

Research on Intelligent Management Solutions for Sustainable, Low-Carbon Future Smart Cities and Industrial Parks in China

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ABSTRACT

China is a developed country promoting intelligent services, which can increase the country's sustainability appropriately. This is done by using innovative technologies to reduce the carbon footprints in the country. The technical innovations have helped maintain low-carbon for the country's future development. Intelligent technologies in the country help manage renewable energy by making environmental transformation easier ([Darda et al., 2019](#)). This research article will help find different management solutions for sustainable low-carbon for future smart cities and industrial parks in China. Moreover, this article will help find an in-depth review of China's policies to manage the future of the industrial parks.

Contribution/Originality: This study helps reveal new management methods for sustainable low-carbon for future smart cities and industrial parks in China by contributing to the search. In addition, by reading this article, readers will be able to get a comprehensive evaluation of China's policies that are designed to manage the future of industrial parks.

1. Introduction

As the world's largest developing country, China has achieved enormous economic development, with an average annual GDP growth rate of 10% over the last two decades. However, the success has come at the cost of environmental deterioration. It has been observed that environmental issues are rising to a considerable level. Outdoor and indoor air pollution, water scarcity, soil pollution, and desertification are all on the rise, posing significant health risks to Chinese residents. For the nation, outdoor pollution is the most significant environmental challenge, and the source of air pollution in the cities has changed from the combustion of conventional coal to the overall mixture of coal combustion, including motor-vehicle emissions. In rural China, most people still use coal

and biomass fuels in stoves, which produces substantial indoor air pollution. The WHO has estimated that solid fuels in the households of China are causing around 420,000 premature deaths a year (Shen et al., 2021).

Besides, China's carbon emissions have threatened the global efforts to fight climate change, as the broader environmental degradation has also imperilled economic growth, government legitimacy, and public health. The nation's environmental crisis has not only put an end to decades of rapid industrialization, but it is also having a significant impact on the health and livelihood of its people. Due to its notoriously poor air quality, the country is the top emitter of unidentified greenhouse gases. In the past decade, China has emitted more ambiguous gases than any other nation, including methane, carbon dioxide, nitrous oxide, and others. China faces additional environmental challenges as a result of environmental degradation, such as water scarcity and soil contamination. Hence, the country is expecting to face tremendous consequences of climate change in the upcoming years, along with floods and droughts. Other impacts of environmental degradation in China consist of the disposal and treatment of electronic waste and the pollution of heavy metals in the soil. At the moment, it is known that the Chinese government has thought about giving climate change more attention.

Moreover, around 70% of electronic waste generated around the globe is contributed by China, which poses a greater risk to human health and the environment (Ma et al., 2020). Many of the small and medium-scale rural factories are contributing significantly to the nation's growing pollution issues. Because of growing urbanization, energy demands are getting higher, which has increased the energy demands on industrial centres and new manufacturing plants, and all of these largely depend on high-energy-consuming products such as steel and cement. So, this can be seen as another major reason why China's environment is getting worse and worse.

In light of this, it is critical to strengthen the concept of resource sustainability and low-carbon environmental protection, particularly in urban industrial parks' management. This is accomplished by utilising innovative technology to lower the nation's carbon emissions. Scientific advances have contributed to the country's future development by keeping carbon emissions low. Intelligent technologies in the country aid in the management of renewable energy by promoting environmental transformation (Darda et al., 2019). This research paper will aid in the discovery of various low-carbon management strategies for future smart cities and industrial parks in China. This study will also help with a detailed analysis of how China plans to run industrial parks in the future.

2. Literature Review

A literature review has discussed the arguments and opinions presented by the authors in the past literature regarding the intelligent management solutions for diminishing environmental degradation by implementing sustainable urban development, industrial parks, and low-carbon intelligent cities in China. Different topics and variables have been presented with the help of theories and facts to discuss different ways of intelligent management taken by the government to prevent the consumption of high-demand energy and enhance sustainability. Furthermore, key issues involved in the growth of sustainability have been pointed out based on the author's viewpoint.

2.1. Need for low sustainable carbon

Climate change is one of the main challenges, creating an ecological imbalance in a country. The increase in carbon footprints due to pollution is affecting the environment. Therefore, the need for low carbon is sustainable for the environment, which can help manage the long-term environmental crisis. As per [Sovacool et al. \(2020\)](#), the involvement of low carbon technologies helps manage deforestation by which proper balance in the society is managed properly. This can help in securing less emission in the country by which pollution can be reduced. Moreover, this can help in managing fewer health problems in society. The involvement of renewable energy sources has helped maintain proper dependencies on importing fossil fuels, which is helpful for the country. This help in improving the sustainability of the country.

[Ahmad et al. \(2019\)](#) also mentioned that China continuously fights against environmental degradation and climate change. Carbon emission in China is constantly threatening the country's public health and economic growth. This has hampered the environmental condition of the nation as well. The main reason for the carbon emission is coal which makes up around two-thirds of energy consumption in China. Hence, it is imperative to bring renewable energy to replace coal to prevent these impacts within the country and the entire world.

On the other hand, it is found that the use of renewable sources can make nations free from being dependent on fossil fuels. Moreover, the transition to low carbon can bring significant economic benefits as using low carbon technologies can open up the growth of jobs and new sources of income. As stated by [Li and Qian \(2018\)](#), using low sustainable carbon can free up the nations from imported fossil fuels and bring cleaner transport which would ultimately reduce the health risks. Therefore, it is analyzed that the use of low carbon helps in reducing greenhouse gases and also enables saving resources. Adopting this sustainable lifestyle is essential for attaining a healthy planet and life.

2.2. Ways for intelligent management for sustainability

2.2.1. Decarbonised transportation

Including the technologies for innovation of electric vehicles can help manage zero-emission in the country. As China has a high population, including autonomous vehicles can help manage innovative sustainability in the country ([Tsoi et al., 2022](#)). Partnership with the ride-hailing companies for producing sustainable supplies of the evaluation fuels in the airlines from the municipal waste can help manage the transportation properly in a more intelligent manner. The concept of decarbonized transport promotes carbon-neutral mobility to stop climate change. Therefore, it enables decision-makers to choose Carbon dioxide mitigation strategies that offer significant climatic commitment. Decarbonizing transport allows government and industry to translate the climate ambitions into the actions mainly by building a catalog related to efficient CO₂ mitigation measures and provides targeted analytical assistance for nations and partners in identifying climate actions that work.

2.2.2. Integration of smart buildings

Using sensors in buildings with the help of artificial intelligence can help customers optimize the use of the services at a lower cost. This can help benefit the customers with easy use of the services in the intelligent buildings. Moreover, integrating digital platforms can increase the sustainability of the services in the country. It has been found that intelligent buildings are using IoT for sharing information, controlling operations, and enhancing human interaction; hence, all these interactions and advancements are pretty crucial for increasing sustainability. Besides this, with these buildings, reducing carbon footprint becomes easier. For example, the sensor used in the building enables in reducing the carbon dioxide levels. As more organizations adapt to these changes, it is assumed that fewer emissions can be produced along with more eco-conscious solutions.

2.2.3. Use of gases and low carbon energy

Renewable energy sources such as solar, bio, and wind can help appropriately manage the environment's reliability. The inclusion of solar energy is harmless to the environment, which can appropriately increase the environment's sustainability (Chen et al., 2018). Moreover, using blue and green hydrogen can help maintain the industrial growth by which proper infrastructure can be maintained in the society. The energy produced utilizing low carbon emissions like wind, solar, hydro, and nuclear power is better for the environment as they generate less carbon in the atmosphere. One of the best ways to use low carbon is to be energy efficient and live a zero-waste lifestyle to ensure a low carbon footprint.

2.2.4. Increasing the quality of life by the health system

The use of intelligent appliances for monitoring the health of people can increase biodiversity. This can increase better management of the waste processes in society and help secure good sustainability in the society by which business developments can be appropriately managed.

2.2.5 Knowledge-based systems

Zhang et al. (2017) conducted a research and found that ontology is a strong tool for managing knowledge in complicated systems such as the Eco-Industrial Park (EIP). According to their research, the ontology-based strategy can improve knowledge interoperability among EIP companies. The ontology-based approach can also enable intelligent decision-making by combining different data from remote databases, implying the prospect of self-optimization in the Internet of Things scenario without human intervention. This study demonstrates that knowledge-based systems can bridge communication gaps between different organisations in the EIP, allowing more potential industrial symbiosis links to be developed in order to increase the overall energy efficiency of the EIP.

2.3. Critical aspects of future smart cities

Physical infrastructure is one of the main aspects that is required to be managed by the countries to develop smart cities. The efficient delivery of water and electricity with renewable energy sources can adequately increase the place's sustainability. This helps

in managing the quality of the infrastructure in society. Moreover, using the proper Information and Communications Technology (ICT) is essential in managing the future of smart cities. As recommended by [Alavi et al. \(2018\)](#), there is a requirement to maintain a proper supply-demand system with the use of ICT in the cities to ensure sustainability in the long term. The use of the electric vehicle for reduction of the transport pollution and biotechnology for reduction of the industrial waste can help in securing proper wellness for the cities to manage their future. These aspects can help maintain the social inclusion and satisfaction of the ordinary people in the country.

[Javed et al. \(2022\)](#) conducted significant research to discover and inspect the most recent technological developments, which would serve as the foundation for the approaching strong period. In their opinion, deep learning (DL), machine learning (ML), internet of things (IoT), mobile computing, big data, blockchain, sixth-generation (6G) networks, WiFi-7, industry 5.0, robotic systems, heating, ventilation, and air conditioning (HVAC), digital forensic, industrial control systems, connected and automated vehicles (CAVs), electric vehicles, product recycling, flying cars, pantry backup, calamity backup, and critical integration of cybersecurity to keep telecommunications secure are all examples of how deep learning, machine learning,

2.4. Analysis of Intelligence Management Capabilities

One of the significant intelligence management capabilities is the implementation of sustainable and low-carbon intelligent cities and industrial parks. As stated by [Wang et al. \(2019\)](#), promoting sustainable urban development and green industrial processes are critical solutions for sustainable and low-carbon social transition in China, considering the significant environmental impacts derived from industrialization and surging urbanization. From the study, it is found that top-down programs in intelligent cities along with industrial parks are adopted to enlighten different local regions of the country. Smart cities are emerging and promoted mainly in developing nations. For example, cities in China like Beijing, Nanjing, Shenzhen, and others have made significant progress in dealing with increasing pollution by implementing the concepts of smart cities.

On the contrary, intelligent technologies and systems provide solutions and external scopes for energy and material optimization. For example, an eco-efficient industrial park has been constructed to shed light on the future of low-carbon parts. The application and utilization of ICT systems like monitoring facilities in the industrial process have increased the processing capacity and brought a positive step towards the environment. However, there is a lack of discussion on the intelligence of management capabilities and technical innovations in past literature that would be the central focus of the current study.

3. Methodology

In this qualitative study, intelligent management solutions for sustainable, low-carbon future smart cities and industrial parks in China are investigated through the use of interviews and a review of the relevant literature.

3.1 Literature Review

In the process of conducting the literature review, we conducted a search for the terms

"Intelligent Management," "Sustainable Development," "Industrial Parks," and other relevant keywords. We then selected academic literature published within the last five years, gathered and examined literature that was comparable to our thesis, summarized the findings of the other studies, and concentrated on the unresolved aspects of those studies, which served as the starting point for our own investigation.

Additionally, the study placed a significant emphasis on the citation of secondary material as an important component. These datasets, which are the outcomes of research conducted by academics and possess scientific and correct features, are a source of information that is detailed for our research.

3.2 Interview techniques

To do an interview based on our thesis, we chose five managers who worked in smart industrial parks and made up five fixed, open-ended interview questions to ask them. We recorded and summarized their comments, and then, based on the in-depth discussion that they provided, we extracted the most pertinent conclusions. Even though this was based on people's personal experiences, it was also based on the experiences of frontline workers, who gave us references for our research that came directly from them.

The following is a list of the questions.

- i. Do you believe that the incorporation of smart cities can be of assistance in preserving the sustainability of intelligent management?
- ii. Do you think the right use of information and communication technology can help manage smart cities of the future?
- iii. Do you think that the requirement for low carbon helps China control its pollution of the environment and make the country more sustainable?
- iv. Based on past experience, does the need for low carbon help China manage environmental pollution in order to make the country more sustainable?
- v. What are your thoughts on the topic of improving the standard of living inside the healthcare system?

4. Results

4.1 Summary of Interviews

We have collated and distilled the content of the five managers' interviews and summarised the relevant content according to interview questions as follows.

Question 1. Do you think the integration of smart buildings can help in maintaining intelligent management sustainability?

From the responses of the first and second managers, it has been found that integrating intelligent buildings can help reduce the waste that can harm the environment. The organization's resource management with smart building infrastructure can help manage the services with less carbon emission. This helps in securing the environment and managing the future correctly. Moreover, the third and fourth managers have stated that energy efficiency is improved with the implementation of smart buildings in the country. This increases sustainability with intelligent management solutions so that zero energy building management can be found. The last and the fifth manager have

mentioned that the intelligent buildings use technology and manage safety for the occupants to maintain the management sustainability. The intelligent building provides a cost-effective environment for optimizing interrelation among the service management processes. This helps in maintaining the resources appropriately for building sustainability.

Question 2. Do you think that usage of ICT in the proper manner can help in managing the future of smart cities?

Answering this question, the first and second managers have stated that the increasing population of the countries requires optimization in socio-economic development. Thus, using ICT can help manage the future of smart cities. Using the ICT helps improve the quality of life by which operation and services can be managed properly. However, third managers have suggested that ICT in future smart cities provides a governance mechanism by which balanced regulation can be maintained appropriately. The involvement of infrastructure growth can help properly use ICT so that the future of smart cities can be maintained appropriately. Moreover, the fourth and the fifth managers have recommended that an integrated environment system can help manage the infrastructure of the intelligent building to secure their futures. The involvement of ICT helps develop innovative policies by which operational enhancement can be made appropriately.

Question 3. Do you think the need for low carbon helps manage China's environmental pollution to improving sustainability?

The first manager stated that there is a need to reduce carbon footprint to mitigate the increasing challenges of global climate change. It also boosts the global economy and helps in maintaining biodiversity. On the other hand, the second manager also said that low carbon helps manage sustainability by boosting the global economy. The third manager, however, stated that resilience, trade, energy security, and enhanced competitiveness within industries also positively influence lowering carbon use. The fourth manager said that frequent climate changes could be prevented by reducing carbon usage. The fifth manager stated that reducing carbon emissions could improve people's health.

Question 4. What is your view regarding increasing the quality of life of the health system?

Based on the opinion of the first manager, it has been found that an intelligent health system helps to have accurate details regarding health and finance. The second manager further stated that people could have personalized ideas regarding convenient and less expensive health treatment options. Furthermore, the third manager stated that some health systems, such as IoT and wearable devices, help patients manage and respond to medical requirements actively. They are also able to have dynamic access to healthcare information. Contradictorily, both fourth and fifth managers stated that intelligent systems are beneficial to reducing the burden of diseases, but implementation costs are subsequently high.

Question 5. What do you think regarding the capabilities of the intelligent management process in smart cities and industrial parks?

Manager 1 opined that the IM process allows cities to set goals and gather data essential to improving. Moreover, it also benefits from improving physical infrastructure and provides equity of access to various services. The opinion of the second manager helped to understand that technological development, improving governance, and the economy is some crucial aspects that can be enhanced by using IM processes. The third manager further commented that the desire to maintain the balance between ecological balance and economic development could be fulfilled with the help of innovative, intelligent processes.

Besides, it also benefits from having proper urban planning and management techniques that benefit growth progress in cities. The fourth manager stated that innovative cooperation could be maintained to achieve sustainability and improve standards of people and life. On the other hand, the fifth manager commented that security concerns and data privacy issues are some significant disadvantages of intelligent cities. Hence, there is a need to assess digitalization and investigate information management in smart cities properly.

4.2. Thematic analysis

Theme 1: Sustainability programs can help in managing the future of industrial parks

Sustainability is the key to maintaining proper societal performances without any toxic harm. The engineering education programs' involvement in managing the cities' services can help increase green developments. Intelligent technologies in the country's traffic system can help provide congestion-free roads (Guo et al., 2020). This can help minimize accidents and manage proper traffic rules in the country. Moreover, the sustainability of the industrial parks in China requires proper equity of services by which the environmental pollution can be degraded. The use of green technology in the industry can help in limiting the waste from the factory. This can help in securing a clean country with good biodiversity.

Theme 2: Growth of low-carbon intelligent cities in China to combat environmental degradation

The main reason behind developing low-carbon, intelligent and sustainable cities is to reduce the CO₂ footprint. The significant advantages of developing smart cities are improving energy efficiency and storage, waste management, and traffic conditions. Based on the reports, it is found that the US Agency provides funds for International Development (USAID) to implement brilliant low-carbon city projects for the Chinese community (Sustain.org, 2022). Hence, this project has been developed to support four leading Chinese cities in bringing low carbon initiatives and reducing GHG emissions. Moreover, with the project, low-carbon urban development has been implemented to bring positive change to the environment. On the contrary, it is evaluated that the implementation of smart cities can bring intelligent grids and innovative water management systems to ensure energy availability across the cities.

China is made a massive investment in the digital transformation of their cities by bringing public-private partnerships and promoting targeted technological innovation.

The country mainly developed intelligent city infrastructure in the metropolitan areas. In 2011, China announced a five-year plan for developing digital cities, and Beijing took the initiative to accelerate the construction of IT infrastructure and other innovative approaches within the city. This infrastructure now serves as the primary source for leveraging the intelligent city concept in China. After doing intense research on new technologies, a handful of companies have taken the lead in transforming cities into smart ones. These include Alibaba, Digi Chuxing, Baidu, Huawei, and Tencent, which have incorporated innovative technologies in cities like Suzhou, Hangzhou, Beijing, Shanghai, and others ([The China Guys, 2021](#)). Therefore, it signifies a substantial growth of smart cities in the country.

China is technologically advanced. Therefore, the application of high-quality technology can improve environmental safety. This can boost the longevity of China's intelligent management systems.

Moreover, maintaining transparency in sharing information with the public can help spread awareness by improving the importance of environmental sustainability. The citizens' empowerment can help make China a prosperous city the country. This helps facilitate the initiatives of adequately managing the energy processes in the country. From the primary qualitative analysis, it has been found that the involvement of the smart building helps in decreasing waste from the intelligent buildings. This helps in securing the business opportunities by which the operational developments can be managed appropriately. The involvement of low carbon emissions in society can develop intelligent management sustainability. This can help manage the safety of the service management process in the environment.

In addition, it has also been found that zero-energy building management can help manage the business operations by which operational developments can be managed appropriately. The inclusion of ICT can help secure socio-economic development so that the future of smart cities can be managed appropriately. This helps manage the services that can involve the governance mechanism by which the sustainability of the intelligent building is increased for a long time. Innovative policies are developed, which helps maintain the opportunities for an intelligent management process. On the other hand, from the literature review, it has been found that green industrial planning is one of the crucial solutions that can help maintain China's low-carbon society. Top-down programs can also be included in China to enlighten the Industrial parks so that environmental sustainability is managed appropriately.

The theme has helped in finding the need for social sustainability programs to improve the future of industrial parks. It has been observed that education programs based on intelligent engineering processes can help generate awareness based on sustaining the future of the industrial parks. The involvement of the equity services is creating problems in limiting the waste from the factory with the sustainability programs. Moreover, it has also been found that the growth of low-carbon energy is needed for developing smart cities and reducing environmental degradation. China is investing massively in the Chinese community by which the low-carbon city can be developed in the country.

The incorporation of IT infrastructure helps maintain the business operations by which the operational development in the smart cities of China can be appropriately maintained. It has been seen that the inclusion of IM processes in cities of China can help

maintain the capabilities of intelligent management processes. The security concerns in the smart cities have helped maintain the operational developments by which the intelligent management processes can be managed appropriately.

5. Conclusion

It can be concluded that the involvement of the green initiatives for managing industrial wastes can help maintain good services. The involvement of an adequate water supply with the help of renewable energy sources can increase the quality of the place. Moreover, the full use of IT services can help decrease time and efficiently use money. Using solar energy to maintain electric supply can increase the country's sustainability. It has been found that using innovative technologies can help manage intelligent solutions for maintaining long-term sustainability in China. Using the interview process has helped find the result properly by which the operational development in China can be managed. The secondary data collection process has helped collect appropriate data so that the quality of the research can be managed. The changes in the organization with the inclusion of the intelligent building can help maintain the carbon footprints by which the digital platforms can be used to properly manage the country's services. The involvement of a low-waste lifestyle can help manage the energy-efficient opportunities so that the business management process can be maintained adequately. The intelligence capabilities of management can help maintain the top-down approaches so that the sustainability of the intelligent buildings can be appropriately managed in the country. Environmental pollution must be managed with green technology, so operational developments can be maintained securely.

Moreover, it has been observed that cleaning the country with proper biodiversity methods can help maintain its operational developments. This has helped in improvising the systems of the country. The involvement of congestion-free roads can help maintain the country's traffic regulations. This has helped in managing the services of the sustainability of the industrial parks. The development of low carbon enhances the intelligent cities by which the environmental degradation can be managed appropriately. The private-public partnerships help promote technological innovations so that the smart city infrastructure in the metropolitan areas. Therefore, the efficient delivery of the electricity and water supply can help in maintaining the wellness of the cities in China. The supply-demand of industrial waste can help in managing the social services so that the quality of the infrastructure can be managed properly.

Ethics Approval and Consent to Participate

The researchers followed the research ethics guidelines established by Universiti Sains Malaysia's Research Ethics Committee. All of the steps in this study that involved people were done in a way that met the ethical requirements of the institution's research committee.

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Conflict of Interests

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