


The functio-spatial structure of airport surroundings: the case of Kraków Airport

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Abstract: The area around Krakow airport is an attractive developmental urban area. The concentration of passenger traffic and the flow of goods is conducive to new development projects. These projects are associated with the operation of airports, as well as new uses which see the proximity of an airport as an additional asset in operating a business based on access to a form of high-speed transport. This paper presents the findings of research concerning the existing spatial structure, transport accessibility and compositional determinants within an area around Krakow Airport, which can be used to assess the phenomena present and formulate principles and trajectories of shaping them in the future. The study was based on an analysis of selected elements of the existing functio-spatial structure, as well as available materials and subject-specific planning documents. Due to the specificity of areas around airports, which undergo dynamic change, it appears key to determine the individual form of development and land cover, that skilfully combines modernity and comfort of use with meshing with the local landscape, featuring a network of linkages and the character of suburban space. The issues present in this area are distinctive of many cities and require coherent land development proposals.

Keywords: airport city, sustainable development, functio-spatial structure, airport, urban planning

1. Introduction

In recent years, areas around airports in Poland were found to be undergoing major spatial changes. This was a result of aerial passenger and cargo transport becoming widespread and well-developed. Airports, by providing a network of local, regional, national and international connections, act as concentrators of major traffic flows that require a wide range of services. These contemporary circulation nodes became attractive spaces for many forms of economic activities, attracting investors interested in the location, providing services to the airport and the clearly highlighted accessibility of these regions. In Poland, the number of passengers using air transport grew significantly over the past several years, which was accompanied by

this mode of transport becoming increasingly widespread, as demonstrated in table 1. One consequence of this was that the number of air transport connections grew and it became necessary to extend airport infrastructure [1] (pp.4-9).

Despite expected changes and the necessity to adapt to the development of the aerial transport industry, activity in areas around airports was initially associated with the extension of terminals and passenger and cargo transport infrastructure, and over time became linked with the concept of planning the areas around airports. This development was affected by the scope of safety zones, as noted by Di Mascio et.al. [2].

This zone stems from the assessment of aviation incident risk. These are areas around runways, where constraints on development are placed. Its reach is defined individually for every airport and depends on site-specific conditions.

The objective of this paper is to present the findings of an investigation of the existing spatial structure, transport accessibility and compositional determinants in the immediate area surrounding Kraków Airport in Poland, which can be used to assess the existing phenomena and formulate principles and trajectories for shaping them in the future.

The investigation began due to the dynamism of the transformation of suburban areas, as airports and the areas around them are highly specific and integral elements of such spaces [3].

Investigation in this area allows the assessment of the current development, available planning materials, and to formulate principles for shaping the functio-spatial structure in the future, as it should form a coherent and attractive fabric at the point of contact between the city, its suburban municipalities and the airport grounds. Defining land development principles can contribute to sustainable development.

Krakow Airport was selected as a case because, at the time of performing research, it was the second-largest airport in Poland. The number of passengers passing through the airport has been increasing dynamically for several years (Table 1), and in the period under study amounted to 68.91%.

Table 1. Yearly number of passengers for Kraków Airport in the years 2016–2019, source: www.ulc.gov.pl

Airport	Number of passengers			
	2016	2017	2018	2019
Kraków airport	4,974,676	5,829,190	6,759,683	8,402,859

In recent years, the suburban zone of Krakow saw structural transformations associated with the development of settlement, which contributes to the necessity to define the form of development of areas around airports. The case of Kraków Airport is distinctive of numerous airports in Poland and Europe in terms of the transformation of the development of areas around them and how their connections with their respective cities are planned. It can also be referenced to spatial analyses of areas around other airports of similar size and degree of development, especially in Poland.

The scope of this study covers the area in close proximity to Kraków Airport, Poland, which is located in the administrative limits of three neighbouring municipalities: Kraków, Zabierzów and Liszki, and is accessible from major transport arterials (Fig.1).

The study is based on original analyses of the existing functio-spatial structure, compositional determinants and transport accessibility.

It also analysed selected planning documents that had been drafted for this region and the relevant literature.

The airport can be said to affect the development of areas around airports, just as they affect their surroundings. In many cases, their forms can be considered hallmarks of their respective cities and affect their visual reception. Therefore, areas around airports require individualised approaches and a rational form of development. The study of these areas can be seen as relevant and essential, due to:

- The dynamic development of suburban zones in recent years, including that of the area within the airport's area of influence,
- Concentrations of a diverse range of economic activity in these areas,
- Functional and compositional relations forming in emergent development structures,
- The current transformation trajectory of areas around airports.

The area under analysis within the vicinity of Kraków Airport is a local case of structure shaping, yet the tendencies discussed are global and are parts of processes that take place elsewhere around the world. They include, among other things, landscape and environmental changes that happen as a result of the urbanisation of new areas [4], [5]. They are diverse in terms of scale and transformation dynamics, but are perceived as interesting areas that can act as starting points for structures with an urban character that are built in connection to a transport node [6] (pp.395-414), [7].

European municipal decision-makers have long since acknowledged the potential of such zones and make attempts to comprehensively plan them, especially in how they form relations with cities proper [8] (pp.100-111). An interesting solution was used in Luxembourg, Copenhagen and Amsterdam, by creating new attractive development structures that were functionally and compositionally linked with these cities.

Referencing selected models of planning these areas featured in the literature, such as the Airport City, Aerotropolis or airport corridor as defined by J.D. Kasarda [9], [10] (pp.1-22), can allow us to investigate an optimal form of planning areas around airports, adapted to the case of Kraków Airport, and a form that is more adapted to local determinants instead of building a new, separate form of city around an airport, specifically in the context of a city of high historical value.

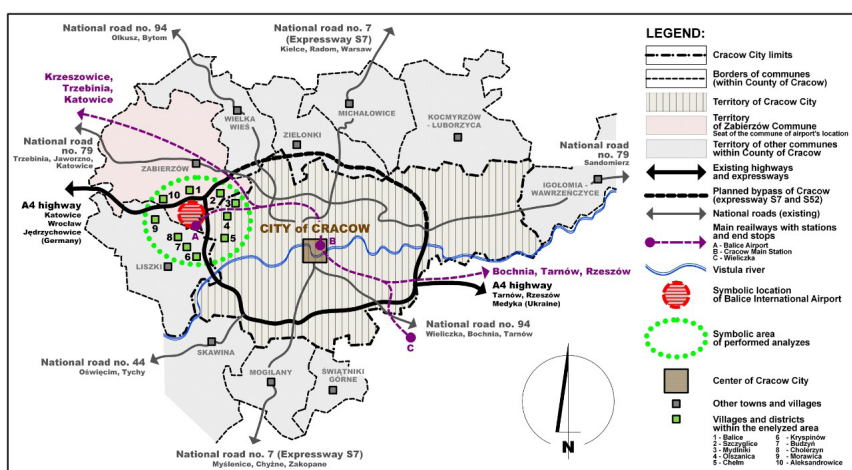


Fig. 1. Diagram showing the location of the airport and the area under analysis within Krakow and its neighbouring municipalities, original work, 2021

1.1. Selected models of planning areas around airports

Planning areas around airports is a process which involves accounting for an airport's impact as a transport node that combines the function of passenger and goods transport. Increasing passenger traffic flows require comprehensive operations, as well as providing a service zone with the maximum possible amount of comfort, thus enhancing the quality of this operation. Hence, in the case of many airports, the terminals themselves and their immediate vicinity become the sites of a wide array of ancillary services and act as elaborate transfer nodes integrally linked with public transport access [11]. At present, airports are transport nodes, but also distinctive structure-genic elements, in most cases located in suburban areas [12,13]. J.D. Kasarda presented an interesting model of development of both airports and their adjacent areas [14]. The globalisation of airline connection and goods exchange is becoming the reason behind adopting a much broader perspective on the shape of space that surrounds airports, especially in the twenty-first century. The Airport City and the Aerotropolis are distinctive spatial forms of urban structures, defined and proposed by J.D. Kasarda. They are associated with airports, but affect the development of the space of the contemporary city. They combine the dense development of the centre in the immediate proximity of terminals (Airport City) with gradually impacting the space and its functional structure along transport corridors that extend from it. They form the entirety of new type of urban fabric called the Aerotropolis, which consists of mixed-use developments associated with aviation, as well as ancillary functions that utilise well-presented and attractive distant surroundings with good transport connections (Fig.2). The author of these models noted that, in the twenty-first century, airports could become elements with a major impact on urban development, similarly to the role that had been played by the railway in the nineteenth century and highways in the twentieth century.

The development of areas around airports forms integral and independent structures in space, which are linked with the core city, and sometimes blend into its tissue. The model of planning areas around airports described by J.D. Kasarda develops individually in areas that accompany airports, adapting to local conditions and development potential. We were able to observe a dynamic development of such areas in Asian cities in recent years.

One interesting case is the zone around Changi Airport in Singapore, which develops around an airport that was used by 55.4 million passengers in 2015, and 65.6 million in 2018, which is an increase by 18.41% [15]. It is an example of model based on the development of its adjacent area long a transport corridor that connects the airport with the city, in this case placed parallel to the airport's runways and that ends at passenger terminals which house elaborate service functions, providing passengers with a wide spectrum of attractions and ways of spending free time. These include a cinema, a swimming pool, shopping galleries, playgrounds and gardens with tropical greenery for rest and recreation. Due to the scale of the project, the terminals are connected by rail and two indoor moving walkways that provide freedom of movement between them. This model, which J.D. Kasarda described as an airport corridor, is also referenced by many areas around European cities. They include the airports of Amsterdam, Luxembourg, Frankfurt or Copenhagen, which form new, intensely developed office, service and housing districts, connected both with the city and the airport via transport linkages [7]. Of course, when it comes to detailed solutions, these projects vary, but they are linked by a shared idea of intense use of the area around the airport, specifically around the primary arterial that connects the airport and the city, and is often supplemented by a high-speed railway line. When analysing the spatial models of areas around airports, we should emphasise

the local determinants of every case, especially those that stem from the competitiveness of a given airport within the system of airports of a given region [16]. It arises from, among other things, an airport's strategic location, the size of the city and its economic significance. These qualities affect air traffic volume, including the transport of goods.

This is why the selected models presented (Airport City, Aerotropolis, Airport corridor), although repetitive by assumption, take on varying sizes, scales and forms when implemented. However, they appear to be an interesting and proper reference for the analysis of the area around Kraków Airport, which recently became an area subjected to transformation and the siting of new functions.

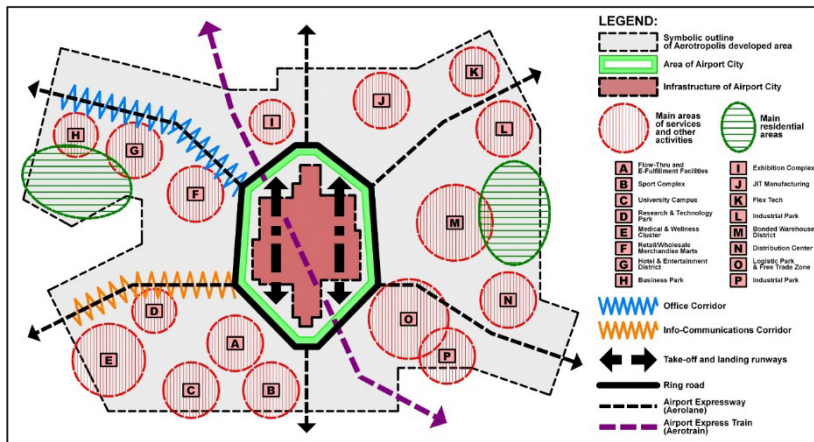


Fig. 2. Diagram of models of models of developing the area around an airport. *Source: own study based on [9][10][14], 2021*

2. Research scope and methods

This study of the area around Kraków Airport in Kraków, Poland, is based on an analysis of selected elements of its existing functio-spatial structure. The investigation covered past suburban villages, new single-family, office, storage and manufacturing and services buildings, as well as forested, agricultural and recreational areas and natural greenery (Fig.3).

Other elements that were analysed included compositional determinants and transport accessibility in this area, which accounted for elevated points, visual axes in the area as identified in the compositional section, forest complexes surrounding the area and providing a vista background. In the section concerning transport accessibility, primary transport arterials, railway lines and stops, and car parks (Fig.4).

The study analysed selected planning materials drafted for this area in terms of land use regulations and planned transport solutions, as well as the relevant literature.

Based on the analyses, an estimate listing of area assigned for selected functional areas as encountered at the time of writing, and in its planned state (resulting from an analysis of selected planning documents) (Tables 2, 3).

The area under study covered Kraków Airport, the area in its immediate vicinity as outlined in the IA General Development Plan (Plan Generalny Rozwoju MPL), and a buffer zone within around 3 km of the airport, which included a part of the territory of Kraków within

urban unit 39 from the Spatial Development Conditions and Directions Study [17] of the city and the former villages of Olszanica, Chelm and Mydlniki, parts of the Zabierzów and Liszki municipalities covered by the Study [18,19], along with the former areas of Aleksandrowice, Balice, Szczyglice, Morawica, Cholerzyn, Budzyń and Krzyspinów villages.

An analysis of the functio-spatial structure in the immediate vicinity of the airport was performed, which also covered the terminal locations, single-family development and services (including car parks, manufacturing and storage) (Fig. 5) and an analysis of how the area evolved between 2003 and 2020 (Fig. 6).

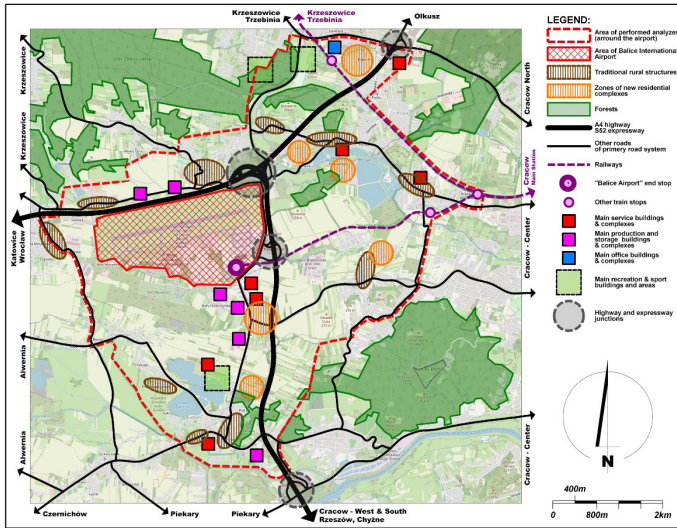


Fig. 3. Analysis of selected elements of the existing functio-spatial structure of the area around Kraków Airport. *Source: own study, 2021*

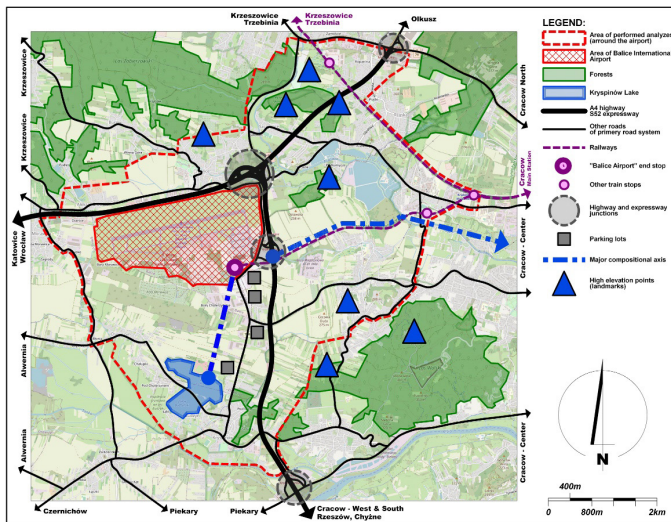


Fig. 4. Analysis of compositional determinants and transport accessibility within the area around Kraków Airport. *Source: own study, 2021*

3. Results

3.1. Overview of local determinants affecting the settlement network

The area under study is located within the administrative limits of three municipalities: Kraków, Liszki and Zabierzów. The airport proper is located in the municipality of Zabierzów. This area is a part of Kraków's suburban area and its settlement layout consists of former villages which have changed in character over the past twenty years and gradually changed their funcio-spatial structures. They transitioned from agriculture, previously featuring typically agrarian development, into a more suburban format, with a predominance of single-family housing, services and fragmentary industrial and storage buildings. The former villages were found to have retained their urban layouts, based primarily on development organised along a main transport route. New development that supplements the structure or forms new enclaves was observed to be accessible via their respective and steadily extended transport layouts. This largely the result of continuing existing transport routes rather than forming new, integrating linkages within the area (Fig.3).

In the section that belongs to Kraków, the former villages that were studied were Olszanica, Mydlniki and Chełm, in Zabierzów they were Szczyglice, Aleksandrowice and Balice, and in the municipality of Liszki they were Kryspinów, Morawica, Cholerzyn and Budzyń. All of them are located within 3 km of the airport. Their predominant function is housing, but sizeable portions of their territory are occupied by greenery and agricultural use, which is a result of the past character of the area. Developed areas comprise 31.2% of the area under analysis (Table 2).

Table 2. Listing of selected existing elements of function-spatial structure elements within the area around Kraków Airport under analysis. *Source: own study, 2021*

Land use	Area under analysis
Airport	12.4%
Housing	15.4%
Services	1.6%
Offices	0.5%
Industry and storage	1.3%
Forests	4.2%
Natural greenery and water bodies	13.5%
Others (including agriculture)	51.1%

3.2. Development structure – architectural and urban form

At the time of performing the analysis, the development structure of the area around the airport was highly diverse. The area immediately adjoining the airport featured a complex of buildings that were handling international and domestic passenger and cargo traffic. They included the main terminal, a multi-level car park and a section that handled cargo transport [20]. This urban form references the Airport City model, yet the continuation and linkages with further areas do not form a legible composition within space.

To the south, in the direction of Kryspinów, there was a developing services, industry and storage complex. Plant-type buildings with 1 to 2 storeys and located on separate plots predominated, which was found to hinder the emergence of an integrated urban complex

(Fig.5). Airport car parks also occupy a significant portion of this area. The spatial transformation of this area in the years 2003 and 2020 indicate the presence of development pressure and a mixing of single-family buildings with service and manufacturing buildings (Fig. 6).

The remaining buildings, mostly housing office or service spaces, in addition to manufacturing, formed small complexes within Zabierzów, Kryspinów, Balice and Mydlniki, which can be seen as a sign of interest in the area among developers, yet it can also be argued that it is not solely a result of proximity to the airport, but also of access to the A4 highway and providing services to Kraków's growing suburban zone.

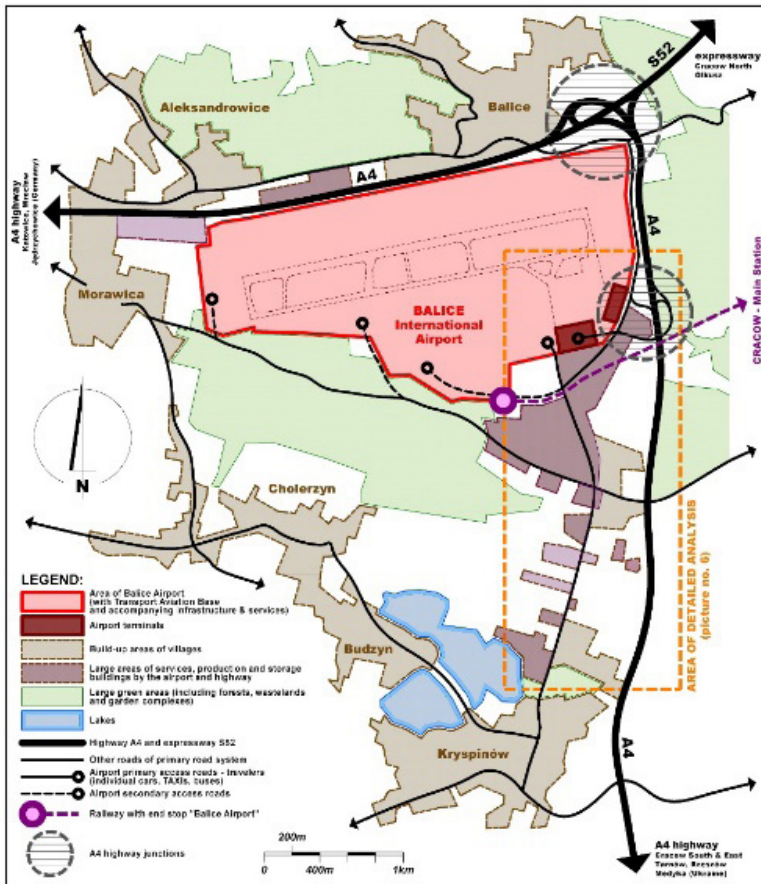


Fig. 5. Analysis of selected elements of the funcio-spatial structure in the immediate vicinity of Krakow Airport. *Source: own study, 2021*



Fig. 6. Analysis of the transformation of selected elements of the functio-spatial structure in the immediate proximity of Krakow Airport in the years 2003 and 2020. *Source: own study, 2021*

3.3. Transport linkages

The area under analysis was observed to have access to the A4 highway, which acts as Kraków's beltway. The A4 connects to the local road network via the Balice and Modlniczka intersections. The local transport layouts provides linkages with Kraków via four arterials from the east, and with the existing settlement layout. The area is connected to Katowice, a nearby major agglomeration, via road through Zabierzów and the A4 highway, and with Oświęcim via a road through Liszki. Internal transport layouts which handle traffic inside the settlement layout and the former villages themselves were found to be illegible, and the immediate surroundings of the airport along the road towards Krysinów was observed to have become a site with multiple large car parks. They are a predominant and unattractive form of land use, but that was nevertheless preferred in this area (Fig.4). A railway line with a stop near the passenger terminal provided a connection with the city. The role of this line was confined to handling traffic from the airport and partly the former village of Mydlniki. This railway line connected with a metropolitan railway system and its stops.

3.4. Compositional and functional determinants with the immediate area

The findings of compositional analyses point to two attractive directions formed by new areas in the development of the zone along which the building structure can grow (Fig. 4). In Figure 4, these are compositional axes.

The eastern direction that connects the airport with Kraków appears to be strategically significant. Supplemented by a railway line, a network of stops and, as included in the plans analysed, a new arterial and development that can become an attractive transport route linked with the city centre.

The southern direction that connects the airport with recreational areas near a lake in Kryspinów defines a space that integrates development in the vicinity of the airport with the existing functio-spatial structure and green areas in a more local manner. At present, this area features point-like instances of service and manufacturing buildings, which considerably limits the identification of this compositional axis in space. The planning documents analysed appeared not to make use of it.

The area north and east of the airport had development of varying height. Major elevation points in this area and its immediate vicinity were measured to range between 255 m above sea level to 384 m above sea level. Together with forest complexes, they form a visual background in the area.

It appears that pursuing compositional relations can contribute to creating attractive fragments in areas around airports, in which newly emergent urban structures, located in the open landscape, could utilise distinctive visual axis directions so as to integrate the space around the airport.

4. Applicable planning documents

Kraków Airport is subjected to the provisions of planning documents drafted for its territory. One of these is Kraków Airport General Plan [21] for the years 2016–2036, approved on 26.11.2018 by the Minister of Infrastructure, which is required as stipulated in the Aviation Law Act. It was subjected to consultation with municipalities covered by the plan and which are affected by the airport's operations and air traffic itself. Among other things, it defines the scope of the airport's impact, as well as planned buildings and elements of airport development associated with its operation and the immediate vicinity. The Plan defines areas for infrastructure associated with handling passenger and cargo traffic, and areas assigned for projects in the pre-existing military section located from the south-west. In the zone of direct passenger processing, located from the south, there is the terminal, a hotel, a train stop and a multi-level car park, surface parking lots, as well as a section with administrative spaces, and cargo handling and technical facilities.

The placement of these buildings from the south-eastern side of the runway, near its start, affected the spatial solutions and urban layout of the complex that provides circulation, but does not create a compositionally legible link with the zone of new development projects located in the south. The existing transport and circulation layout is the result of old linkages with Zabierzów and Liszki, and despite several modernisation projects in the immediate vicinity of the terminals, it does not provide safe relations with the railway. Due to the siting of the airport in a location that belongs to three municipalities, planning documents that concern this zone are not often up-to-date to the same degree. The eastern part that belongs to Kraków was,

at the time of writing of this paper, in the design phase and was to be ultimately divided into five local spatial development plans: Balice I, Balice II, Podkamyk, Olszanica and Zakamycze.

Fragments of these plans shall affect the planning of the area around the airport in its eastern section. At this stage, it was possible to reference the current Spatial Development Conditions and Directions Study [17] of the city of Kraków. Within the ‘Olszanica’ structural unit, this document assumed a new transport link with the airport in the form of an extension of Armii Krajowej Street. This arterial can become the main road to connect the city centre with the airport, introducing a legible direction and possibility of creating an attractive functio-spatial structure. Around the airport itself, the Study assumed the placement of service buildings, including exposition, office and commercial spaces, which can be seen as a form of recognising the potential of the airport’s vicinity in terms of new functions that enhance its competitiveness on the scale of the city and the wider region. The plan also assumed the relocation of the highway intersection in the area of the airport, and as such a modernisation of the transport layout, the airport’s accessibility and its infrastructure. The provisions of Kraków’s Study in this area preserved the settlement layout within the former villages of Mydlniki and Olszanica, to be dominated by existing and future single-family housing. The area of the airport and its vicinity in the area under study is also subjected to the Study of the municipalities of Zabierzów and Liszki [18,19]. In the Zabierzów municipality, the territory of the airport and the highway from the north was assigned for concentrating services. The villages of Aleksandrowice, Balice and Szczyglice are primarily areas occupied by single-family housing. The municipality of Liszki covers territory from the south-western part of the airport and that of the old villages of Morawica, Cholerzyn, Budzyń and Kryspinów, which were assigned for the development of single-family housing, and in close proximity to the airport—for commercial areas. The Study of the municipality of Liszki also assumed the development of recreational areas around the water reservoirs of Kryspinów and an extension of the transport layout for this area.

An analysis of land use provisions in the studies of Kraków, Liszki and Zabierzów for the area under analysis demonstrates an increase of areas assigned for development. In the territory of the Kraków municipality, this is 46.4%, in Liszki it is 39.2%, and in Zabierzów it is 27.4% (Table 3). This specifically applies areas for single-family development, which is to focus around the existing settlement network, primarily tied with historical suburban villages, but at present it is tied with growing suburban development. The documents were found to feature concentrations of commercial uses in close proximity to the airport, from the east and south, yet apart from a new link with Kraków, they were not found to introduce new, integrating solutions.

Table 3. Listing of specific land uses as featured in the Spatial Development Conditions and Directions Studies of the municipalities of Kraków, Liszki and Zabierzów for the area under study. Kraków Airport, source: SUiKZP. Source: *own study, 2021*

Land use stipulated in the SUiKZP	Municipality		
	Kraków	Liszki	Zabierzów
Housing	19.8%	25.4%	16.1%
Services	23.2%	5.5%	9.8%
Industrial plants and storage	3.4%	8.3%	1.5%
Greenery	36.2%	21.9%	18.6%
Other	17.4%	38.9%	54.0% (including the airport)

6. Discussion

General development plans of areas around airports are essential elements of planning them [22]. Such documents were highlighted by, among others, J.D. Kasarda and I.M.H. Canon [23] (pp.29-31), who noted its complexity. Economically, it is intended to attract domestic and foreign capital into the area, providing opportunities for profit. The proximity of an airport is rated as a development opportunity as it provides access to global markets via aerial transport and high traffic concentrations. Controlling the attraction of new investors and developers via attractive architectural and urban form, and the zoning of individual functions, can contribute to the development of such areas and establishing a space for economic activity that can compete with other areas of a city. As noted by these authors, it is a long-term process that requires numerous experts and coordination of efforts by decision-makers. In the process of carrying out such a project, especially in the initial phase, in close proximity to an airport, and over time, in its extended zone of influence.

Airport-focused urban development is an essential trajectory that economically activates contemporary cities. However, it should also be synchronised with spatial planning of significance to the city and its region [24] (pp. 800-811). Scholars from these fields note the conflicts between spatial planning in these areas, which are under the purview of local governments, and the development pressure of large corporations who focus more on matters of project profitability rather than the form of developing the functional-spatial structure [25] (pp.914-921).

Does the Spatial Development Conditions and Directions Study for Kraków reference these models by Kasarda? It appears to do so partially, in the area linked with the airport itself, on a local scale and form, subjected to handling aerial traffic. In more distant areas, it showed characteristics of concentrating activities, but this concerned singular buildings and urban complexes that did not form a cohesive urban space that could define new development trajectories.

This general aspect was noted by L. Krier [26], who stressed that many urban planning solutions do not automatically create an atmosphere of the city. It appears that, in the case under analysis, one of the causes behind this could be the administrative division of the territory around the airport and as such its character as a point of contact between three municipalities with differing potential and character. The area around the airport is crucial to each of them, but it is not their sole developmental area.

The planning documents presented were not found to define innovative development trajectories for this zone, apart from the siting of service uses in the immediate vicinity of the airport, in the area around the terminals from the east and south. In addition, transport linkages were likewise within the standards of accessibility and did not create well-defined directions, axes or public spaces.

The general plan of the airport's development, in terms of scope, was found to be confined to the airport's immediate vicinity, and did not affect the development of the more distant part of the zone. The various commercial and office complexes formed singular enclaves and the areas assigned for housing projects, mostly single-family units, were slowly filling the space around the airport, creating an impression of randomness and being scattered.

The model of building a city around an airport (airport city, aerotropolis), in the case of the Kraków Airport, was found to appear to be limited, and any attempts at realising it through planning document provisions of each municipality, concern its immediate vicinity, and any pursuits of turning it into an aerotropolis appear to be largely aimless. The reason for

this is the transformation of the suburban zone in this area rather than the dominant impact of the airport itself. Accommodations, parking spaces and catering services offered around the airport stem largely from providing services to passengers, and their placement does not form a coherent space, merely answering the basic needs of the place.

It appears that the form and manner of public space design in these areas is crucial, as in the case of areas around airports, such spaces integrate them both overall and in their individual fragments.

The role and significance of these types of elements in the city and the specificity of their design and reception was discussed by M. Carmona [27] (pp.374–405) [28],[29] (pp.241–259). Providing sustainable environmental development, including transport-related development, is another essential aspect, which appears to come with additional challenges in areas around airports [30] (pp.61-73), [31]. Changes in land use around airports and in suburban zones. the role of spatial planning in these urban and rural areas, specifically with the intent to preserve the value and quality of the environment, were noted by K. Swangiang [32] and Z. Pucherowa et.al. [33]. This can be seen as a sign that scholars recognise spatial transformations and their impact on the environment, which significantly affects the shaping of areas around airports.

7. Conclusions

My analyses of the area around Kraków Airport in Poland point to its current transformation trajectory as being within the confines of building singular infrastructural buildings associated directly with the airport, and building service and manufacturing buildings in the areas around the airport. This scheme of action treats the space around the airport as being attractive to new projects, yet without clear characteristics of creating a coherent airport city space. It is instead a form intended to handle passenger and cargo air traffic, and is not seen producing a new and attractive form of development that could truly begin the creation of the area. The transformation of the area around the airport is considerably affected by growing development pressure in Kraków's suburban area. This is also indicated by the development of housing areas based on old suburban villages located around the airport, Zabierzów, Aleksandrowice, Balice, Kryspinów, Morawica, Cholerzyn and Budzyń, as well as areas of Kraków's former suburban hamlets: Mydlniki and Olszanica, which are currently within the city's administrative limits.

It appears that the further intensification of settlement in these regions, especially in the form of housing, could constrain the airport's development and degrade it to the role of an element of functio-spatial structure and not an attractive place that could become a starting point for a new space that could integrate various forms of development, specifically in the vicinity of the function that is to provide access to global markets and linkages. In the area under analysis, the airport occupied a sizeable territory with restricted access, including runways and their accompanying infrastructure, which is why it is also a functional barrier, as is the highway from the north and east.

However, this does not predefine the potential for shaping the area around the airport, especially along the southern and eastern direction. It appears that the most compositionally and functionally attractive direction is the one towards the city. My analysis of existing development showed that the greatest potential and opportunity for creating a new structure lied with a planned transport corridor that would link the airport with the city. This requires a skilful balancing of development scale and form in the area, ensuring interesting compositional relations and making use of environmental assets (the Rudawa River Valley, the former bed

of the historical Młynówka Królewska Creek near Mydlniki, which dates back to the fourteenth century). It also appears essential to connect with existing housing areas in Olszanica, Mydlniki and Wola Justowska.

This study can be used to formulate the following general conclusions concerning areas located around airports:

- New development structures should specifically adapt to the character of suburban areas, with a preference for solutions aimed at the sustainable development of these areas and the preservation of green areas, including agricultural ones, as well as cultural continuity.
- We should pursue extending the scope of general airport development plans to include plans of the development of the areas around them, defining major development trajectories, the preferred development structure, and create a space that integrates the area and that is linked with the nearby suburban fabric.
- Delineating major development trajectories should be done by utilising local determinants, e.g. in terms of composition. Greenery in the form of landscaped areas that supplement the development structure, provide insulation from nuisance-causing uses and act as a foreground for areas of intense development, should be an essential element of the area.
- Service concentrations should form spatially cohesive zones which provide links with the city, and come equipped with housing, properly insulated from nuisance-causing uses.
- The main road link with the city should be an element that increases the airport's accessibility and a compositionally and functionally attractive transport and circulation route that defines the entrance zone to the city. Continuing development along such an arterial could become a starting point for a mixed-use airport-city transport corridor.
- Creating a new functional-spatial structure around airports and the zones in their immediate proximity should provide a safe and attractive public space that affects the integration network of the new urban fabric.
- Spatial planning and urban design that accounts for local determinants is the only proper tool for the sustainable planning of areas around airports and providing the structures that emerge in such areas with spatial cohesion.

Detailed conclusions concerning the principles of shaping the area around Kraków Airport:

- The link with the city along the eastward compositional axis and the potential for southward development should be taken advantage of.
- Forming development structure should be based on a new transport layout
- The intensification of development along compositional axis should feature public space that create attractive and integrating linkages with the airport.
- Urban sprawl should be prevented, and leisure areas adjoining the Kryspinów reservoir should be protected.

References

- [1] Huderek-Glupska S., „Co oznacza sukces portu lotniczego i kiedy ma wpływ na gospodarkę miasta i regionu?”, *Przegląd Komunikacyjny*, 2017, vol. 11, pp. 4-9. https://doi.org/10.35117/A_ENG_17_11_01

-
- [2] Di Mascio P., Perta G. Cantisani G., Loprencipe G., “The Public Safety Zones around Small and Medium Airports”, *Aerospace*, 2018, 5, 46. <https://doi.org/10.3390/aerospace5020046>
- [3] Bajwoluk T., *Przestrzeń podmiejska. Wybrane zagadnienia struktury funkcjonalno-przestrzennej*. Kraków: Wydawnictwo Politechnik Krakowskiej, 2020.
- [4] Thornbush M. J., Allen C.D., *Urban Geomorphology. Landforms and Processes in Cities*. Elsevier, 2018.
- [5] Tzu-Ping Lin, *Urban Microclimate*. Elsevier, 2021.
- [6] Wang Y., Chou Ch., Yeo G., “Criteria for Evaluating Aerotropolis Service Quality”, *The Asian Journal of Shipping and Logistics*, 2013, 29, 3, pp.395-414.
- [7] Conventz S., Thierstein A., “The knowledge economy, hub airports and accessibility. A location based perspective”, in *The Case of Amsterdam-Schiphol, European Regional Science Association (ERSA) Conference*, Barcelona, Spain, 2011.
- [8] Zak D., Getzner M., “Economic Effects of Airports in Central Europe: A Critical Review of Empirical Studies and Their Methodological Assumptions, Horizon Research Publishing”, *Advances in Economics and Business*, vol. 2(2), 2014, pp.100-111, <https://doi.org/10.13189/aeb.2014.020206>
- [9] Kasarda J. D., “The Evolution of Airport Cities and the Aerotropolis”, in *Airport Cities: The Evolution*, ch.1, London: Insight Media, 2008.
- [10] Kasarda J. D., “Aerotropolis: Business Mobility and Urban Competitiveness in the 21st Century”, in *Culture and Mobility*, ch. 1, Heidelberg: Heidelberg University Press, 2013, pp.1-22.
- [11] Stangel M., *Airport City. Strefa okololetniskowa jako zagadnienie urbanistyczne*. Gliwice: Helion, 2014.
- [12] Schlaack J., “Defining the Airea: Evaluating Urban Output and Forms of Interaction Between Airport and Region”, in *Airports in Cities and Regions: Research and Practise*, eds. Knippenberger U. and Wall A., 113–26. Karlsruhe: KIT Scientific Publishing.
- [13] Schlaack J., *Flughafen und Airea, Impulsgeber fur Stadtregionen*. Berlin: DOM Publishers, 2015.
- [14] Kasarda J.D., “Aerotropolis”, in *The Wiley-Blackwell Encyclopedia of Urban and Regional Studies*; Orum A.M. Ed.; Hoboken: John Wiley&Sons, 2019.
- [15] Changai Airport, <https://www.changaiairport.com> [Accessed: 12 Jan 2021]
- [16] Source: https://static.fraport.de/ONLINE/zdf/zadafa_e_2015/mobile/index.html#p=14 [Accessed:12 May 2021]
- [17] SUIKZP miasta Krakowa uchwała nr CXII/1700/14 Rady Miasta Krakowa z dnia 9 lipca 2014, <https://www.bip.krakow.pl> [Accessed: 25 Jan 2021]
- [18] SUIKZP gminy Zabierzów Uchwała Rady Gminy Zabierzów z 16.07.2010 nr L/488/10 <https://www.sip.gison.pl/zabierzow> [Accessed: 25 Jan 2021]
- [19] SUIKZP gminy Liszki Uchwała Rady Gminy Liszki z 23.03.2011 nr VI/36/2011 <https://www.liszki.pl> [Accessed: 12 Feb 2021]
- [20] Wróbel P., “Kraków Airport – studium przypadku. Przekształcenia architektoniczno-urbanistyczne”, *Builder* 01(270), 2020. <https://doi.org/10.5604/01.3001.0013.6476>
- [21] Plan Generalny Lotniska Kraków–Balice (2018) <https://www.krakowairport.pl> [Accessed: 18 Jan 2021]
- [22] Bradley A.L.W., *The Independent Airport Planning Manual*, Woodhead Publishing, UK, 2010.
- [23] Kasarda J.D., Canon I.M.H., “Creating an Effective Aerotropolis Master Plan”, *Regional Economic Review*, 2016, vol. 5, pp.29-31.
- [24] Boloukian R., Siegmann J., “Urban Logistics; a Key for the Airport-Centric Development – a Review on Development Approaches and the Role of Urban Logistics in Comprehensive Airport-Centric Planning”, *Transportation Research Procedia*, 2016, vol.12, pp. 800-811. <https://doi.org/10.1016/j.trpro.2016.02.033>

-
- [25] Ventura P., Zazzi M., Rossetti S., Carra M., “Urban Development and Airports in Northern and Central Italy: Main Trends and Focus on Parma Giuseppe Verdi Case Study”, *Transportation Research Procedia*, 2020, vol.45, pp.914-921. <http://doi.org/10.1016/j.trpro.2020.02.076>
- [26] Krier L., *Architektura wspólnoty*. Gdańsk: Słowo/Obraz Terytoria, 2011.
- [27] Carmona M., “Re-theorising Contemporary Public Space: A New Narrative and a New Normative”, *Journal of Urbanism*, vol. 8(4), 2015, pp.374–405. <https://doi.org/10.1080/17549175.2014.909518>
- [28] Carmona M., “Principles for public space design, planning to do better”, *Urban Des Int*, 2019, 24, 47-59. <https://doi.org/10.1057/s41289-018-0070-3>
- [29] Carmona, M., Hanssen, G.S., Lamm, B. *et al.*, “Public space in an age of austerity”, *Urban Des Int*, 2019, 24, pp. 241–259 . <https://doi.org/10.1057/s41289-019-00082-w> Russo F., Comi A., “City characteristics and urban goods movements: A way to environmental transportation system in a sustainable city”, *Procedia Social and Behavioral Sciences*, 2012, vol. 39, pp.61-73.
- [30] Verma P., Singh P., Singh R., Raghubanshi A., *Urban Ecology. Emerging Patterns and Social-Ecological Systems*. Elsevier, 2020.
- [31] Swangjang K., Iamaram V., “Change of Land Use Patterns in the Areas Close to the Airport Development Area and Some Implicating Factors”, *Sustainability*, 2011, 3, 1517-1530. <https://doi.org/10.3390/su3091517>
- [32] Pucherová Z., Mišovičová R., Bugár G., Grežo H., “Changes in Landscape Structure in the Municipalities of the Nitra District (Slovak Republic) Due to Expanding Suburbanization”, *Sustainability*, 2021, 13, 1205. <https://doi.org/10.3390/su13031205>