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Spatial Trends of Adaptive Reuse Projects: Challenges and Opportunities for Developing Cities

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1 ABSTRACT

Contemporarily; there has been increasing complexity and interplay among issues associated with developing spatial forms and structures of urban areas to foster inclusivity and sustainability. Likewise, the emergence of the smart cities discourses has led to planning that is informed and supported by information and communications technology (ICT). Globally adaptive reuse project have been driven by a need to address the sprawl of vacant buildings in the city. These buildings have been neglected over time due to economic structural changes, technological changes and migration of people. This paper explores the spatial trends of adaptive reuse projects in the City of Johannesburg. The study employs a case study approach to assess the adoption and implementtion of adaptive reuse projects in Johannesburg, South Africa from 2002 to 2020. Using geolocation data from municipal records, the spatial location of adaptive reuse projects were visualised and assessed using an ArcGIS prediction analysis. A questionnaire was used to assess the sustainability parameters associated with these adaptive reuse projects. The results reveal accessibility, functional adaptability, and market demand as the key factors influencing the conversion of properties in the past 20 years. The spatial trends revealed locations with a high concentration (hot spots) of adaptive reuse projects being suburbs in the northern portions of Johannesburg, such as Bryanston and Randburg that have had a considerable influx of corporations expanding their operations. Moreover technologies to assess the locations of adaptive reuse projects have the potential to inform the policy and legislative instruments and frameworks on spatial planning to guide better developmental practises in the city.

Key words: adaptive reuse projects; sustainable; Johannesburg; information and communications technology; geolocation

2 INTRODUCTION

Contemporary developing cities are suffering from an acute lack of affordable housing and urban sprawl (Bakker et al., 2015; Hall and Posel, 2019). In South Africa, since the dawn of independence major cities have experienced rapid migration, with people seeking a better quality of life in cities where employment growth is high and social amenities more readily available (Harrison and Todes, 2015). Many people have settled on the outskirts of these cities leading to peripheral growth and less densification, and ultimately unrestricted urban sprawl (Harrison, and Todes, 2015). The migration coupled with high poverty levels and the legacy of apartheid spatial planning causes more people to look for more affordable housing and rely on the government to intervene (Bakker et al., 2015).

The end of apartheid brought accelerated economic growth, urbanisation and racial desegregation, which led South Africa's spatial planning into a self-correcting process to redress the spatial segregation and injustices of the past apartheid system (Bakker et al., 2015). This phenomenon is evident from the growth analysis of metropolitan cities such as Johannesburg, Tshwane and Ekurhuleni. These metropolitan cities, which are situated approximately 50 kilometres apart, are growing towards each other (Bakker et al., 2015), with Johannesburg in the south growing to the north and Pretoria in the north, expanding southwards and Ekurhuleni to the east of Johannesburg and south of Pretoria growing to the west towards Johannesburg and north towards Pretoria. These cities' spatial development growth has caused many companies to relocate to new economic nodes (SAPOA, 2017). The relocation was further made possible by public infrastructure investments such as the Gautrain, which unlocked property development opportunities along the transport corridors (Lombard et al., 2017).

The growth in the number of companies relocating from what was previously the Central Business District to newly established economic nodes has led to an increase in the number of abandoned, dilapidated and vacant buildings (Vejby, 2015; Drewes et al., 2018) and, consequently in inner-city degradation (Drewes et al., 2018). In more recent times, the slowdown in the economy, coupled with reductions in space per worker requirements, has created new vacancies in the newer office nodes (Vejby, 2015). This has created a challenge for policymakers and developers to consider the adaptive reuse of office buildings to solve the housing backlog in South Africa's major cities and reduce vacancies in the office market.

3 RELATED WORK

Adaptive reuse refers to a process of assigning new use to a building without changing the original structure and material of the building by further extracting raw materials after demolition and deconstruction (Tan et al., 2018). While Vardopoulos (2019) defines it as a conversion process aimed at retaining as much of the original construction of a building while enhancing the functional performance or meet new function of any building. Adaptive reuse can take two forms, either 'within use' or 'across use' (Olivades et al., 2017; Aigwi at el., 2018). 'Within use' refers to adaptive reuse a building without changing the original function, or 'across use' refers to when the adaptive reuse of building assumes a new position from the original, such office to residential conversion (Olivades et al., 2017). Hybrid adaptive reuse refers to the type of adaptive reuse project where new components are added to the existing building to enhance the functional performance of a building to meet new spatial requirements (Adeyeye et al., 2010). Adeyeye et al., (2010) states that this approach combines existing buildings with new buildings to enhance the performance of the old. This study, however, focuses on 'across use' type adaptive reuse.

Adaptive reuse is driven by factors such as climate change, increase in migration and mass tourism (Luciani & Del Curto, 2018), technical innovation, investment momentum, financial distress, decreased Organisational footprint, networking concepts and sustainability requirements (Rovers et al., 2017). Other drivers of adaptive reuse include sustainability objectives, vacant and dilapidated buildings and housing needs (Remøy & Voordt, 2014). Local authority enacting policies that encourage conservation and regeneration in designated conservation areas and buffer zones (Remøy & Wilkinson, 2012). Land use planning is one of the main measures contributing to urban resilience and efficiency and a well-integrated and functioning urban system (Drewes et al., 2018).

Technological innovation is considered as the primary driver of corporate real estate decisions that allow companies to improve their operational efficiency. Thereby meeting new customer requirements, retain market share and seize competitive advantage through enhanced efficiency, staff reductions and reduced operating expenses to achieve the development of efficient running real estate portfolios (Rovers et al., 2017). The downsizing and operational efficiency results are the increase in industrial property vacancy due to less demand for building stock and drive the need for adaptive reuse of the commercial buildings evident in the current global trend showing a reduction in companies' real estate holding (Rovers et al., 2017). Rovers et al., (2017) states further that disposal is driven investment momentum, financial distress, decreased Organisational footprint, networking concepts and sustainable requirements. Corporate real estate disposal framework aims at ensuring financial optimisation by ensuring that all variables are weighted and selected independently. A team with diverse skills sets is assigned to the project, to aligne to real estate market cycle and buyers preferences. Lastly consideration of the future use after disposal is key as it guarantees the management of risk of business disruption and reputational repercussions.

The main aim of adaptive reuse is to preserve the historical and architectural integrity of the buildings, restore the obsolete and dilapidated urban areas, reduce the adverse impact on the environment while increasing efficient usage of material and energy resources (Petković-Grozdanovića et al, 2016). The other benefits of adaptive reuse are value creation for the area and the affected asset by converting them into tourism attractions that can contribute towards urban regeneration and sustainable development and generating economic, social and cultural benefits to the community (Vardopoulos, 2019). Adaptive reuse is cheap and faster and economically, socio-culturally, environmentally and sustainably beneficial to the communities (Aigwi, Egbelakin & Ingham, 2018). Adaptive reuse is an effective approach to regenerating inner city properties and embracing sustainability, and preserving heritage buildings (Aigwi, Egbelakin & Ingham, 2018). Conversion costs of adaptive reuse are lower than demolition and new-build and reduce high level of vacancy and dilapidation (Remøy & van der Voordt, 2014). The conversion of vacant offices was

considered sustainable compared to demolition and new-build (Remøy & van der Voordt, 2014). Adaptive reuse is saves building materials and transportation and producing less waste than demolition and new construction (Remøy & van der Voordt, 2014). Property prices experience a positive increase after the completion of adaptive reuse or revitalisation project (Kee, 2019). In addition to the factors driving adaptive reuse benefits include an increase in the life of the building, less consumption of materials, reduce negative impact of old and dilapidated buildings and financial incentives (Dyson et al., 2015).

Critical Success Factors are described as a set of conditions, events and circumstances contributing to project success (Ika et al., 2012). Furthermore, Ika et al., (2012) consider a project as successful when it is relevant, efficient, effective, impactful and sustainable. According to the World Bank, in Africa, ten project development success criteria can be categorised into three as those related to the project management success, those related to project impact, those related to the project profile (Ika et al., 2012). Vardopoulos (2019) identify two types of factors affecting adaptive reuse, namely cause and effect factors. Cause factors refers to positive factors whose influential impact is greater than influenced impact and they are regarded as critical factors to the sustainable development, whereas the effect factors are negative and their influential impact is lower than controlled impact and are not regarded as stable and initiative factors affecting the system (Vardopoulos, 2019). Effect factors are regarded as a result of cause factors hence they are not regarded as critical success factors (Vardopoulos, 2019). Essential factors of success for developments projects can also be grouped into political, legal, cultural, technical, managerial, economic, environmental, social and physical factors (Lavagnon et al., 2011).

Factors bringing success to adaptive reuse development should include a set of revitalisation measures by the government to encourage the wholesale conversion or redevelopment and provide a useful reference to have a clear understanding of adaptive reuse. This will inform the provision of an incentive (Tan et al., 2018), technological innovation (Vardopoulos, 2019), development of regulations and expansion of stakeholder knowledge on sustainable development (Tan et al., 2018). Government policy on the provision of government subsidies stimulates owners or developers to carry out repairs and maintenance on old buildings. Assigning qualified professionals consequently plays a positive role in the success of rehabilitation projects (Sing, Love & Liu, 2019).

Overall the architectural criteria relevant for the success of the adaptive reuse of industrial facilities into residential buildings includes building spatial capacity, natural lightning, the possibility for the addition of open spaces to the housing unit, functional quality of the newly planned housing space and the case of introduction of vertical and horizontal communication (Petković-Grozdanovića, Stoiljković et al., 2016). These innovative municipal building codes refer to adaptive reuse of existing buildings (Olivadese et al., 2017). Linkages to public transport and integration with public and green spaces (Drewes et al., 2018) also increase the probability of project success. A critical step in the success or failure of the adaptive reuse process and consequently the project is the Identification of a new functional purpose (Langston et al., 2008).

In addition, the flexibility of the project, implementation approach, awareness and sense of urgency, professional capacity of the project team, networking and team composition and expertise, project management structure, selecting the right team for the project are also critical to the success of the project (Lavagnon et al., 2011). Other factors such as choosing the appropriate option like incremental implementation versus big bang, strong project management composition, extensive training, use of appropriate individuals, control environment and project implementation are also considered critical (Lavagnon et al, 2011, Vackland & Nieuwenhuijs, 2005), consistency of leadership, policy direction, availability of resources, number of people involved, the attitude of the project team, alignments to clients and stakeholders and potential customers, experience of the project team and local environment and market conditions (Lavagnon et al, 2011, Struyk, 2007), clear understanding of the scope, competencies of the project team, effectiveness of the project team, adequacy of the resources, continuing support and commitment to objectives, clear policy, adequacy of local capacities, strong ownership of the project (Lavagnon et al, 2011, Khan & Moe, 2008) and trust and effective communication (Diallo & Thuillier, 2005).

4 MATERIALS AND METHODS

The study employs a case study approach to assess the adoption and implementation of adaptive reuse projects in Johannesburg, South Africa from 2002 to 2020. Using an ArcGIS prediction analysis, geo-

location data from municipal records showed that the spatial location of adaptive reuse projects was visualised and assessed. The City of Johannesburg has received approximately over 9185 applications for adaptive reuse of properties since 2002. To examine the applications' spatial locations, the study used word count as a parameterisation to measure the frequency of location names on the applications received by the municipality. Tagul was used to visualise the most frequent location names on the applications.

A questionnaire was used to assess the sustainability parameters associated with these adaptive reuse projects. The study relied on a questionnaire-based survey that was administered to 20 town/urban/spatial planners in the city of Johanneburg. The questionnaire was administered online through Google forms so as to obtain a good response rate. The questionnaire had closed and open-ended questions centred on two themes (see Table 1).

Theme	Description
The success of adaptive reuse projects	Factors influencing the success of adaptive reuse projects
	Critical challenges affecting the implementation of adaptive reuse
Spatial distribution of adaptive reuse projects	Locational trends
	Perceptions of professionals in the built environment

Table 1: Questionnaire themes

5   RESULTS AND DISCUSSION

The results reveal applications concerning properties from Bryanston had the highest number being 886 (see Figure 1). Bryanston is an affluent suburb in Sandton with many large companies such as Tiger Brands, Microsoft Corporation, and Google South Africa. This has over time grown the economic potential of Bryanston. Other locations with a high number of applications were Lenasia (305) and Ferndale (314). These suburbs are similar to Bryanston. Over the years, there has been a considerable influx of corporations expanding operations, which has had a positive impact on the suburbs' economy and has led to employment creation.

Figure 1: Word cloud of applications

Through interviews with municipal officials, these locations are cuurently referred to as nodes of economic importance. These nodes are relatively easy to access, with spacious landscapes and ample parking. Another reason for an influx of application at these locations is that the municipality has developed various initiatives to encourage economic growth in these areas, as seen through the Spatial Development Framework (SDF).

Another driving force why people decide to rezone properties has been that specific locations offer cost advantages, such as cheaper to buy an old building and rezone the property to a new use than to demolish and rebuild. However, from interviews with municipal officers, rezoning applications are not always approved as objections can be received against changing the rights of properties.
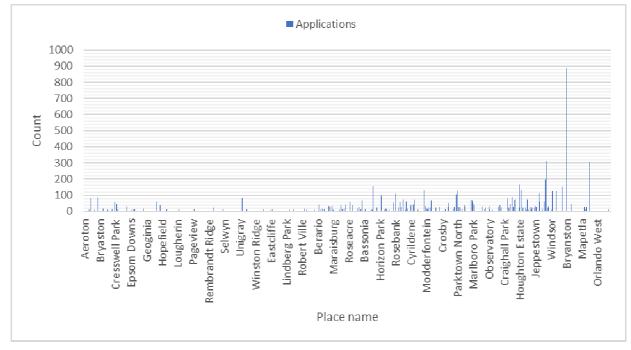

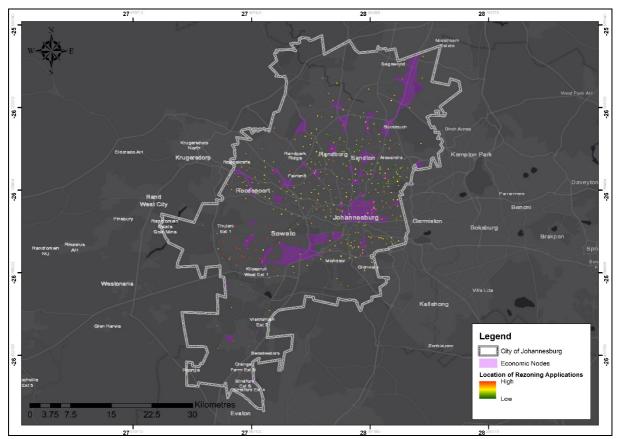Figure 2: Location of properties vs number of applications

Figure 3: Spatial location of adaptive reuse projects

Figure 2, similar to the word cloud reveals the number of rezoning applications in comparison to the location of the property to be rezoned. Figure 2 shows the locations with the highest number of applications being properties in Bryanston with 886, Ferndale with 314, and Lenasia with 305. Location with applications

between 100 to 200 was Dunkeld West with 158, Melrose with 134, Morningside with 196, Houghton Estate with 166, Melrose with 134, Rosebank with 111 and Parktown North with 131. This reveals a hot spot as locations in Johannesburg's northern parts have a high number of applications. Whilst locations to the south of the city have less than 100 applications submitted to the municipality.

The spatial distribution of rezoning applications was then visualised using Arc Gis Pro. Arc Gis Pro is a spatial analyst software used for analysing spatial data trends and creating maps. Figure 3 visualises the geographic location of the properties and presents the trends identified in Figure 2. Presenting spatial data in platforms such as Arc Gis Pro has the merit of visualisation of trends. From Figure 3, it is apparent there are a large number of applications for properties that are located at the Central Business Districts of the city.

Through interviewing members of the public and private sector, it was revealed, that although there a fewer rezoning applications from the south of the city, this is not an indication that properties are not converted from their original land-use rights. "There are limited applications from the Southern portion of the municipality due to limited law enforcement on properties to the south, as individuals illegally conduct business on their property without receiving approval from the council" an urban planner revealed. Hence, there is a need for more regulatory measures to ensure all land-use rights change is done through the rezoning process.
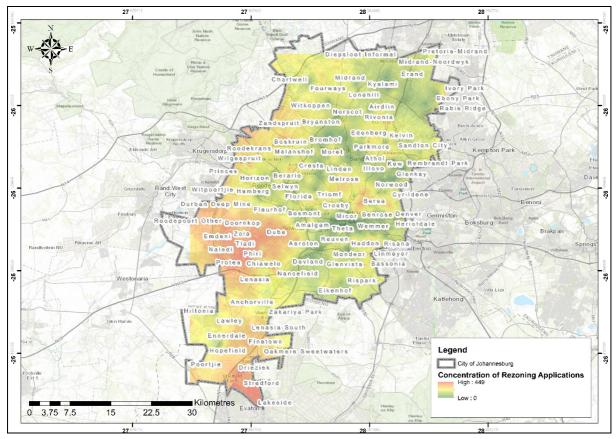

Figure 4: Prediction map of adaptive reuse projects trends

After assessing the spatial distribution of the properties, a need to visualise these trends arises to predict the growth in the number of rezoning applications based on the current distribution of rezoning applications. The research utilises the kriging interpolation tool in Arc Gis to predict the spatial growth of adaptive reuse applications. The results reveal hot and cold spots in the city. Figure 3 revealed a correlation between the economic nodes and locations with high number of applications. Figure 4 reveals a similar trend, whilst also revealing locations of potential economic growth as a hot spot belt is evident towards the South-West of Johannesburg.

An error analysis was then used to determine the margin of error from the prediction analysis from the input data being the blue line (see figure 5 and 6). The standard error revealed in the semi-variogram plot (see figure 6) reflects flaws in the prediction assessment and also reveals limitations on the procedure. A clear trend in the prediction is visible in the Normal QQ plot (see figure 5). The prediction model revealed a

heavy-tailed normal QQ plot, which relates to data trends revealed in Figure 2, as shown by the degree of skewing of dots. In addition to spatial analysis, there is a need to reveal the key factors why certain locations attract a high number of requests than others, which was determined by assessing the questionnaire responses.
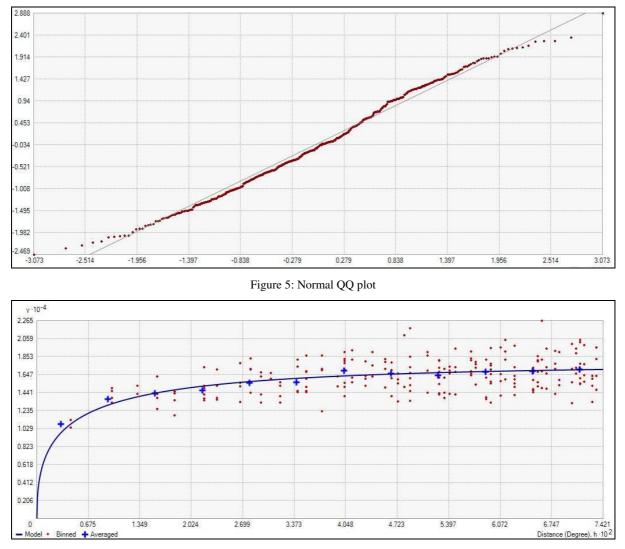

Figure 5: Normal QQ plot

Figure 6: Semi-variogram

5.1 Factors Influencing conversion of properties

In both the private and public sectors, there is an overall agreement that adaptive reuse projects are essential when realising the economic potential of properties. From the private sector perception, this process has a great bearing, particularly in determining project success factors. These factors have over the years been used a ranking to determine which properties should be converted either from office builds to housing units or verse versa. Several challenges hinger whether a property shall be rezoned (see figure 7), among which technological difficulties (98) and conditions of service and systems (91). Functional changeability (82) was also noted as a key challenge, as properties whose key function is not easily changeable generally do not have many rezoning applications, as these general receive comments against the rezoning application from the council. Another notable impediments of rezoning are the space layout of the building (76). The space layout would be an impediment for a developer who wishes to only change the land-use rights of a building or property without changing the building's layout design.

Financial incentives (82) and market demand (74) are also key factors in determining the rezoning of a property (see Figure 8). When there is a high demand for business offices, council has noted there will be a high number of applications to rezone properties so that they have the rights to have business functions. While if there is a demand for housing facilities, there will be many applications to convert the building to accommodate the high demand for housing facilities. For example, a common scapegoat is that increased

demand for low-cost housing councils will support rezoning applications that are in line with this demand. Another example application for properties located along the corridors of freedom is supported by council to boost economic activities along these corridors.
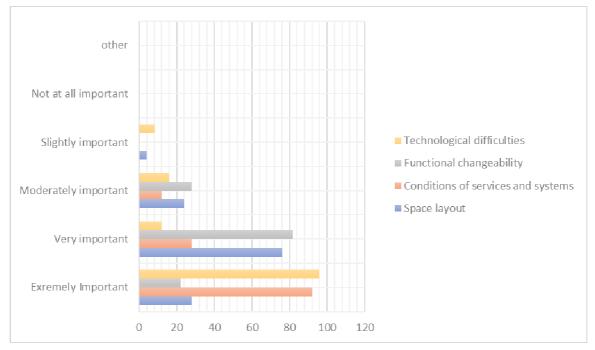

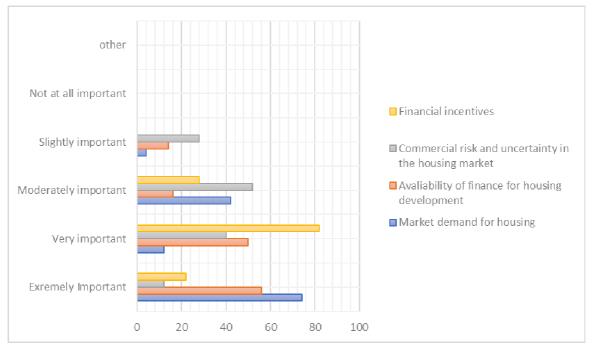Figure 7: Perceptions of factors influencing adaptive reuse

Figure 8: Critical challenges affecting implementation of adaptive reuse

Figure 9 reveals that the project timeline (97) and compatibility with existing surroundings (99) are essential factors in determining the nature of the rezoning application. Council has noted some applications are withdrawn by the applicate such as those that take long to be approved or those that may require the developer to attend a Tribunary to support an application after council has received comments against the approval of the rezoning application. Preservation of history and culture (52) is a moderate impediment, as builds of historical importance can only be rezoned according to guidelines of the National Heritage Resources Act (1999).
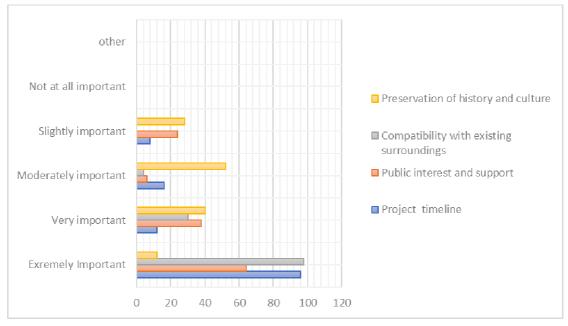
Figure 9: Challenges affecting implementation of adaptive reuse

Implications from the results reveal a need to view and acknowledge the development as a driver for change and infrastructure upgrades. There is a paucity of economic growth in the northern suburbs of Johannesburg. This has led to led to the further decline of Johannesburg's city centre. There is a need for strategic urban management that address the spatial-social divide of the city. However, there is still a key obstacle to inclusive development due to a lack of strong institutions to lead, coordinate and champion this approach. These issues are consistent with other cities across the country. The major challenge in Johannesburg's inner city and marginalised areas is to provide the conditions and the infrastructures that will enable individuals and businesses to develop.

6 CONCLUSION

The results reveal accessibility, functional adaptability, and market demand as the key factors influencing the conversion of properties in the past 20 years. The spatial trends revealed locations with a high concentration (hot spots) of adaptive reuse projects being suburbs in the northern portions of Johannesburg, such as Bryanston and Randburg that have had a considerable influx of corporations expanding their operations. Through assessing the spatial distribution of adaptive reuse, it has been observed that developing cities such as Johannesburg need planning that both promote innovation whilst also looking beyond mere economic needs. The golden era of smart cities referees to it, as a balance in infrastructure investments and a positive contribution to socio-economic transformation and sustainable development. This assessment reveals both the macro-level and micro-level implications of rezoning a property. Building conversions that do not address the community's needs generally receive comments against them during the public participation stage. Hence the developers should clearly outline how they would address the adverse implications of the building conversion as part of the supporting documents for a rezoning application. Moreover, technologies to assess the locations of adaptive reuse projects can inform the policy and legislative instruments and frameworks on spatial planning to guide better developmental practises in the city.

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