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## Challenges and Opportunities in the Sustainable Development of Infrastructures in Intermediary Cities: The Case of Huancayo, Peru

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### Abstract

The sustainable development of infrastructure in intermediary cities represents a crucial challenge in Latin America, where it seeks to balance urban growth with environmental preservation and social cohesion. Huancayo, one of the most representative cities in Peru's Andean region, faces problems related to disorderly growth, lack of planning, and the need for efficient infrastructure. However, there are also opportunities linked to the implementation of renewable energies, efficient waste management, and the modernization of urban transport. This article addresses the main difficulties and opportunities in the process of sustainable infrastructure development in Huancayo, analyzing local efforts in sectors such as housing, urban mobility and sanitation. Based on a situational diagnosis, strategies that promote sustainable development are proposed, emphasizing the importance of citizen participation and long-term planning. The conclusions underline the need for a multisectoral and inclusive approach to transform these challenges into opportunities to improve the quality of life and preserve the city's natural environment.

**Keywords:** Sustainable infrastructure, Intermediary cities, Urban mobility, Waste management, Renewable energies

## **Introduction**

The development of sustainable infrastructure has gained relevance on the international agenda due to the need to mitigate the effects of climate change, promote social well-being and improve urban resilience (Serrano, 2017). Around the world, cities of various sizes face the challenge of balancing economic growth with environmental protection. Investment in clean technologies, the adoption of renewable energies and the efficient management of resources are some of the key factors to achieve more sustainable cities (Ferrari Lavalle, 2019). However, the achievement of these goals is hampered by insufficient funding and lack of coordination between different levels of government in many countries (Crespo Delgado & Luján Díaz, 2022).

At the regional level, Latin America is in an accelerated process of urbanization, which generates specific challenges related to infrastructure and sustainability. The unplanned growth of intermediary cities has led to problems of access to basic services, increased pollution, and inefficient waste management. Although some countries in the region have implemented urban and environmental policies, many cities still have limitations in the adoption of sustainable practices. Investments in green public transport and the circular economy represent opportunities to reverse this situation (Condori Quispe & Aguero Angulo, 2021).

At the national level, Peru faces the challenge of modernizing its urban infrastructures in a context of uneven economic growth and urban planning problems. Huancayo, as an intermediate city, reflects this problem by experiencing disorderly growth that compromises the quality of life of its inhabitants (Addis, 2022). The lack of coordination between local and regional governments, coupled with limited investment in sustainable infrastructure, exacerbates existing problems in sectors such as urban mobility and waste management. However, emerging initiatives in renewable energy and land use offer a pathway to more sustainable development in the future (Chuñir et al., 2019).

## **Challenges and Opportunities in Huancayo's Sustainable Infrastructure**

### **Disorderly Urban Growth and Poor Planning**

The rapid growth of Huancayo has generated a process of uncontrolled urban expansion, characterized by land invasions and the proliferation of informal settlements in peripheral areas. These areas lack essential services such as drinking water, sewage, and electricity, which increases social vulnerability and inequality (Sarria Molina, 1999). In addition, the unplanned occupation of the territory has resulted in the fragmentation of green spaces, the destruction of natural areas and the creation of dense and chaotic urban areas, which

deteriorates the quality of the urban environment. The lack of comprehensive urban planning also hinders the creation of efficient and sustainable infrastructures, generating conflicts in land use.

The implementation of modern and participatory land use plans can guide the growth of the city towards a more organized and sustainable model. It is essential to promote the creation of sustainable housing through regulated urbanization programs that respect ecological zoning. In addition, the construction of inclusive public spaces such as parks and recreational areas can promote healthy coexistence and improve social cohesion, contributing to urban sustainability.

### **Urban Mobility and Sustainable Transport**

Mobility in Huancayo faces significant challenges due to the high reliance on individual motorized transport, leading to traffic congestion, air pollution, and loss of productive time. The lack of an efficient mass public transportation system, coupled with poor infrastructure for pedestrians and cyclists, exacerbates the problem. In addition, the lack of well-integrated bike lanes discourages non-motorized mobility, further increasing the emission of polluting gases (Valencia, 2008).

Modernizing public transportation by incorporating electric or hybrid buses represents a viable option to reduce carbon emissions. Likewise, the creation of interconnected bike lanes and safe pedestrian zones would encourage the use of alternative means of transport, promoting sustainable mobility. These measures would not only improve air quality, but would also contribute to the physical and mental well-being of citizens, by facilitating more active mobility.

### **Solid Waste Management**

Inefficient solid waste management represents a major challenge for Huancayo, where waste generation has exceeded adequate collection and disposal capacity. The accumulation of waste in streets and rivers not only pollutes the environment, but also increases risks to public health. Uncontrolled landfill disposal practices increase soil and water pollution, exacerbating environmental problems (Addis, 2022).

The adoption of a circular economy approach could transform waste management in Huancayo. Investing in recycling and composting programs, along with environmental education campaigns, would help reduce the amount of waste sent to landfills. In addition, the implementation of incentives for the separation of waste at source and the creation of waste pickers' cooperatives would allow for more

efficient management, promoting social inclusion and improving environmental sustainability.

### **Use of Resources and Renewable Energies**

The excessive use of resources such as water and energy compromises the sustainable growth of Huancayo. The increase in water demand has generated water stress in some local sources, while the dependence of electricity supply on non-renewable sources increases greenhouse gas emissions. Without a clear strategy for saving and efficiency in the use of resources, the city risks depleting its natural resources and increasing its environmental footprint (Sarria Molina, 1999).

Investment in renewable energy, such as solar and wind, represents a key solution to reducing dependence on fossil fuels. The installation of solar panels in public and private buildings could contribute to the city's energy diversification. On the other hand, improving the efficiency of water use through recycling systems and promoting saving practices could significantly reduce the pressure on water sources. These initiatives would not only ensure a more responsible use of resources, but also strengthen Huancayo's resilience to the challenges of climate change.

### **Conclusions**

Sustainable infrastructure development in Huancayo requires a comprehensive approach that considers both existing challenges and emerging opportunities. Long-term urban planning, modernisation of public transport, efficient waste management and the transition to renewable energies are essential to ensure sustainability in the city. In addition, it is essential to promote the active participation of citizens in decision-making processes and to foster partnerships between government, the private sector and civil society. The opportunities identified provide a glimpse of a more prosperous future for Huancayo, where sustainable infrastructure not only improves the quality of life of the inhabitants, but also protects natural resources and ensures a more resilient urban environment in the face of environmental challenges.

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