Exploring the Possibilities of the 4IR for Revitalising a Declining Mining Town

Dane Buttner
Department of Urban and Regional Planning
University of the Free State
Bloemfontein, South Africa

Janette Britz
Director Infrastructure Planning
Northern Cape Department of Education
Northern Cape, South Africa

Abstract

The main contributing factor to the decline of mining towns is the depletion of natural minerals. The focus of this study was Kimberley, located in the Northern Cape province of South Africa. Kimberley was established in the 1860s following the discovery of diamonds in the country. Over the following decades, the town expanded considerably and was designated as the capital city of the Northern Cape province in 1994. However, as natural mineral resources were depleted, the mines in Kimberley ceased operations, which contributed to the town's decline.

This paper investigated the revitalisation required to give the mining town new life and explored the possibility of integrating Fourth Industrial Revolution (4IR) methods to reconstruct Kimberley. The 4IR is generally identified with artificial intelligence, robotics, the Internet of Things, genetic engineering, and quantum computing. However, this study also examined renewable energy, intelligent building techniques, and optimal development as aspects of the 4IR. It focused on the

potential of the 4IR to revitalise a declining mining town, with particular emphasis on gentrification. A mixed methodology was adopted, which included a review of relevant literature and the formulation of questionnaires (Internet surveys) for Kimberley residents, with the results and findings analysed constructively.

Based on the findings, the introduction of optimal building technology to support renewable energy and green infrastructure is discussed. This proposal aims to revitalise the declining mining town with the assistance of the 4IR.

Keywords: Fourth Industrial Revolution (4IR), revitalisation, declining mining town, green infrastructure.

Introduction

Mining activity significantly contributes to a town's economic growth. When a mine closes, the town can become a ghost town (Winde & Stoch, 2010). The primary purpose of this paper was to explore the potential of the Fourth Industrial Revolution (4IR) to revitalise declining mining towns, as these towns continue to shut down one by one, even if they have not yet reached the status of ghost towns. The mining town examined in this paper is Kimberley in the Northern Cape, which has been operational since the 1860s. Although the mines in Kimberley are closing, the town retains the advantage of being the capital of the Northern Cape province. Despite its status as a declining mining town, Kimberley has excellent potential for revitalisation through 4IR interventions.

Yusuf et al. (2020) indicate that the 4IR is generally characterised by artificial intelligence (AI), which encompasses robotics, the Internet of Things, genetic engineering, quantum computing, and the latest technological interventions that are designed to improve various industries, businesses, health, education, and livelihoods. With this in mind, this study analysed population responses to an Internet survey to determine opinions on Kimberley as a declining mining town and the potential of the 4IR to revitalise it. The data analysis revealed that Kimberley has a rich history and features many historical buildings. This paper aimed to demonstrate that the

4IR can introduce optimal building technology to contribute to renewable energy and green infrastructure as a means of revitalisation. A robust methodology was adopted to achieve the objectives of this paper.

A mixed research method was employed, and secondary data were analysed through a literature review of Kimberley's background during the Industrial Revolution (IR) eras. Internet surveys were distributed, and the results from the population's responses were analysed. The primary research question explored whether the 4IR can revitalise Kimberley as a declining mining town.

Literature Review

This section presents the theoretical and conceptual framework in which this study was positioned. It provides an overview of the factors that play a significant role in exploring the possibilities of the 4IR to revitalise a declining mining town. This review is divided into three sub-sections: Kimberley's background through the IR ages, declining mining towns, and revitalisation and gentrification. All these sections significantly contribute to formulating a comprehensive understanding of this paper's core features.

Background of Kimberley Through the Industrial Revolution (IR) Ages

Kimberley is an established town with a rich history that can be divided into four distinct IR ages. Koc and Teker (2019) define IRs as different eras of technological innovations that have significantly contributed to global economic development. Figure 1 illustrates the duration of these four IR ages. The following section outlines Kimberley's history in relation to each IR evolution.

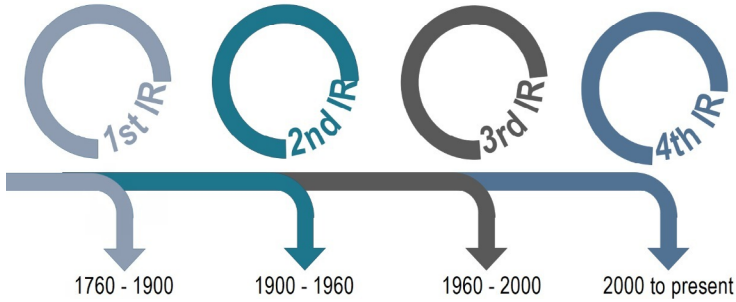

Figure 1: IR Evolution. Source: Based on Xu et al. (2018)

The First Industrial Revolution (1IR)

Mohajan (2019, p. 2) explains that the 1IR was identified in the 1760s as the transition from "human or animal labour technology to machinery, new chemical manufacturing and iron production processes, improved efficiency of water power, the increasing use of steam power, and the development of machine tools". However, the steam engine can be seen as the central aspect of the 1IR, which significantly contributed to economic development. Scholars further elaborate that the 1IR occurred from 1760 to 1900 and introduced the steam engine, which used coal to power these machines (Melnyk et al., 2019; Xu et al., 2018). Figure 2 demonstrates Kimberley's historical evolution from 1860 to 1899.

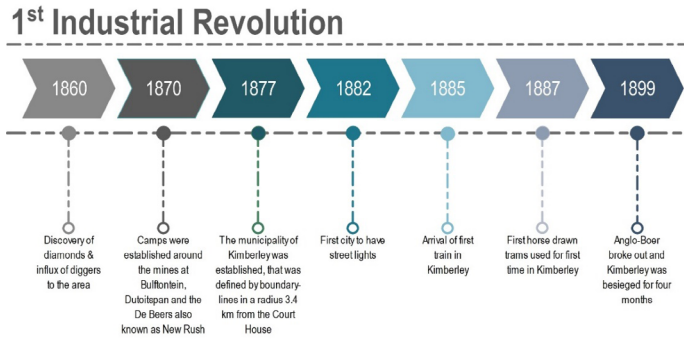

Figure 2: Kimberley's First IR Evolution. Source: Based on Sol Plaatje Municipality (2008)

Kimberley was established during the 1IR when the first diamond was found in 1860 by a young boy outside Hopetown (John, 2012). Figure 2 identifies three historical milestones from 1860 to 1877 that influenced Kimberley's mining sector. It illustrates that Kimberley was the first town to receive street lights, which is an excellent example of industrial progress. In 1885 and 1887, two significant improvements occurred with the arrival of the first train and the first horse-drawn trams as means of transport. The Anglo-Boer War, also known as the South African War, broke out in 1899 (see Figure 2) at the end of the 1IR, which drastically affected mining production in Kimberley, as the town was besieged for four months.

The Second Industrial Revolution (2IR)

The 2IR spanned from 1900 to 1960 and was marked by the invention of the internal combustion engine, which played a pivotal role in ushering in a new era of industrialisation. This era was characterised by mass production assembly lines that utilised oil and electrical power (Koc & Teker, 2019, p. 305; Xu et al., 2018, p. 90). The 2IR encompassed the development of the internal combustion engine and the mass manufacturing of products. Sharma and Singh (2020) noted that Henry Ford was the inventor of the first assembly line for vehicle production, a concept that was inspired by the assembly line used in slaughterhouses. Figure 3 illustrates Kimberley's historical evolution from 1900 to 1939.

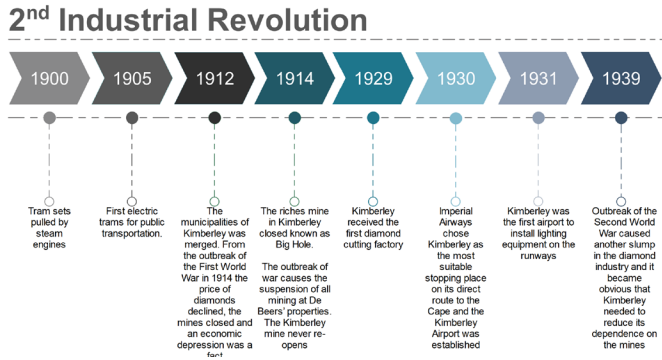

Figure 3: Kimberley's Second IR Evolution. Source: Based on Sol Plaatje Municipality (2008)

Figure 3 illustrates that from 1900 to 1905, Kimberley made significant contributions to the 2IR with the introduction of the first steam engine and the first electrically operated trams in the country. It also highlights the merging of municipalities after World War I to promote economic development. Three historical milestones greatly contributed to Kimberley's growth during the 2IR era from 1929 to 1931, including the establishment of the first diamond-cutting factory, Kimberley's status as a midway stop for airlines, and the opening of the first airport with runway lights. In 1939, the outbreak of World War II drastically affected the mining sector, which led Kimberley to become increasingly dependent on the mining industry.

The Third Industrial Revolution (3IR)

The 3IR occurred from 1960 to 2000, during which electronics and information technology were implemented to automate the production of goods (Sharma & Singh, 2020; Xu et al., 2018). The 3IR is characterised as the age of cutting-edge, speedy, intelligent, and highly effective systems used to optimise production in businesses (Peter & Mbohwa, 2018). With this in mind, Figure 4 does not identify various IR innovations that occurred during this period; rather, it focuses on the historical establishment of Kimberley.

Figure 4 highlights that, in 1968 and 1970, Kimberley received two key pieces of infrastructure: the Supreme Court and the Harry Oppenheimer House, the latter of which was erected as the first diamond-sorting house. According to Figure 4, the year 1977 marks the introduction of an IR approach when Kimberley acquired the first remote-controlled ore trains for underground operations. This clearly illustrates that the controlled, operated trains are a form of 3IR electronic technology. From 1983 to 1994, three significant historical milestones occurred: the establishment of Galeshewe, Galeshewe becoming part of the Kimberley municipality, and Kimberley being designated as the province's capital city.

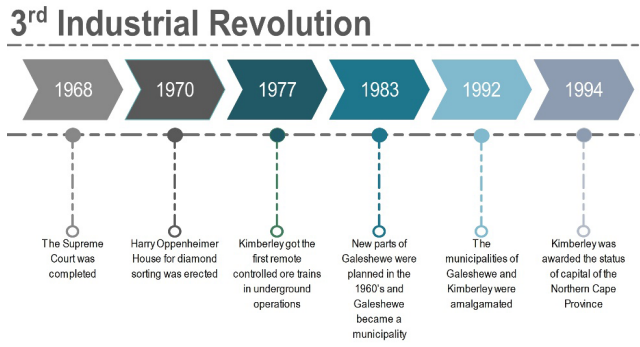

Figure 4: Kimberley's Third IR Evolution. Source: Based on Sol Plaatje Municipality (2008)

The Fourth Industrial Revolution (4IR)

The 4IR, defined as computer-generated production (Xu et al., 2018), began in 2000. Philbeck and Davis (2018, p. 17) identify that the 4IR is built on the achievements of the 3IR, which was "data-centric", as well as the creation of electricity and telecommunications during the 2IR. It is agreed that the 4IR would not have been possible without the technological advancements of the previous industrial eras. The 4IR is also referred to as the fusion technology era, which combines the physical, digital, and biological worlds to enhance various sectors and improve livelihoods (Mhlanga & Moloi, 2020). These

scholars indirectly confirm that the 4IR is a fusion of different technologies that emerged from earlier IRs. Figure 5 illustrates Kimberley's historical evolution from 2000 to the present as part of the 4IR.

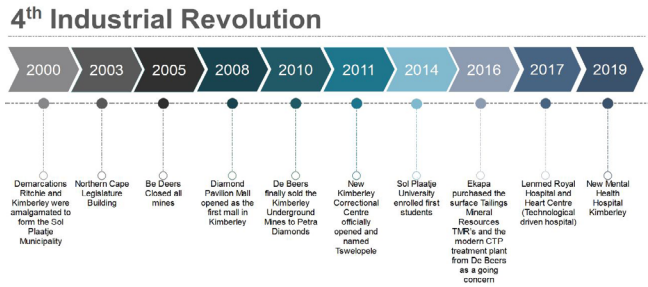

Figure 5: Kimberley's Fourth IR Evolution. Source: Based on Ekapa (2022); Jordaan (2022, July 29, personal communication with architect on Kimberley's history during the 4IR); Sol Plaatje Municipality (2008)

Figure 5 recognises that Kimberley and the surrounding small towns merged into Sol Plaatje Municipality at the start of the 4IR. Additionally, Figure 5 illustrates that from 2003 to 2019, several historical infrastructure projects were completed that significantly contributed to Kimberley's development. Some of these infrastructures are state-of-the-art facilities that enhance the education and health of the residents of Kimberley.

Declining Mining Towns

Mining towns were established during the 1IR, with mining defined as the means of extracting natural resources, and mining towns as the settlements surrounding these mining sites (Curriculum Visions, 2018). These settlements were typically temporary camping-style accommodations with limited access to essential resources (Scott et al., 2013). Kimberley is an excellent example of a mining town that evolved into a well-established town over the years; however, it also illustrates a

concerning trend, as mining towns can often be classified as declining towns.

Declining towns are also referred to as shrinking cities, a phenomenon that is not new in urban areas. Jakar and Dunn (2019, p. 2) state that declining cities are characterised by "empty downtowns, deteriorating neighbourhoods, and struggling families" that result from demographic and economic changes and the movement from urban centres to suburbs on the outskirts of urban areas. The economic decline of a town is a primary factor that contributes to population decline in urban areas. While economic factors and the movement of residents contribute to the decline of towns, declining towns in turn contribute to the decline of mining towns.

In conclusion, declining mining towns are small communities that were established to provide housing and basic necessities for mine workers and their families. As natural resources begin to deplete, these mines close, which leads to a significant decline in the towns. Knierzinger and Sopelle (2019) point out that deindustrialisation is one of the main contributing factors to the decline of mining towns. Weaver et al. (2016) indicate that deindustrialisation contributes to the rapid decline of factories and related employment opportunities, as jobs move to other regions or are affected by international factors.

Revitalisation

Revitalisation is an urban organisational approach aimed at streamlining the improvement of deprived, declining, and challenging urban spaces, with the focus on various aspects of the urban areas and their residents. It involves the act of giving new life, creating growth, and developing or reforming a space (Ramlee et al., 2015). However, revitalisation encompasses numerous related concepts, such as recovery, development, revival, rebuilding, protection, regeneration, and restoration; it is important to note that rehabilitation is not synonymous with revitalisation. Mwendera and Chilonda (2013) emphasise the need to distinguish between revitalisation and rehabilitation. Rehabilitation focuses more on the engineering methods used

to refurbish physical structures and is identified as prolonged maintenance aimed at recovering physical infrastructure, whereas revitalisation concerns the entire urban setting. Raszkowski (2018) explains that revitalisation is an inclusive method of recognising degraded areas or declining towns and framing integrated processes to restore and safeguard these areas, and fostering a close, committed relationship between the community, their physical infrastructure, and the economy for sustainable development.

Gentrification

Gentrification emerged in the 1960s as a form of neighbourhood modification in urban spaces (Richardson et al., 2019). However, gentrification was not the first concept of urban transformation. For this paper to explore the potential of the 4IR for the revitalisation of Kimberley, a declining mining town, it is essential to consider the impact of gentrification on urban transformation. Moos (2016) explains that gentrification involves the categorisation of urban communities based on racial classifications. In the South African context, gentrification is associated with apartheid cities, where the government divided urban spaces into different racial classifications. These apartheid cities segregated urban areas according to various racial groups, which contributed to the apartheid of South African neighbourhoods due to the colonial state. Furthermore, gentrification also emerged in inner-city areas, with the aim to relocate racial groups to other neighbourhoods for higher economic values, which was a process that occurred gradually (Dewi & Ristianti, 2019).

Methodology

A mixed research methodology was adopted to achieve this study's primary objective of exploring the possibilities of the 4IR for revitalising a declining mining town. Bulsara (2015, p. 6) explains that mixed research methodology involves "collecting, analysing, and integrating quantitative and qualitative research in a single study or a longitudinal programme of inquiry".

Combining these two research methods in a single study provided an enhanced understanding of the research problem. The mixed research method employed both quantitative and qualitative descriptive approaches to achieve the study's primary objective.

Descriptive research is defined as research that focuses on present actions that arise (Salkind, 2018). The 4IR can be seen as a current phenomenon that is gaining momentum, while revitalising a declining mining town is also an ongoing endeavour. This indicates that the descriptive research method was the most feasible approach for this research to explore the possibilities of the 4IR in revitalising a declining mining town.

Descriptive quantitative and qualitative research can be defined as a method that is designed to recognise the specific nature of a problem and provide an overview of the current status of the issues at hand (Doyle et al., 2020; Stangor & Walinga, 2019). This paper aims to answer the question: Are there opportunities for the 4IR to revitalise declining mining towns, with a focus on Kimberley as the study area?

The descriptive research method of this study utilised multiple data sources. Creswell (2009) explains that using multiple methods involves employing several different sources for data collection, rather than relying on a single data source. These data sources are classified as primary and secondary data. Figures 6 and 7 discuss the descriptive quantitative and descriptive qualitative research methods individually, focusing on the data-collection and data-analysis approaches that were adopted.

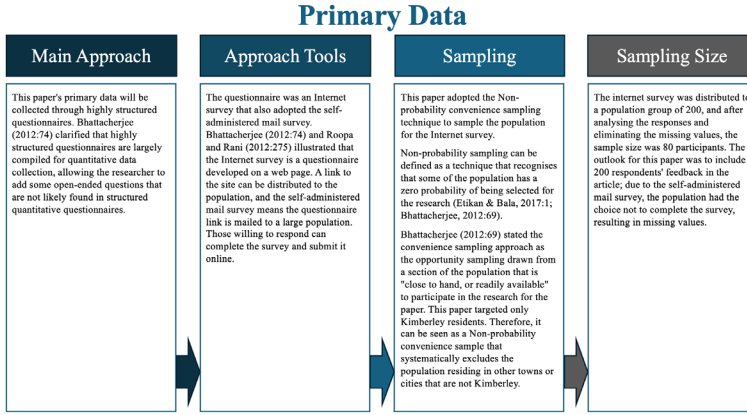

Figure 6: Research Methods: Descriptive Quantitative Research Part 1. Source: Researchers (2022)

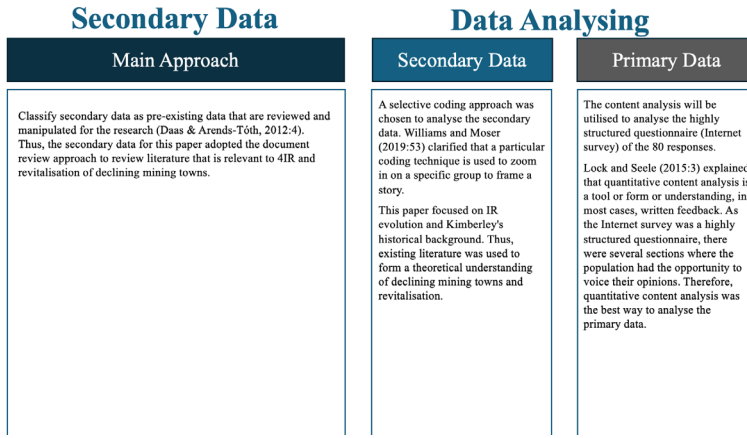

Figure 7: Research Methods: Descriptive Quantitative Research. Source: Researchers (2022)

Findings and Results

The findings and results section analysed the primary data collected to determine whether the study's main objective, namely exploring the possibilities of the 4IR for revitalising a declining mining town, specifically Kimberley, is achievable.

This section examines the responses to the Internet surveys to understand the Kimberley mining situation and to identify potential opportunities for 4IR interventions. The section is divided into three sections: a brief overview of demographics, Kimberley as a declining mining town, and the possibilities of the 4IR for revitalisation.

Brief Demographics

The Internet survey divided Kimberley into five sections to determine where the population resided. Figure 8 indicates the population's demographic profile results.

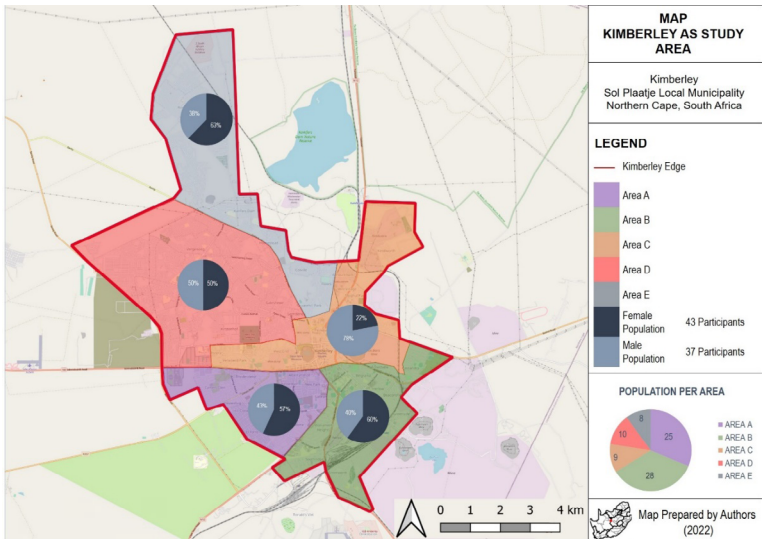

Figure 8: Map of Kimberley Divided Into Five Areas and Population Gender. Source: Researchers (2022)

Referring to Figure 2, Kimberley was established in 1860, located in Area C (as shown in Figure 8). Currently, most of the central business district (CBD) is situated in Area C, which may explain why participants from that area comprised only nine. Figure 4 indicated that the Galeshewe area was established in 1983, classified as Area D in Figure 8. In 1992, all five areas in Figure 8 merged to form Kimberley. The majority of the population

resides in Areas A and B, primarily within Kimberley's residential zones.

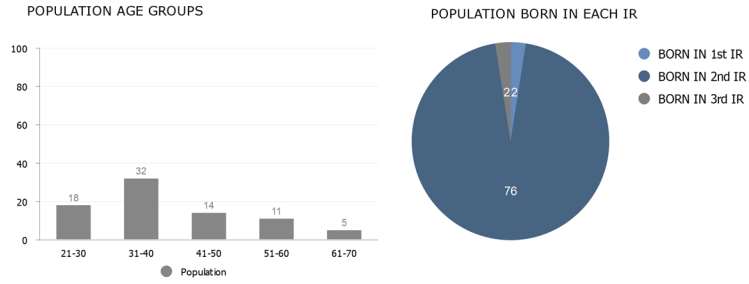

Figure 9: Population Age Groups. Source: Researchers (2022)

Figure 9 recognises that most of the population was born during the 3IR and could have seen the shift to the 4IR in 2000, which was critical in analysing if the 4IR can promote revitalisation.

Kimberley as a Declining Mining Town

The second section of the Internet survey was based on Kimberley and mining towns. The questions started with the population's understanding of the term "declining cities". Figure 10 illustrates the feedback.

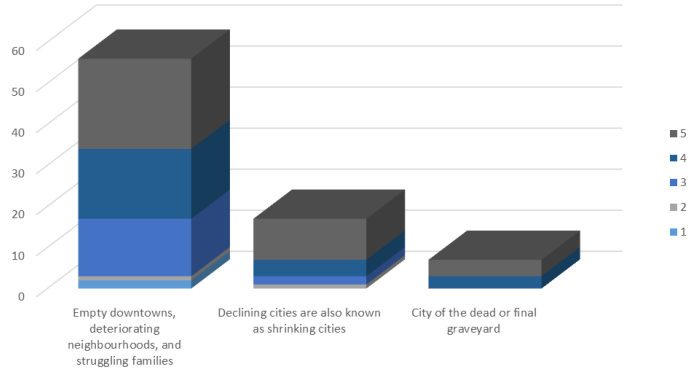

Figure 10: Defined and Rated Kimberley as a Declining Town. Source: Researchers (2022)

The three options for defining declining cities were sourced from numerous pieces of literature. The population indicated that 70% agreed with Jakar and Dunn's (2019, p. 2) definition of declining cities as "empty downtowns, deteriorating neighbourhoods, and struggling families". Figure 10 shows that 21% of the population perceived it as a shrinking city, while 9% concurred with Fol and Cunningham-Sabot's (2010, p. 4) definition of a "city of the dead or final graveyard". A conclusion drawn from the population's responses is that the most commonly used definition of declining cities is empty CBDs, worsening neighbourhoods, and struggling low-income families. This is an accurate term for declining cities, as they remain functional but are in decline. The population provided their understanding of declining cities by scoring whether they believed Kimberley is a declining town on a scale from one to five, where five indicated the highest likelihood. Figure 10 demonstrates that most (75%) of the population agreed that Kimberley is a declining town.

The literature identified deindustrialisation as the primary contributing factor to the decline of mining towns. Figure 11 shows that 54% of the population in Kimberley agreed that deindustrialisation was the main factor, followed by suburbanisation at 26%. However, 20% of the population indicated that demographic changes were a contributing factor, which could also be a possible reason for the decline.

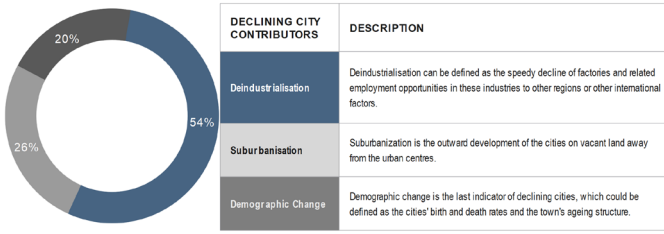

Figure 11: Reasons for Kimberley Being a Declining Town. Source: Based on Weaver et al. (2016)

Figure 12 indicates that 93% of the population agreed that Kimberley is or was a mining town. This aligns with the

literature that states Kimberley was established as a mining town in the 1860s.

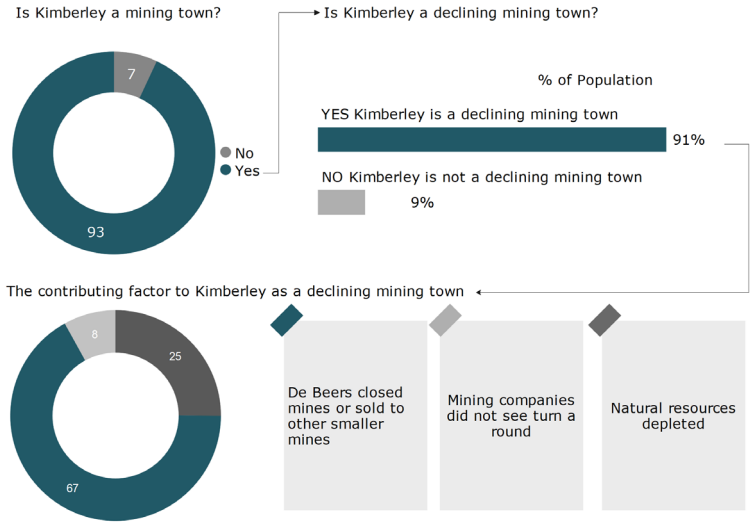

Figure 12: Kimberley as a Mining Town. Source: Researchers (2022)

Figure 12 demonstrates data relevant to the population that stated "yes" to Kimberley being a mining town. It identifies that 91% of the respondents agreed that Kimberley is a declining mining town, with contributing factors cited as reasons for this decline. Furthermore, 67% of the population indicated that the main reason was De Beers closing the majority of their mines or selling them off, as De Beers has been the first and primary mining company in Kimberley since 1870 (see Figure 2). Depleted natural resources were identified as a contributing factor by 25% of the population, as De Beers closed its mines primarily due to the depletion of these resources. Figure 5 showed that in 2005, De Beers closed all its mines in Kimberley, and in 2010, sold the viable mines to other companies.

Figure 13 presents a map of Kimberley's closed mines, various dumping sites, and the three mines that are still in operation.

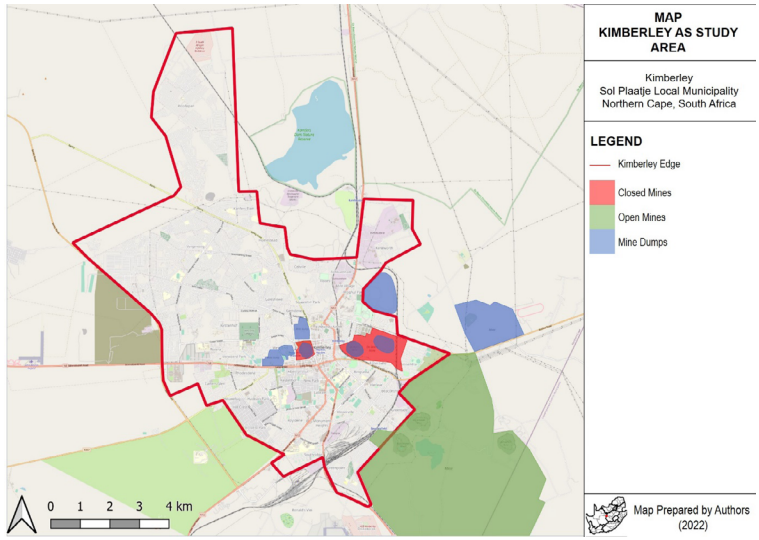

Figure 13: Map Illustrating Kimberley's Closed Mines, Mines, and Dump Sites. Source: Researchers (2022)

Figure 5 supports the formulation of this map, and the mining dump site was identified through personal observation. Figure 13 indicates that while some mines in Kimberley have closed, there are still operating mines in the area, which contributes to its status as a declining mining town.

4IR Possibilities for Revitalisation

The last section of the Internet survey focused on the 4IR and its potential to promote revitalisation in Kimberley. Figure 14 shows that only 54% of the population were aware of the term 4IR, which is surprising given that we live in the 4IR.

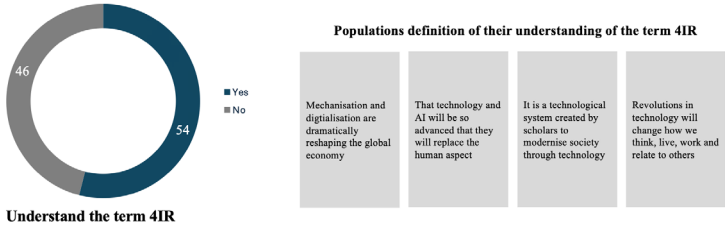

Figure 14: Understanding of the Term "4IR". Source: Researchers (2022)

The population was asked to define their understanding of the term "4IR", and most stated that they were unfamiliar with it. Others primarily described it as modern technology and innovations. Figure 14 illustrates some of the population's responses.

The Internet survey then shifted focus to revitalisation. First, the population was provided with a literature review section and asked whether they believed Kimberley could be revitalised. Eighty-six percent agreed that Kimberley could be renewed. Table 1 indicates the feedback from the population on how Kimberley can be revitalised.

Table 1: Population Responses to Revitalising Kimberley. Source: Researchers (2022)

Overall interest field	Portion of the population's responses	%
Change of leadership	The town requires better management and more optimal state resources to revitalise Kimberley.	40%
Investment Opportunities	By receiving an influx of investments and talent, Kimberley can grow and expand its businesses and use the extensive empty lands at its disposal (for new companies, houses, factories, etc.).	15%
	More investment in infrastructure development by the government and private sector. Expansion of the town and the re-establishment of factories such as clothing and bakeries to create employment opportunities.	
	With proper planning and private investment, it will be possible to revitalise Kimberley; if implemented correctly, many opportunities will positively impact the town, work opportunities, tourism, etc.	
Job creation	We need people who are capable of revitalising the city.	15%
	All the revitalisation projects can provide employment opportunities for the local communities.	
Planning	If Kimberley gets new attractions and restores old buildings, streets, and gardens, it will attract more people.	20%
	Residents, businesses, local government, and other stakeholders must work together to ensure a revitalised Kimberley. More integrated planning is needed.	
Technological	Technology is the future of society; through it, our systems can be more modernised for effective and efficient functioning.	10%
	With the 4IR implemented, Kimberley would be reconstructed and recover from deterioration. Kimberley will become a developing city that is revitalised.	

Two proposals were drafted to understand if they would work to revitalise Kimberley using the 4IR.

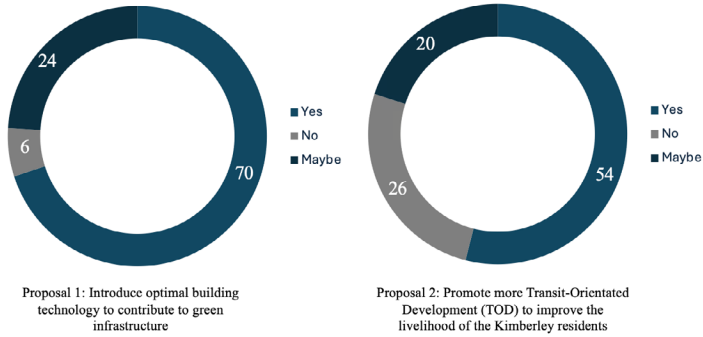

Figure 15: Population Opinion of Proposals 1 and 2. Source: Researchers (2022)

The first proposal was to introduce optimal building technology to contribute to renewable energy and green infrastructure. Figure 15 shows that 70% of the population agreed that this proposal will revitalise Kimberley.

The second proposal focused on the promotion of more transit-oriented development in Kimberley. Figure 15 illustrates that only 54% of the population believed that this proposal was feasible in Kimberley.

The following are some of the population's proposals for revitalising Kimberley through the 4IR:

- Entertainment and tourism for youths: People are social beings who like to be engaged. Kimberley currently offers no recreation or tourism-oriented opportunities focused on the social development of people aged 14 to 35. Younger generations leave because there is nothing to do in Kimberley, and salaries are low.
- Kimberley can be a smart city with all the necessary technology.
- Implement more green and recycling possibilities. Use the poor community for this and create work opportunities.

- Make Kimberley a distribution hub for several different industries due to its location.
- The old mine dumps in town can be removed or reused and become prime areas for property development.
- The revitalisation of the CBD to attract businesses will revive the inner city.

Three of the population's proposals are closely related to the first proposal regarding renewable energy, intelligent building techniques, and optimal development as aspects of the 4IR. The proposal to make Kimberley a logistical hub will significantly revitalise the area, but it remains a theoretical suggestion that requires substantial investigation.

In conclusion, the population confirmed that Kimberley is a declining mining town, with deindustrialisation and the depletion of natural resources contributing to its current state. They supported the idea that Kimberley could be revitalised and provided several suggestions on how this could be achieved. The population was presented with two 4IR revitalisation proposals, which significantly bolstered this notion. The findings also indicated that the population proposed utilising the 4IR to rejuvenate Kimberley.

Discussion

This research primarily relates to existing knowledge on declining towns (specifically declining mining towns), revitalising these towns, and the 4IR as a means to promote revitalisation. It examined the impact of revitalisation on gentrification. The findings indicate that 70% of the population agreed with the literature regarding the characteristics of a declining town, which include empty downtown areas, deteriorating neighbourhoods, and struggling families. Consequently, the research investigated the factors that contribute to Kimberley's decline, with 54% of the population identifying deindustrialisation as the main factor. The literature also acknowledges that deindustrialisation is one of the contributing factors to the decline of towns. Furthermore, it notes that during the apartheid era, gentrification occurred

as urban spaces were divided into racially segregated neighbourhoods, and explores how the 4IR may facilitate the integration of these groups. Ultimately, this research aimed to assess the potential of the 4IR to revitalise Kimberley as a declining mining town, while also focusing on the implications for gentrification.

The research aimed to introduce optimal building technology to contribute to Kimberley's renewable energy and green infrastructure and to explore how these interventions may facilitate gentrification. The findings indicated that Kimberley has experienced significant innovations throughout the various IR phases, alongside the closure of mines, including those owned by the De Beers Company, which has sold off these sites. Furthermore, 91% of the population believed that Kimberley is a declining mining town, although they also saw potential for revitalisation. Forty percent of respondents identified the need for new municipal leadership, while 20% emphasised the necessity of more integrated planning. This research focused on the new leadership of the municipality and the planning aspects highlighted by the population's responses to revitalise Kimberley. The most pertinent findings related to the municipality's need for new leadership to effectively plan and maintain the livelihoods of Kimberley's communities, as well as to restore old buildings, streets, and gardens, and incorporating more modernised systems and technology to promote renewable and green infrastructure.

Figure 16 illustrates a historical building in Kimberley that has the potential to be revitalised through 4IR interventions.

Figure 16: Historical Building in Kimberley. Source: Researchers' (2022) own photograph

The following section on interventions for buildings first focuses on the established older buildings and the newly constructed infrastructure that have the potential to contribute to renewable energy through 4IR interventions. It also discusses how these measures can combat gentrification in Kimberley that stem from the apartheid era.

Interventions for Buildings

Figure 16 indicates that there is limited scope for change to the front of the building. Nevertheless, this building faces south-west, which means that the west side receives afternoon sunlight. A proposed intervention is to install modern solar panel window covers on the front of the building, which can generate renewable energy. The architect appointed for this project will integrate these solar panels into the building's façade. Additionally, the roof can be covered with solar panels, and modifications can be made to the back of the building to allow northern sunlight to enter to provide natural light and heat. The interior can be transformed into a state-of-the-art

space with the latest 4IR innovations. Personal observations reveal that Kimberley's CBD has several old, vacant buildings that are deteriorating each year. These buildings can be revitalised through 4IR innovations to provide accommodation in the CBD for previously disadvantaged citizens. As Kimberley has limited space to construct new residential areas, revitalising old buildings into residential blocks will alleviate the pressure on the municipality to find new land parcels.

How will these old buildings be revitalised into residential blocks? Firstly, most of these buildings in the CBD are offices; a complete redesign will therefore be required to convert the interiors into residential units. Incorporating 4IR building technologies will ensure that the buildings are revitalised to be self-sustainable. Given the limited space, the roofs can be converted into eco-friendly recreation areas for families. This will address the revitalisation of existing buildings. The second part of the discussion focuses on newly constructed infrastructure that incorporates the 4IR.

Figure 17: Sol Plaatje University Buildings. Source: Researchers' (2022) own photographs

Figure 17 demonstrates the buildings of Sol Plaatje University in Kimberley, which began enrolling students in 2014, which means that these are all newly constructed buildings. Both photographs, taken from the western side, suggest that the developers missed an opportunity to incorporate renewable energy and green infrastructure into the design.

Firstly, regarding the western side of the building, although the windows are covered to mitigate the harsh western afternoon sun, the developers could have incorporated solar panels and covered the walls with them. This panel-covered design would have enhanced the university's modern infrastructure. Secondly, the photographs indicate that the roofs are utilised for renewable energy; however, they could have been covered with solar panels to enable the university to function off-grid. It is evident that the newly constructed infrastructure lacks the green infrastructure element.

Conclusion

This paper investigated the potential for revitalising the declining mining town of Kimberley through 4IR interventions. The findings concluded that while Kimberley remains a declining mining town with some operating mines, overall operations have diminished, especially following the closure of all De Beers mines in 2005, which have not reopened again. The research employed both primary data (an Internet survey of the Kimberley population) and secondary data (a literature review)

to explore the possibilities for revitalising Kimberley. Kimberley was classified as the capital of the Northern Cape province in 1994, which reinforces its status as a declining town rather than a ghost town.

The paper primarily focused on the revitalisation of buildings in Kimberley, encompassing both established and newly constructed structures. It aimed to introduce optimal building technology to enhance renewable energy and green infrastructure while combatting gentrification. The research identified one structure in Kimberley that can be revitalised using 4IR interventions, which can serve as an example for other established buildings that could benefit from the same approach. Additionally, the paper examined the newly established university in Kimberley, which opened in 2014 and has almost no renewable energy interventions. The proposal highlighted that the university, along with other newly established infrastructure, has significant potential to incorporate green infrastructure.

There are further research opportunities, as the population identified that the main idea behind revitalising Kimberley is to change the management structure, which could be explored from a political perspective.

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