) critiques that studies often crudely treat companies located in an agglomeration, such as within any metropolitan area, as having geographical proximity to each other, and overlook built environment configurations that can cause a significant impact on the relative geographical proximity and affect inter-industry ideas exchange and innovation. Places with good walkability and public transport, mixed land use and ample gathering places achieve more inter-industry ideas exchange and facilitate innovation because they have relative geographical proximity that brings people together for ideas exchange.

Regression models show that cities with good walkability, reflected by having more density, are significantly positively associated with more innovation patents because these cities give more opportunities for random face-to-face encounters and inter-industry ideas exchange, ultimately spurring innovation (Fang and Rao, 2021). This is why some renowned science parks made considerable investments in improving walkability to facilitate innovation. For example, Stockholm Life Innovation District covered the two highways that previously divided the district with a deck, and built housing, laboratories, schools and open spaces on the deck to restitch the district. The innovation district 22@Barcelon buried railway tracks to build walkable streets and open areas. Boston's innovation district removed the elevated highways that previously separated itself from the rest of the city (Katz and Wagner, 2014). Moreover, Wang *et al.*'s (2022) quasi-experimental study finds that opening new subway stations in cities led to increased patent citations and innovation patent outputs within the cities. Subway expansion facilitates convenient, affordable travel, fostering random encounters between diverse industry professionals, which in turn increases opportunities for inter-industry ideas exchange and innovation (Mulas *et al.*, 2015; Wang *et al.*, 2022).

The allocation of land uses also affects innovation. The exchange of ideas between industries via human interactions diminishes with increased distance, so ideas tend to remain localised around companies rather than disseminated throughout the metropolis (Tavassoli *et al.*, 2021). To facilitate innovation, there should be a mix of industries in each and every street (Sung *et al.*, 2015; Vey *et al.*, 2018). There should be a mix even within each building, for instance, allocating large-footprint industries like manufacturing on the ground floor and offices and research facilities on higher floors (Grodach and Gibson, 2018). A regression study at a microscopic geographical scale (one km-by-km walkable grids) confirms that grids composed of diverse industries promoted inter-industry ideas exchange and innovated more patents, whereas specialised grids discouraged innovation (Fang and Rao, 2021).

Lastly, gathering places play a key role in promoting innovation. Public gathering places such as parks and squares, along with semi-public gathering places like cafes and bars, provide spaces for planned events and act as common focal points for individuals from different industries to randomly meet, socialise and exchange ideas (Grandadam *et al.*, 2013; Vey *et al.*, 2018; Capron *et al.*, 2022). Interviews in a science park found that random face-to-face encounters and inter-industry ideas exchange were hindered because gathering places were missing (Carvalho, 2012). Similarly, Almeida and Daniel's (2025) systematic literature review on entrepreneurial ecosystems in low-density territories characterised by remoteness and ruralness finds that the lack of events and gathering places hinders knowledge dissemination.

Developments following Kasarda's (2019) Aerotropolis planning model are often composed of numerous business parks disjointed by highways and railways. Scholars and planners have criticised those developments as unwalkable, and lacking public transport access and gathering spaces (Yun, 2015; Hirsh, 2019; Van der Heijden and Schaafsma, 2020). Additionally, the model advocates a cluster-based planning approach based on industry (Kasarda and Cannon, 2016). Dubai South is an example of this with its Commercial, Exhibition, Humanitarian, Golf, Logistics and Aviation Districts (Dubai Aviation City Corporation, 2022). Freestone (2009, p. 167) describes the built environment of an Aerotropolis as "sprawl and scatter":

> From a broader planning perspective, the aerotropolis model also tacitly endorses the inevitability if not desirability of an extensive "sprawl and scatter" pattern of suburban land use development.

While the Aerotropolis model has been criticised by planning scholars and practitioners for lacking an urbanised built environment, limited empirical studies exist. Some exceptions are Tse *et al.* (2021) establishing quality of place indexes for three Aerotropolises representing different census regions in the USA through mapping and counting urban amenities favoured by the modern knowledge workers. Kamruzzaman *et al.* (2021) found merely a 2.1% urbanisation rate between 2004 and 2014 based on analysing satellite images of 75 Aerotropolises globally, thus questioning the attractiveness of the aviation-export-driven Aerotropolis growth assumption. This study seeks to address this gap by empirically investigating the importance of an urbanised built environment to Aerotropolises, particularly in fostering innovation. The absence of an urbanised built environment suggests a deficiency in relative geographical proximity (Torre and Rallet, 2005; Micek, 2018; Froy, 2021). According to Boschma's (2005) Proximity Theory, lacking relative geographical proximity could limit inter-industry ideas exchange and innovation within Aerotropolises. Therefore, this study aims to answer the following research question:

RQ2. What is the role of urban design in fostering innovation in Aerotropolises?

Skills-related industries sharing the same knowledge base facilitate innovation

While being challenged by different ideas and norms is the foundation of innovation, Boschma (2005) and Frenken *et al.* (2007) found that a level of cognitive proximity between industries, defined as a shared knowledge base and skills, is needed to enable effective communication and learning and ultimately innovation. For example, it might be unlikely for a pig farmer and a microchip company, even as neighbours, to learn from each other due to their vastly different skill sets (Boschma and Iammarino, 2009). Van Dinteren and Jansen's (2021) guide on science park masterplanning recommends developers select companies from different industries but still share a similar knowledge base to facilitate inter-industry ideas exchange and innovation. Based on the Differentiated Knowledge Bases model by Asheim *et al.* (2011) and Grillitsch *et al.* (2018), skills-related industries with cognitive proximity could be understood as those sharing one of these three epistemologically distinct knowledge bases: analytical, synthetic or symbolic, which are distinguished by their rationale in knowledge creation, the way knowledge is developed and used, actors involved, knowledge types and the types of product or service produced.

Industries with an analytical knowledge base are scientifically-based (Asheim, 2007). Analytical-based industries such as ICT, higher education, life science, medical technology and agricultural biotechnology are focused on understanding the natural world (Asheim and Coenen, 2006; Martin, 2012). They perform original research and development, communicate through scientific models and patents (Asheim, 2007; Asheim *et al.*, 2011), and prefer locations with good research environments like world-leading universities and sophisticated laboratories (Asheim *et al.*, 2007).

Industries with a synthetic knowledge base are engineering-based industries (Asheim, 2007). Synthetic-based industries focus on production and problem-solving for clients by applying existing knowledge (Asheim, 2007). They maintain close relations with clients and

suppliers, and their workers gain skills from polytechnic or on-the-job training (Asheim *et al.*, 2011). Examples of synthetic-based industries include automobiles, aviation, engineering and business consultancy services (Broekel and Boschma, 2012; Pina and Tether, 2016; Chen and Hassink, 2020). They prefer locations with large labour markets (Asheim and Hansen, 2009) and coordinated market economies that enable cooperative long-term business networks and close user-producer interactions (Asheim and Coenen, 2006).

Industries with a symbolic knowledge base are creative-based industries (Asheim, 2007). They are concerned with creating meanings and desires through aesthetic aspects and they value experience over formal qualifications. Their workers work typically in studio environments, and "habits", "youth", "street" or "fine cultures" are common languages among their workers (Asheim, 2007; Asheim *et al.*, 2011). Examples of symbolic-based industries include tourism, restaurants, arts and entertainment (Manniche and Larsen, 2013; Coll-Martínez *et al.*, 2019). They prefer creative locations with many cultural events (Inkinen, 2015) and openness to different ethnicities, nationalities and bohemians (Asheim and Hansen, 2009).

Most existing studies distinguish an industry's knowledge base by in-depth case studies or adopt existing classifications reported in the literature, because theoretically and qualitatively judging the tendency towards a particular knowledge base would be more straightforward (Aslesen and Freel, 2012; Sedita *et al.*, 2017).

Empirical evidence finds that inter-industry ideas exchange between industries with the same knowledge base are preferred because they are skills-related. Interviews with companies' representatives and innovation consultants show that although almost all companies were interested in inter-industry ideas exchange due to their importance for innovation, companies mainly only conducted ideas exchange with industries from the same analytical, symbolic or synthetic knowledge base, and believed other knowledge bases are irrelevant due to cognitive distance (Bennat and Sternberg, 2020). Similarly, Strambach and Klement's (2012) study on 693 ideas exchanges based on timeline reports on innovation events, written biographies and interviews show that most ideas exchange occurred within the same knowledge base, either analytical, symbolic or synthetic, whereas only 20% of ideas exchange involved combining different knowledge bases.

Almost all Aerotropolises have multiple industries (Kasarda and Appold, 2014; Kasarda, 2022; Zandiatashbar and Hamidi, 2022), but they are seemingly not skills-related from the same knowledge base. For instance, from Kasarda and Appold's (2014) common industries list, the hotels and entertainment, wholesale merchandise and convention and exhibition industries are symbolic-based. The list also shows synthetic-based industries such as precision and time-critical manufacturing, aviation, logistics and distribution and producer services such as finance and consulting. Analytical-based industries, including information and communication technology, wellness and medical and medical instruments, are also presented in the list. Following Boschma's (2005) Proximity Theory for Innovation that emphasises cognitive proximity, this study postulates that Aerotropolises can facilitate the exchange of ideas and innovation when they consist of cognitively proximate industries, indicated by sharing an epistemologically identical knowledge base (Asheim *et al.*, 2011; Grillitsch *et al.*, 2018). Conversely, innovation may be hampered when Aerotropolises comprise a random mix of skills-unrelated industries, although this is being frequently promoted (c.f. Kasarda and Appold, 2014). However, there is a lack of research on the impact of industry variety on innovation in the Aerotropolis context. Therefore, this study aims to address the following research question:

RQ3. What is the role of industries' knowledge base similarity in fostering innovation in Aerotropolises?

Methodology

This study is grounded in the positivist paradigm, assuming an objective reality apprehended through generalisable theoretical propositions, which is verifiable via objective empirical

analysis of regularities and causal relationships (Howe, 2012; Melnikovas, 2018; Su, 2018). Positivists aim to both validate theories against existing patterns (Su, 2018) and predict probable futures by extrapolating from causal, law-like theoretical relations (Tapio and Hietanen, 2002; Melnikovas, 2018). To verify the generalisability of Boschma's (2005) Proximity Theory for Innovation in the urban form of an Aerotropolis, this study analysed how participants have carried out inter-industry ideas exchange and innovations in their Aerotropolises and evaluated participants' agreement with "what-if" hypothetical statements aligned with Boschma (2005) to confirm potential future enhancements for fostering inter-industry idea exchange.

Howe (2012), Gibson (2017) and Morgan (2019) advocate for using mixed-methods methodology in positivist research, emphasising that theory verification is more robust when qualitative and quantitative evidence are triangulated through convergence, where separately collected and analysed qualitative and quantitative data yield identical results; and complementarity, where quantitative results recognise generalisable patterns using a larger sample size while qualitative findings provide detailed information about processes that quantitative results cannot capture. Accordingly, this study employed parallel mixed-methods methodology, combining an online 5–10-min predominantly quantitative survey with closed-ended questions, supplemented by open-ended responses, alongside qualitative semi-structured Zoom interviews lasting 45 min on average.

To seek generalisability, the authors conducted global research with participants whose work locations are in an Aerotropolis in 2022 as part of an Honours program research. Responses from participants of various Aerotropolises, namely Amsterdam Airport Schiphol (Zuidas), Hong Kong International Airport, Indira Gandhi International Airport (GMR Aerocity New Delhi), King Shaka International Airport (Durban Aerotropolis), Orlando International Airport (Lake Nona), Rajiv Gandhi International Airport (GMR Aerocity Hyderabad), San Francisco International Airport, Singapore Changi Airport and Sydney Kingsford Smith Airport (Mascot Precinct) were received. The survey and interview questions were developed, and the resulting data were interpreted using the framework established by Boschma (2005). The employed survey and interview questionnaires covered the ideas participants gained from other industries, their frequencies, how and where they occurred, the actual impact of knowledge base, the contribution of these ideas towards innovations in participants' companies, agreement on the effectiveness of potential built environment and industry composition interventions and open-ended questions regarding what facilitates ideas exchange and innovation in general. The types of innovation were adopted from the OECD (2004) community innovation survey that covered the different dimensions of product innovation such as new or significantly improved products or services launched to the market. Also, OECD (2004) covered process innovation as new or significantly improved methods of producing; logistics, delivery or distribution methods; supporting activities for company processes such as maintenance systems, accounting or computing.

After pilot-testing the survey, the authors shared it on LinkedIn with their Aerotropolis connections to snowball-sample more participants. Responses that only provided background information, did not identify an airport or worked outside the 30 km Aerotropolis radius were excluded. Finally, 26 useable survey responses were included, with 24 fully completed and two partially filled out. The majority of survey participants were senior staff, such as directors, managers and chartered professionals. For the interviewees, the authors chose to interview entrepreneurs as they are more likely to apply innovative ideas they gained from other industries (Block *et al.*, 2013; Wicaksono and Ririh, 2022). Interviewees were recruited by identifying entrepreneurs in Aerotropolises based on subject matter publications. Five interviewees from three continents participated in this research, representing a diverse group of industries: business consultancy; textile; medical instrument; food, beverage and hospitality. Overall, survey and interview responses came from nine Aerotropolises on five continents and ten different industries (Figure 1). Survey responses were analysed through frequency counting and percentages, and thematic grouping of short answers. Interview data,

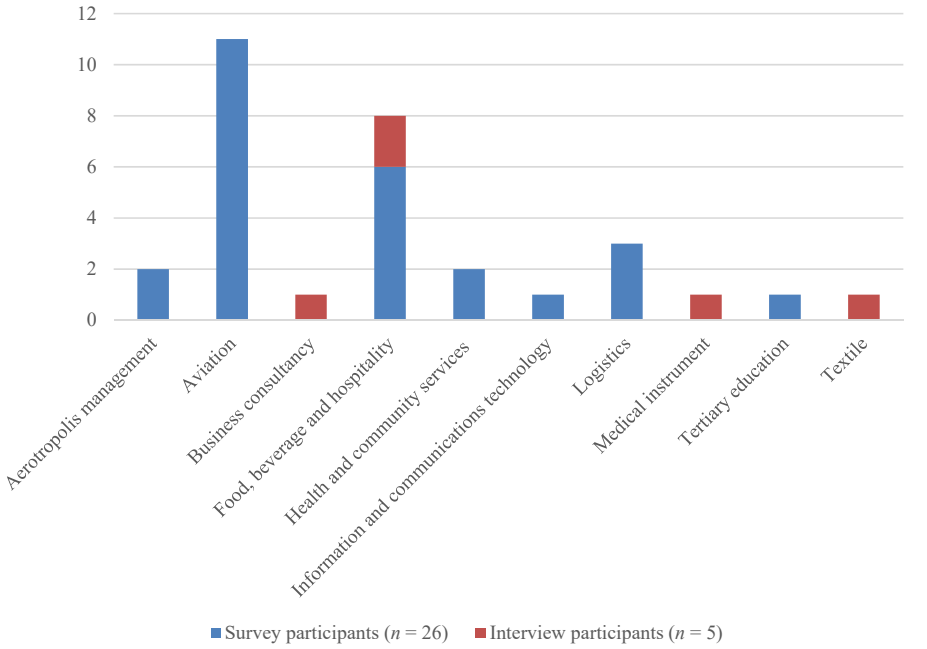

Figure 1. Industry distribution. Source: Authors own work

transcribed electronically by Zoom, was manually analysed by the authors using thematic analysis following Boschma's (2005) framework.

The relatively small number of Aerotropolises compared to other types of urban developments such as science parks, results in a smaller pool of eligible potential participants and therefore a smaller sample size of survey and interview data. Future research could strengthen findings and conclusions through the incorporation of in-depth case studies (Yin, 2003). In this study, the authors added a discussion based on secondary, publicly-available information on two cases, Orlando and Hong Kong Aerotropolis, that possess many aspects mirroring the theoretical propositions so that these cases are well-suited for verifying the theory and reaching further triangulation (Yin, 2003). Although this discussion is not a formal study providing exhaustive case evidence, initial insights from these critical cases might be valuable.

Results and discussion

This section presents and discusses survey and interview results addressing the overarching research question: What facilitates innovation in Aerotropolises? Overall, there are four main findings:

(1) Ideas from other industries have sparked product and process innovation

(2) Urbanised built environment further stimulates innovation

(3) A variety of skills-related industries from the same knowledge base could further promote innovation

(4) Community atmosphere and events facilitate innovation

Findings for research question 1: to what extent are product and process innovations happening in Aerotropolises?

Survey and interview results show that all participants gained a range of ideas from the diverse industry mix that exists in their Aerotropolises (Kasarda and Appold, 2014; Kasarda, 2022; Zandiatashbar and Hamidi, 2022), including cutting-edge technical concepts such as advancements in blockchain technology and novel applications of artificial intelligence. Participants also acquired marketing and organisational ideas pertaining to staff development programs, product launch strategies and market trend changes due to new business developments.

In detail, participants reported that the ideas they gained from other industries in their Aerotropolises led to product innovations, that is the launch of new or significantly improved services (15/26 survey participants) and products (10/26), as well as various process innovations such as improvements in supporting activities such as maintenance and computing (11/26) and logistics (10/26) (Figure 2).

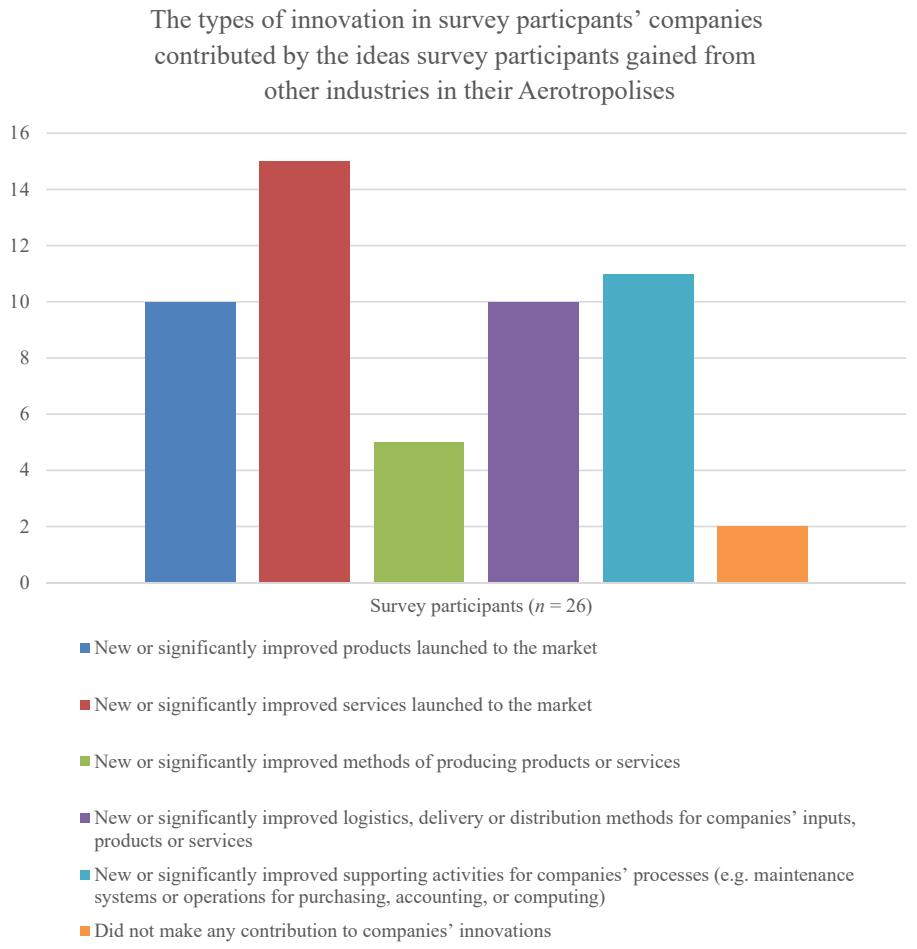

Figure 2. Types of innovation contributed by inter-industry ideas exchange in Aerotropolises. Source: Authors own work

Interviewees further emphasised the value of inter-industry ideas exchange, as it allows one "to think outside the box".

> People from other industries, they can see from an outer perspective. We sometimes are not able to think out of the box, especially when we are in a very tight schedule or very busy environment. (C2W)

The findings are consistent with the existing literature, confirming that gaining ideas from other industries drives innovation (Jacobs, 1969; Enkel and Gassmann, 2010) and the importance of industry diversity in a city for driving innovation (Feldman and Audretsch, 1999). Interaction with employees of other industries encourages them to "think outside the box", challenges commonly accepted perspectives of a specific industry and might identify connections that are otherwise invisible from their own narrow industry-specific viewpoint. When conventional practices are questioned, it opens up possibilities for innovations.

Furthermore, the following quote clearly indicates that interacting with companies located outside the Aerotropolis in other districts of the metropolitan region is often "more of a hassle" due to longer commutes, thereby limiting potential innovation:

> Being outside of [Aerotropolis masked], I think it would have been less. I mean, it's more of a hassle to go to see them because they're just not local. If it's next to other things that are in close proximity to each other, then maybe go and see them. (A2Y)

This supports Boschma's (2005) Proximity Theory that increases in physical geographical distance hinders innovation.

In sum, it is found that some product and process innovations have occurred within the urban form of the Aerotropolis. These innovations are facilitated by the broad ideas exchange among Aerotropolis-locating workers in different industries.

Findings for research question 2: what is the role of urban design in fostering innovation in Aerotropolises?

Consistent with findings by Sung *et al.* (2015), Vey *et al.* (2018), Fang and Rao (2021), the overwhelming majority of research participants agreed (62% of survey respondents) or strongly agreed (17%) that co-locating with other industries in the same immediate neighbourhood facilitates inter-industry ideas exchange (Table 1). Interviewees also suggested that proximity to other industries in a mixed-use business neighbourhood could lead to more innovation by easing engagements with people from different industries. Industry clustering is risking innovativeness in the long run as it is prone to group-thinking and cognitive lock-in that creates barriers towards radical novelties (Østergaard and Park, 2015; Schmidt *et al.*, 2020).

Table 1. Survey participants' opinions towards factors facilitating inter-industry ideas exchange

Survey participants (n = 24) Opinions	Strongly agree	Agree	Disagree	Strongly disagree
Inter-industry ideas exchange will be easier if industries in their Aerotropolises share the same knowledge base	21%	58%	17%	4%
Inter-industry ideas exchange will be easier if their workplaces in Aerotropolises are immediately surrounded by companies in other industries	17%	62%	21%	0%
Inter-industry ideas exchange will be more difficult if their workplaces in Aerotropolises are only reachable by car (i.e. no walkable connection and no public transport access)	9%	52%	39%	0%
Inter-industry ideas exchange will be easier if there are many gathering places in their Aerotropolises	13%	75%	8%	4%

Source(s): Authors' own work

Moreover, in line with Mulas *et al.* (2015), Fang and Rao (2021) and Wang *et al.* (2022), the survey shows that 52% of participants agreed and 9% strongly agreed that lacking walkability and public transport access hinders inter-industry ideas exchange and innovation (Table 1). Without walkability and public transport, interviewees suggested it would be harder to travel around to meet new people and gain different perspectives.

The authors initially expected that inter-industry ideas exchange would be scarce or non-existent in Aerotropolises, given Freestone (2009), Yun (2015), Hirsh (2019) and Van der Heijden and Schaafsma's (2020) sprawl and scatter criticism towards the Aerotropolis planning model. However, upon studying the actual occurrence of inter-industry ideas exchange, the findings were mixed. According to the survey results (Table 2), 17% of participants had often experienced inter-industry ideas exchange with people from nearby Aerotropolis companies within walking distance several times a week, while 29% did so with companies in Aerotropolises accessible by public transport. However, there were also 12% of participants who had never experienced inter-industry ideas exchange with people from nearby Aerotropolis companies within walking distance, and 21% had never done so with companies in Aerotropolises reachable via public transport. This may be the outcome of different urban designs within an Aerotropolis. Some parts may offer good walkability and public transit accessibility, which can have a positive impact for workers to exchange ideas with neighbouring companies. For instance, within Hong Kong Aerotropolis, the edge city of Tung Chung boasts a high level of walkability and public transit access, particularly around the railway station (Town Planning Board, 2020). As a result, employees working in this area might be more likely to gain ideas from companies within walkable distance and public transit reach. Conversely, those working in outskirt areas with limited walkability and public transit access, such as Chek Lap Kok island (Town Planning Board, 2015), are less likely to have such interactions. The disparity between edge cities and outskirt areas regarding access to walkable roads and public transit can also be found in some other Aerotropolises (Banai, 2017).

Confirming Carvalho (2012), Grandadam *et al.* (2013), Vey *et al.* (2018), Capron *et al.* (2022) and Almeida and Daniel (2025), results from this study show that gathering places such as plazas and cafes in Aerotropolises encourage innovation. Table 1 shows 75% of survey participants agreed and 13% strongly agreed that having many gathering places in

Table 2. Inter-industry ideas exchange experienced by survey participants

Survey participants (n = 24) Actual occurrences	Often (several times a week)	Sometimes (about once or twice per month)	Seldom (about once or twice per year)	Never
Experienced inter-industry ideas exchange from skills-related industries in their Aerotropolises	8%	50%	34%	8%
Experienced inter-industry ideas exchange from other Aerotropolis-locating companies within walking distance	17%	29%	42%	12%
Experienced inter-industry ideas exchange from other Aerotropolis-locating companies reachable via public transport	29%	25%	25%	21%
Experienced inter-industry ideas exchange with other Aerotropolis workers during random face-to-face encounters at public gathering places in their Aerotropolises	8%	38%	25%	29%
Experienced inter-industry ideas exchange with other Aerotropolis workers during random face-to-face encounters at semi-public gathering places in their Aerotropolises	12%	33%	38%	17%

Source(s): Authors' own work

Aerotropolises facilitates inter-industry ideas exchange. Interviewees also emphasised the importance of people coming together for innovation and suggested that gathering places provide two ways for this to happen:

Firstly, gathering places are focal points, allowing individuals from different industries to randomly meet and exchange ideas.

> We have like open spaces that's more like a bar where people coming. The thing is that they, at the moment [Aerotropolis masked], don't have that much space. So everyone, most of the people, also like important people, they come into the same area. It is not really hard to find people. (A1Z)

Having gathering places might be especially important in sprawling Aerotropolises' vast and wide transport corridors.

Secondly, gathering places offer venues for events where inter-industry ideas could be exchanged.

> I think very important for innovation is that people come together. For example, in a library or you know this kind of buildings, people in different kinds of backgrounds all over the world, you know, they come together. I think that like a kind of space where you can talk with each other. (A1Z)

Table 2 shows 8% of the participants reported that they experienced inter-industry exchange of ideas during random face-to-face encounters at public gathering places, such as plazas and sidewalk gardens several times a week, while 38% of them did so once or twice a month. Similarly, 12% of the participants reported that they experienced inter-industry exchange of ideas during random face-to-face encounters at semi-public gathering places, such as cafes and bars, several times a week, and 33% of them did so once or twice per month. However, some of the participants (17%) reported that they never experienced inter-industry exchange of ideas during random face-to-face encounters at semi-public gathering places, and 29% reported the same for public gathering places. It is worth noting that the survey only asked about inter-industry exchange of ideas via random face-to-face encounters. However, interviewees revealed that they often deliberately planned to meet acquaintances from other industries located in the Aerotropolis at gathering places to discuss innovative endeavours, confirming the importance of such places in fostering innovation.

These results indicate that urban design including good walkability, public transport, mixed land use and ample gathering places in Aerotropolises might facilitate workers from different industries to exchange ideas and ultimately spur innovation. As these urban design configurations are representations of relative geographical proximity (Torre and Rallet, 2005; Micek, 2018; Froy, 2021), Boschma's (2005) theoretical claim on relative geographical proximity facilitating innovation is validated.

Findings for research question 3: what is the role of industries' knowledge base similarity in fostering innovation in Aerotropolises?

While it is essential to have multiple industries collaborating and sharing ideas with each other for innovation (Jacobs, 1969; Frenken *et al.*, 2007; Enkel and Gassmann, 2010; Lee and Sohn, 2019), participants clearly expressed that the exchange of inter-industry ideas would be further promoted if the Aerotropolises were thoughtfully designed by carefully selecting skill-related industries that share a common knowledge base and "language". According to the survey, 58% of participants agreed and 21% strongly agreed that exchanging ideas between industries will be easier if the Aerotropolises are formed by industries that share the same knowledge base (Table 1). This approach ensures cognitive proximity, which facilitates meaningful conversations and innovation synergies as theorised by Boschma (2005), Frenken *et al.* (2007), Asheim *et al.* (2011), Strambach and Klement (2012), Bennat and Sternberg (2020).

To illustrate, this quote highlights the difference in cognitive easiness in understanding among symbolic-based industries (restaurant and the arts) and the challenges faced in grasping concepts between symbolic and analytical-based industries (restaurant and computer science).

> Arts, maybe I could get some idea when it comes down to the decorations within the restaurant. They will say, oh, you can make this colourful, or a wall like this, which would make your atmosphere much better. . . . . I think arts industry would still help me out. But when it comes down to computer science, or something like the other industry, I don't think I would really get any, it's a completely different field. (C2W)

The ease of inter-industry ideas exchange between skills-related industries can be further reflected by the high frequency of their occurrence in Aerotropolises. According to the survey results, 50% of survey participants experienced inter-industry ideas exchange from skills-related industries in their Aerotropolises around once or twice per month, and 8% experienced it more often by several times a week, although another 8% never did so (Table 2).

Initially, the authors did not expect to find this high volume of inter-industry ideas exchange between skills-related industries in Aerotropolises because the common Aerotropolis industries shown in Kasarda and Appold (2014) imply that they are skills-unrelated from vastly different knowledge bases. However, after a closer look at published information of the sampled Aerotropolises, it was found that some of them had already restructured their industry composition to a more skills-related mix.

Interviewees from such an example observed that there were vibrant ideas exchanged between the medical and sports industries, which contributed to innovation. Their skills-relatedness because of having the same analytical knowledge base allows people to "know what you're talking about"

> Because this is like a fairly healthcare space. Most of the people already know what you're talking about, because, you know, there's a lot of doctors and medical people in this town, and also in the sports industry. . . . . a lot of people they know their space, and they know the healthcare area. They also can help you much more easily, because they already understand this kind of space. (A1Z)

These findings provide insights that Aerotropolises could benefit from adhering to Boschma's (2005) principle on cognitive proximity to facilitate innovation, and carefully choose a combination of skill-related industries that share a common knowledge base rather than having a haphazard mix of cognitively distant industries from different knowledge bases (Asheim *et al.*, 2011), as is common for many current developments. For instance, in Memphis Aerotropolis, its core industries include manufacturing, waste management, finance (synthetic-based); information, educational services, health care (analytical-based) and retail (symbolic-based) (Antipova and Ozdenerol, 2013).

Additional findings from open-ended questions regarding what facilitates ideas exchange and innovation

Despite the common perception that Aerotropolises are greenfield developments with little history and time to cultivate genuine communities (Kasarda and Chen, 2021), interviewees demonstrated that a community atmosphere exists in some Aerotropolises. Interviewees expressed that such community atmosphere in Aerotropolises, reflected by the friendliness of people and openness to helping each other, was also a critical factor to inter-industry ideas exchange and innovation.

> So yeah, you really can connect with them and also improve and create some new ideas . . . so I know some people that meant like very high people in big organisations here, and you know, you see them on the street and, you know, drink a coffee with them directly. It's very down to earth. . . . . and I think that's a great part of this community. (A1Z)

The importance of community in facilitating innovation is further emphasised as the majority of interview and survey participants recommended organising social gatherings or business events regularly to promote inter-industry ideas exchange in Aerotropolises. This finding is particularly interesting as the importance of events appears to transcend diverse geographical

and cultural contexts, possibly due to the innate social nature of humans. Events stimulate community formation and subsequently facilitate innovation, as suggested by an interviewee:

> They like to grow the community. So, they will often have events in different places . . . . . like jam sessions, you know, where we would play music, food, drinks and everything . . . . . this is a more casual environment, you know, I want to talk a little bit about what you do, about what I do, just build good relationships, professional relationships. (A2Y)

This is consistent with research findings from master-planned science parks and policy-driven industrial clusters, suggesting events can accelerate community formation by bringing together individuals who might not otherwise meet to forge social ties and build mutual trust (Richardson, 2013; Katz and Wagner, 2014; Van Dinteren and Jansen, 2021).

Summarising, these results indicate that a genuine community atmosphere with social proximity, cultivated through social gatherings and business events, could foster innovation in Aerotropolises.

General discussion on innovation in Aerotropolises

Almost all Aerotropolises-in-development documented by Kasarda (2022) have plans to grow a vast range of seemingly unrelated industries. For instance, Western Sydney Aerotropolis plans to grow advanced manufacturing, aerospace and defence, freight (synthetic-based); quantum computing, artificial intelligence, medical research, agribusiness (analytical-based); arts and cultural industries (symbolic-based) (Committee for Sydney *et al.*, 2022). However, other examples do exist. For instance, Orlando Lake Nona Aerotropolis has a clear strategy prioritising analytical-based healthcare and human performance industries, so companies at the intersection of technology, wellness, sports, medicine and nutrition are most welcomed (Tavistock Development Company, 2019; Lake Nona, 2021; Lake Nona Impact Forum, n.d.). For example, Johnson & Johnson Human Performance Institute, which conducts corporate leadership training and R&D using science-based approaches, chose to locate in Lake Nona to leverage synergies with medical, research and educational institutions in the local community (Orlando Economic Partnership, 2018).

Orlando Lake Nona Aerotropolis has become a successful innovation hub with innovations such as the largest autonomous vehicle network in the USA, AI-informed glass windows to enhance wellness of inhabitants and 5G-enabled solutions developed and tested across healthcare and mobility companies (Real Comm, 2022; Worth Media, 2023).

Choosing the appropriate knowledge base depends on the unique context of each Aerotropolis and requires stakeholder management and in-depth demand and feasibility studies. For instance, if an Aerotropolis has a robust research infrastructure, such as world-leading universities and sophisticated laboratories, it would be more attractive to analytical-based industries (Asheim *et al.*, 2007). Otherwise, if the Aerotropolis is strong in its creative milieu with many cultural activities (Inkinen, 2015) and an open human climate (openness to different ethnicities, nationalities and bohemians) having symbolic-based industries would be more suitable than having synthetic-based industries as a conductive business environment with a large labour market outweighs an open human climate for synthetic based industries (Asheim and Hansen, 2009).

Lake Nona Aerotropolis also adopts other strategies to achieve collaborative innovation (Marcus, 2020). Lake Nona recognises that physical connectivity is vital for collaborative innovation so they cater to various personal mobility options, including 70 km of paved and unpaved walking trails and the largest and longest-running single-site autonomous commuter network in the USA, which has replaced over 16,500 car journeys (Tavistock Development Company, 2024). It also features the mixed-use building "Pixon MS^2", purposefully designed to foster collaborative innovation with shared spaces for health and tech startups strategically located in the mixed-use town centre, surrounded by numerous amenities to further promote synergies (Tavistock Development Company, 2024). Additionally, Lake Nona Aerotropolis

hosts nearly 1,000 free events annually (McKee and Walters, 2024). The community features a diverse array of walkable gathering spaces, such as fitness centres and a container/food truck park, to promote interaction and collaboration (McKee and Walters, 2024).

Notwithstanding the importance of geographical and cognitive proximity, innovation might also be influenced by the absorptive capacity of companies, measured by its R&D intensity such as the ratio of R&D staff and expenditures (Escribano *et al.*, 2009; Triguero and Fernández, 2018). Companies' absorptive capacity, especially for small companies (Segantini, 2024), is also influenced by regional innovation initiatives, including publicly funded R&D and available training enabling companies to develop new cognitive schemas on knowledge (Lau and Lo, 2015).

The aviation industry is known for its strong emphasis on R&D (Eriksson and Steenhuis, 2015). The close-ended survey results of this study, for example, have identified some instances of innovation in products, services, methods of production, logistics and supporting activities within the aviation industry in Hong Kong Aerotropolis. Hong Kong Aerotropolis is located within the Shenzhen-Hong Kong-Guangzhou science and technology region, which achieved a second place in the Global Innovation Index 2023; Cheung (2024). It is home to several world-class universities and the government has introduced schemes for promoting human capital development, such as funding R&D positions and providing industrialisation and technology training opportunities (Cheung, 2024). Future research could disentangle the fractional impact of regional innovation initiatives, inter-industry skills exchange and the built environment towards innovation outputs within Aerotropolis urban forms.

Contributions to theory and practice

This study extends Boschma's (2005) Proximity Theory for Innovation to the context of Aerotropolis. Confirming the theory, the findings show that inter-industry idea exchange and innovation occur within the Aerotropolis boundary that inherently reflects absolute geographical proximity. Also supporting the theory, the study reveals that innovation performance could be further enhanced by promoting other forms of proximity paramount to innovation, such as an urbanised built environment that fosters relative geographical proximity, as well as skills-related industry mix showcasing cognitive proximity, and organising more events to promote social proximity formation.

Based on the results of this study, we recommend the following innovation facilitation strategies for Aerotropolis developers and planners.

Focus on either scientific, engineering or creative-based industries

We call on planners to establish a focus area of industries with either analytical (scientific), synthetic (engineering) or symbolic (creative) knowledge base during the early stages of masterplanning for each Aerotropolis, in a way similar to Lake Nona's strategy explained previously (Tavistock Development Company, 2019; Lake Nona, 2021; Lake Nona Impact Forum, n.d.). For established Aerotropolises, the industry mix could be analysed and initiatives could be formed to start driving towards more strategic long-term alignment. In cases where the shares of industries show no specialisation in a specific knowledge base, such as Memphis revealed earlier (Antipova and Ozdenerol, 2013), Aerotropolises could consider ending concessions for companies from industries in the two knowledge bases that are less fitting into its education, cultural and business context (see Asheim and Coenen, 2006; Asheim *et al.*, 2007; Asheim and Hansen, 2009; Inkinen, 2015). This should be done while balancing factors that are less relevant to innovation but are nevertheless important to the overall successful development of Aerotropolises, such as air connectivity, policy objectives, workforce development and economic contributions (Archibald and Zeller, 2018; Chang *et al.*, 2020; Ngwenya, 2020).

Robust walkability and public transit access

Instead of a motor-oriented suburban land use development with numerous business parks built on land parcels disjointed by highways and railways, we call on planners to build at human scale with a high level of walkability and provide ample public transport options in the Aerotropolis.

For existing Aerotropolises that tend to be "sprawl and scattered", long-term redevelopment plans should be implemented to urbanise the built environment further. Following Katz and Wagner (2014), this could include constructing mixed-use developments above existing highways and railways to restitch the district together.

Mixed-use development

In opposition to Kasarda and Cannon's (2016) industry cluster-based Aerotropolis land use planning advice, we recommend that land use planning in Aerotropolis neighbourhood streets and the configuration of buildings should encourage a diverse mix of industries as introduced in the "Pixon MS^{2}" case of Lake Nona Aerotropolis (Tavistock Development Company, 2024), as long as they are primarily from the same knowledge base, either analytical, synthetic or symbolic.

Gathering places and events

It is acknowledged that established Aerotropolises could not entirely redevelop their built environment overnight to facilitate innovation. These structural reforms take time and significant capital investment. However, commencing with relatively less costly strategies by constructing gathering places may be a practical yet useful approach to initiate the process as well as organising events for the Aerotropolis community. A cost-effective way to create more opportunities for the community to mix could be to trial food trucks before investing in more permanent structures or shutting down selected roads with infrequent car usage and turning them into pedestrian-only areas to promote walkability and random interactions. If the provision of gathering places is coupled with a high level of walkability, Aerotropolis workers could be incentivised to wander around and have stimulating conversations with others.

Conclusion

Aerotropolis developments strive to foster innovation growth, but it is unclear as to what facilitates innovation in Aerotropolises. In this article, the authors delved into management and economic geography literature and used Boschma's (2005) Proximity Theory for Innovation to investigate what facilitates innovation in Aerotropolis. Survey and interview results with people working in Aerotropolises worldwide were presented to understand the occurrences of inter-industry ideas exchange and innovation in Aerotropolises and the facilitating factors. Results show inter-industry ideas exchange between workers can lead to innovation in Aerotropolises. Such an outcome can be facilitated through an urbanised built environment with robust walkability and public transport, mixed land use and gathering places that allow workers to assimilate more easily, as well as having skills-related industries from the same knowledge base. Furthermore, a genuine community atmosphere shaped by organising many events can facilitate innovation.

These results provoke a re-evaluation of Aerotropolis planning and development principles. We call on Aerotropolis planners to transition from the sprawling cluster-based built environment to an innovation-fostering built environment with a more urbanised, mixed-use and walkable form. Industry composition that lacks knowledge base and skills-relatedness considerations should transition to a more aligned industry composition that considers local knowledge base circumstances.

One limitation of this study is the limited sample size. However, saturation was reached in survey responses and the in-depth interviews, offered a form of triangulation. Future research

could conduct in-depth case studies, which to the authors' understanding have not been carried out for this topic, to further investigate the impact of specific interventions in gathering places and events on innovation. Insightful case studies could be Aerotropolises that are already making changes to promote interactions between workers. For instance, Helsinki Aviapolis is building 24/7 urban nodes such as the forest plaza (Møller Architect, 2023) and the "Spot Schiphol" community initiative by Schiphol Group (2024) connects and inspires workers in the Aerotropolis through parties and boot camps. Future research could also apply the rigorous but highly underutilised time-series quasi-experimental methodology in established Aerotropolises, investigating innovation growth over time after having changes in the built environment, industry composition or organising events. An Aerotropolis that could be analysed is Milan Linate Airport. The currently sprawling Aerotropolis will be revitalised into an innovative smart district based on the 15-min city concept (CAPA, 2023). The concept aims to maximise human and commercial interactions within the small local area, facilitated by ample cycling and pedestrian pathways, as well as public squares and meeting spaces (CAPA, 2023).

This study has shown that applying principles of Boschma's (2005) Proximity Theory to Aerotropolises could help enhance innovation in Aerotropolises, ultimately helping this urban form to achieve its goal of economic development. By proposing this alternative urban development model that focuses on fostering innovation, we hope this study will provide timely insights for Aerotropolises striving to position themselves as innovation hubs (Arend, 2022) and stimulate further discourse on enhancing the current Aerotropolis urban development model.

Ethics approval

The ethical aspects of this research project have been approved by the Human Research Ethics Committee (HREC) of the University of South Australia. The ethics approval number of this research project is 203634.

During the copy-editing of this work, the authors used Grammarly Generative AI to improve language and readability. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Note

1. The following is a summary of common industries that agglomerate in Aerotropolises as listed in Kasarda and Appold's (2014) blueprint Aerotropolis masterplanning guide: hotels and entertainment, retail, convention and exhibition, producer services, corporate headquarters, information and communication technology, wellness and medical, wholesale, logistics, precision and time-critical manufacturing, biomeds and pharmaceuticals, high-tech electronics repair, high-value agricultural and food products, medical instruments and aviation-dependent industries. Examples of aviation-dependent industries are corporate offices of express shipping companies and airlines, as suggested by Freestone and Tice (2013).

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