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Reflections: Analysis of management and investments in educational infrastructure, towards multifunctional designs in prevention of health emergencies

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Abstract. Introduction: Given the level of management and investment in infrastructure In the absence of limited public resources, educational infrastructures can be adapted to respond to health emergencies; the Covid-19 pandemic revealed the ineffectiveness of these spaces, limiting the response to the crisis. **Objective:** To know the appreciation of public management and investment in educational infrastructures towards multifunctional designs for health emergencies. **Methodology:** The research with a qualitative approach, used semi-structured interviews with two specialists in each of the areas: education, health and investments. **Results:** The analysis revealed the urgency of having specialists in architecture, civil construction to adapt designs of existing educational infrastructures; or modify them on site to include key elements such as increasing the places of contact of electrical energy for various services such as ventilation and accesses. **Conclusions:** The adaptability of educational infrastructures for multiple uses is essential. Experts in structural designs will be able to optimize resources to respond to health emergencies.
Keywords: Management, public investments, infrastructure, multifunctional, health.

Reflexiones: Análisis de gestiones e inversiones en infraestructuras educativas, hacia diseños multifuncionales en prevención de emergencias sanitarias

Resumen. Introducción: Ante el nivel de gestiones e inversiones en infraestructuras pública limitadas, las infraestructuras educativas podrán ser adaptadas para responder a emergencias sanitarias; la pandemia del Covid-19 reveló la inoperancia de dichos espacios, limitando la respuesta ante la crisis. **Objetivo:** Conocer la apreciación sobre gestiones e inversiones públicas en infraestructuras educativas hacia diseños multifuncionales para emergencias sanitarias. **Metodología:** La investigación con enfoque cualitativo, empleó entrevistas semiestructuradas a dos especialistas en cada una de las áreas: educación, salud e inversiones. **Resultados:** El análisis reveló la urgencia de disponer de especialistas en arquitectura, construcción civil para adecuar diseños de infraestructuras educativas existentes; o modificarlos en obra para incluir elementos clave como incrementar los lugares de contacto de energía eléctrica para diversos servicios como ventilación y accesos **Conclusiones:** Es esencial la adaptabilidad de las infraestructuras educativas para usos múltiples. Expertos en diseños estructuras podrán optimizar recursos para responder ante emergencias sanitarias.
Palabras clave: Gestiones, inversiones públicas, infraestructura, multifuncional, sanitaria.

Reflexões: Análise das gestões e investimentos em infraestruturas educacionais voltadas para projetos multifuncionais de prevenção a emergências sanitárias
Resumo. Introdução: Dado o nível limitado de gestões e investimentos em infraestruturas públicas, as infraestruturas educacionais poderiam ser adaptadas para responder a emergências sanitárias; a pandemia da COVID-19 revelou a ineficácia desses espaços, limitando a resposta à crise. **Objetivo:** Conhecer a percepção sobre as gestões e investimentos públicos em infraestruturas educacionais voltadas para projetos multifuncionais para emergências sanitárias. **Metodologia:** A pesquisa, de abordagem qualitativa, utilizou entrevistas semiestruturadas com dois especialistas em cada uma das áreas: educação, saúde e investimentos. Resultados: A análise revelou a urgência de contar com especialistas em arquitetura e construção civil para adequar os projetos das infraestruturas educativas existentes; ou modificá-los em obra para incluir elementos chave, como o aumento dos pontos de contato de energia elétrica para diversos serviços, como ventilação e acessos. **Conclusões:** É essencial a adaptabilidade das infraestruturas educativas para usos múltiplos. Especialistas em design de estruturas podem otimizar recursos para responder a emergências sanitárias.
Palavras-chave: Gestões, investimentos públicos, infraestrutura, multifuncional, sanitária.

I. Introduction

Public infrastructures, particularly those dedicated to education, have traditionally been conceived with a sole focus on teaching and learning. However, the recent experience of global health crises has highlighted one of the major deficiencies in the design and planning of public infrastructures. of these infrastructures: their lack of adaptability to be used in health emergencies. In many contexts, especially in urban areas with high population density, educational infrastructures do not have the necessary characteristics to become health centres or spaces that respond effectively to crisis situations.

The lack of flexibility in the design of these infrastructures means that, in the face of an urgent need for a health response, the available resources are limited by the rigidity of existing spaces, which are not designed to house medical equipment, offer health care or guarantee adequate ventilation and accessibility conditions. This situation is aggravated in areas with high levels of social vulnerability, where health infrastructures are insufficient and, in many cases, are not prepared to deal with emergency situations.

Therefore, public infrastructure management must evolve to include a more comprehensive and multifunctional approach in its planning. This means that, at the design stage of educational infrastructure projects, their capacity for reconversion in times of health emergency must be considered. Aspects such as universal accessibility, adequate ventilation, ample spaces that allow efficient and safe circulation, and the possibility of installing medical equipment quickly and effectively, must be considered from the beginning. These elements, which would normally be associated with health infrastructure, must be part of the design of educational spaces to ensure that they can fulfill a dual function in times of crisis.

Various international studies and approaches have highlighted the importance of public infrastructure design, suggesting that buildings intended for education should be designed to be easily adaptable to health needs in the event of an emergency. Authors such as Pérez and Ramírez (2021) and Rodríguez and Gutiérrez (2021) advocate planning that not only responds to pedagogical needs, but also to public health needs. These integrative approaches allow not only to improve the response capacity to emergencies, but also to optimize public resources allocated to infrastructure, avoiding duplication of spaces or facilities.

That is to say, infrastructure planning must be thought of not only from a sectoral perspective, but with a broader vision that contemplates multiple uses and the capacity for rapid adaptation to exceptional circumstances. This also implies a reflection on how public policies can guarantee that the resources invested in the construction of educational spaces not only respond to education, but that, in the near future, they can serve society in times of health crisis. In this way, not only the quality of education would be ensured, but also the capacity of an infrastructure to protect the health of the population in extreme situations.

This article explores the importance of redesigning public education infrastructure, with a flexible approach that allows for its rapid adaptation to public health needs, without compromising educational quality. To do so, the article analyses the relationship between investment in educational infrastructure and its potential to be used in health emergencies, as well as the benefits of a multifunctional design that can optimize resources and maximize the resilience of public infrastructures in the face of future crises.

The COVID-19 pandemic exposed multiple deficiencies in public infrastructure, particularly in the health and education sectors. Throughout 2020 and 2021, many countries were forced to adapt their infrastructure to deal with the health emergency, revealing the inadequacy of health infrastructure and the lack of versatility in educational infrastructure. In many districts of Lima Norte, such as Independencia, large public resources have been invested in the construction of new educational infrastructure, but, at the same time, health institutions are insufficient, and in many cases are not prepared to deal with large-scale health crises. Although educational infrastructure represents a

significant investment, its adaptation to also function as a health center in the event of an emergency has not been considered.

This article addresses the need to rethink public buildings into educational infrastructure, proposing a flexible design that allows the conversion of these spaces to be used also in health services. This approach seeks to take advantage of the lessons that the pandemic left on the importance of resilience and adaptability of infrastructures, especially in emergency contexts. The proposal focuses on the urgency of incorporating into the designs of new infrastructure projects elements such as accessibility, ventilation, adequate lighting and spaces for the implementation of elevators and ramps, which are vital for their multifunctional use.

The theoretical framework of this research focuses on the review of studies that have addressed the importance of public infrastructure planning, especially in the context of health emergencies. In recent years, several authors have pointed out the need to redesign public service infrastructures to make them more resilient and versatile, so that they can adapt to different types of crises. Pérez and Ramírez (2021) highlight that the resilience of urban infrastructures is a key factor to guarantee their functionality during emergencies, such as health emergencies. These authors emphasize that infrastructure planning must incorporate elements of flexibility, allowing buildings, especially those intended for education, to be quickly adapted for other purposes in emergency situations. In addition, they add that infrastructure design must prioritize durability and ease of adaptation to new uses, such as health centers.

Rodríguez and Gutiérrez (2021) delve into the adaptation of public infrastructures for post-pandemic health, pointing out that the experience of the health crisis highlighted the inadequacy of health infrastructures in many urban areas. The authors suggest that, following the pandemic, public infrastructure projects should include a multi-purpose approach, in which facilities can serve both for education and for health care in the event of an emergency. This requires an architectural design that allows for rapid and efficient changes in the use of space.

López and Martínez (2021) address urban planning in emergency situations, suggesting that public infrastructures should be designed with the aim of adapting to public health needs effectively. Through their studies, they argue that infrastructure planning should integrate a broader vision, considering not only educational uses, but also their potential to be reconverted into hospitals or health centers. This perspective is essential to improve response capacity in emergency situations.

Sánchez and Castillo (2021) provide a critical view on the challenges of flexible design of public infrastructures. According to these authors, although educational infrastructure has teaching as its main objective, it must be designed in such a way that it can be converted into healthcare spaces, maintaining a balance between pedagogical and healthcare requirements. In their study, they propose that the adaptation of infrastructures must consider both architectural and legal aspects, ensuring that the transformations are rapid and without major legal complications.

Torres and Herrera (2021) examine the need for the integration of educational and health infrastructures, indicating that governments must be aware that an educational infrastructure can play a crucial role in the response to health emergencies. The research concludes that investment in public infrastructure must ensure that buildings are multifunctional and can adjust to public health demands without requiring major structural reforms.

García and Fernández (2021) argue that the lack of adequate infrastructure for health and education in areas of high social vulnerability is one of the greatest deficiencies detected during the pandemic. These authors propose that public infrastructure should be designed taking into account possible health crises, and that part of the resources invested in the construction of new schools should also be used to modernize and adapt existing infrastructure for use in emergencies.

Martínez and Bravo (2021) carry out a comparative analysis of the different approaches adopted by different countries to deal with the pandemic, and how these approaches relate to public infrastructure. They highlight that the countries that were able to adapt their educational and health infrastructures quickly and efficiently were those that had already planned for flexibility in the design of buildings, allowing for multiple and agile use of spaces.

Ramos and Sánchez (2021) reflect on the lessons learned regarding infrastructure planning during the pandemic, and suggest that future investments in public infrastructure should incorporate design elements that facilitate their reconversion, especially in densely populated urban areas. They consider that public infrastructures should be designed in such a way that they can take on new roles as needed. Guzmán and Alvarado (2021) conclude that infrastructure design should be holistic, considering possible health contingencies as part of the planning process. According to these authors, public buildings must have the necessary characteristics to be used flexibly, and their design should include aspects such as accessibility, adequate ventilation, and the ability to install medical equipment.

Bravo and Mendoza (2021) reinforce the idea that public infrastructures must be conceived with a long-term vision, where not only immediate educational needs are taken into account, but also possible health demands. They provide a strategic vision on how the design of educational infrastructures can contribute to mitigating public health crises.

II. Methodology

The research was carried out with a qualitative, comparative and propositional approach, aimed at analyzing the lessons learned during the COVID-19 pandemic in relation to public infrastructure and its ability to adapt to health emergencies. With this objective, semi-structured interviews were developed, which were conducted with six specialists in public management, with training in key areas such as education, health and public investments. The details of the process are described below, from the preparation of the interviews, necessary to understand the analysis of the results.

2.1 Sample. Selection of participants : The six specialists were selected by convenience based on a prior survey of the linked workers, on who could be the ideal professionals to provide a specific interview, taking into account their professional and academic experience in public management and infrastructure planning. The selection was based on their expertise in one or more key sectors, such as education, health and investments; in addition to their knowledge of public management in infrastructure projects, with special emphasis on adaptability to health emergencies.

2.2. Interview design : The interviews were structured using a semi-structured approach, allowing for flexibility in responses but guided by a set of key questions. These questions were developed by a team of experts in public management, with the purpose of identifying the structural weaknesses of public infrastructure during the health crisis and alternatives for its improvement. In addition, the questions were reviewed and approved by three specialists in management and investment in public infrastructure projects in Peru, to ensure that they were relevant, clear and pertinent to the research objectives.

2.3. Moderation of the interviews : The interviews were moderated by a public management expert with experience in coordinating this type of process. The moderator was responsible for guiding the conversation, ensuring that relevant topics were covered and allowing participants to share their opinions freely, but within the framework of the research objectives.

2.4. Interviews : The interviews were conducted in person, setting an approximate time of one hour for the interview with each specialist, respecting the conditions of other activities that had to be coordinated. It was then established that the interview could be segmented in coordination with the interviewee, ensuring that each segment was longer than 20 minutes. Each specialist was provided with a set of

questions beforehand, to facilitate preparation, but flexibility was maintained to explore new topics that arose during the dialogue.

III. Results

The results obtained from interviews with six specialists in the fields of education, health and law reveal several key points about public infrastructure, particularly in the education sector and its adaptation to health crisis situations. The findings are then consolidated and improved, highlighting the problems detected, the proposed alternatives, the benefits of multifunctional infrastructure and the contributions to the well-being of the population, through the following concordances:

Buildings and infrastructures initially designed for educational services can be efficiently adapted to provide health services, provided that the technical guidelines and regulations established by highly qualified professionals in architecture, civil engineering and construction, as well as experts in the management of infrastructure for the health sector, are followed. This adaptation process should not be an isolated effort, but should involve the multidisciplinary collaboration of experts from both sectors: education and health. Therefore, it is essential to establish expert committees made up of architects, civil engineers, builders and public managers specialized in educational and health infrastructure. This interdisciplinary team would be responsible for defining the technical guidelines and ensuring that the structural and usage modifications are carried out efficiently and in accordance with the needs of both sectors.

In the context of buildings that are already showing progress in their construction, it is assumed that, although it is not a completely new construction, it is urgent to proceed with key structural modifications and adjustments to optimize the infrastructure and make it suitable for the health sector. Among the recommended adjustments, the improvement of the finishes and endings stands out, which should include a greater number of electrical outlets, additional plugs, more robust ventilation systems and more complete and efficient lighting. These elements are crucial to ensure that the space is safe, functional and suitable for the installation of medical equipment, which requires a constant power supply and an environment with controlled ventilation. Lighting must be sufficient to ensure the comfort and safety of patients and healthcare personnel.

In addition to these changes, architectural designs need to be flexible and allow for rapid reconfiguration of spaces, ensuring that they can adapt to different needs depending on the type of health emergency. This approach to adaptable infrastructure not only responds to health crises, but can also be useful for other purposes, such as sheltering people during natural disasters or as distribution points for resources in emergency situations.

Coincidences in the problems detected

Experts agreed that the current educational infrastructure is rigid and not designed to adapt quickly to health emergencies. The lack of flexible spaces and limited integration with other public infrastructures, such as health, hinder a rapid and effective response. In addition, existing legal regulations present barriers that prevent the conversion of schools into health centres during crises, limiting their ability to adapt.

Alternatives and proposed solutions

The design of multifunctional infrastructures, capable of adapting to different needs depending on the emergency, was proposed. This would include modular spaces, allowing for rapid and effective reconfiguration, as well as the implementation of more flexible regulations that facilitate the conversion of educational buildings into health facilities without legal or bureaucratic complications. The

importance of collaboration between the health, education and urban planning sectors to develop joint strategies was also highlighted.

Benefits of multifunctional infrastructure

Multifunctional educational infrastructure allows for the optimisation of public resources, as it can be adapted to multiple purposes, such as healthcare, without the need for large investments in new infrastructure. It also facilitates a faster response to health emergencies, reducing the overload of the health system. It also helps reduce operational costs and improves the resilience of communities to disasters and crises.

Contributions and benefits for the well-being of the population

The ability to transform schools into health centres improves access to medical services, especially in rural or resource-limited areas. This can save lives and ensure better care. Furthermore, the flexibility of these infrastructures not only favours educational continuity in times of crisis, but also contributes to the safety of the population, reducing exposure to health risks. Finally, it fosters a sense of community and solidarity by offering common spaces for different uses in times of emergency.

In other words, the results indicate that it is essential to rethink educational infrastructure so that it is more flexible and capable of adapting quickly to crisis situations. Proposals for multifunctional design and improved regulations are essential to optimise public resources and improve the capacity to respond to emergencies, promoting the well-being and safety of the population.

IV. Discussion

The COVID-19 global pandemic has exposed the structural and operational deficiencies of health and education systems worldwide. In many countries, and especially in densely populated urban areas, educational infrastructure not only lacked adequate conditions to provide a safe learning environment, but was also not designed to adapt to health emergency situations. This vulnerability highlights an urgent need: to rethink public investments in educational infrastructure, giving it a more versatile approach that allows for a rapid reconversion of these spaces to be used as health centres in critical moments.

Public infrastructure management has shown that urban planning and infrastructure construction must consider not only the current needs of the educational sectors, but also their possible adaptation to health emergencies. Various studies point to the importance of public infrastructures being resilient and multifunctional, especially in crisis contexts such as the COVID-19 pandemic, where the response capacity of health systems was insufficient due to the lack of adequate facilities. In particular, educational infrastructure projects must incorporate accessibility features, adequate ventilation, ample spaces, electrical systems suitable for medical equipment and facilities for the installation of ramps and elevators into their designs, essential elements to ensure that these infrastructures can be used effectively in emergencies.

Public investment in infrastructure is one of the key areas that governments need to focus on, as these buildings must not only fulfil their original function of providing adequate space for learning, but also have the capacity to be adapted to new functions, such as healthcare. This proactive approach to infrastructure planning is indispensable to ensure that future generations not only have access to quality education, but that infrastructure can also respond effectively to future health emergencies.

Recent studies, such as those by Pérez and Ramírez (2021) and Rodríguez and Gutiérrez (2021), have emphasized the need to incorporate flexibility in the design of public infrastructures so that, in

extraordinary situations, they can be reconverted for other needs, such as healthcare. The idea of "multifunctional infrastructures" is a key concept that should guide investments in educational infrastructure and, even more so, in those places where health infrastructure is insufficient. Furthermore, as López and Martínez (2021) point out, the adaptability of educational spaces must be assessed in a comprehensive manner, taking into account the capacity to house medical equipment, cross ventilation, and the installation of energy systems that can sustain mass healthcare in a crisis.

Below are other related comments

This article examines the execution of public works projects in a Peruvian regional government through the results-based management approach, a highly relevant topic in public management. The analysis highlights how this approach can improve efficiency and effectiveness in the implementation of infrastructure projects, crucial for regional development. Garay (2022) emphasizes that results-based management not only evaluates the fulfillment of objectives, but also allows the social impact of the works executed to be measured. The importance of this article lies in its ability to offer solutions to the problems of execution and sustainability of public infrastructures in local contexts. This approach is a reference for the planning of projects that could be better adapted to health and education needs in emergencies, given the importance of efficient execution to respond to unforeseen events.

The study presented by Ramos (2022) offers an innovative model to evaluate work performance and human interactions in educational environments through a questionnaire administered by university managers. This approach is crucial for public management in universities, where interpersonal dynamics and performance are determinants for the success of institutional management. The article also emphasizes the need for evaluation instruments that allow a better understanding of labor relations and their impact on educational quality. This type of proposal is closely linked to the need to create educational infrastructures that promote healthy work environments, which can be an important step towards greater versatility in the design of infrastructures that facilitate their conversion into health centers in emergency situations.

Mendizábal (2022) explores the importance of psychomotor management and how this area impacted the fundamental rights of children during the pandemic. This article shows that, despite the restrictions imposed by the health crisis, the adaptation of educational and health spaces to the new needs of children must be a priority. In terms of public management, it is crucial that both educational and health infrastructures are designed to offer a comprehensive response to the demands of children in emergency situations. This perspective makes it possible to strengthen the design of infrastructures capable of responding more effectively to health emergencies, especially if flexibility in the use of space is incorporated.

Caján (2022) examines the working conditions and motivation of nurses in a hospital, addressing key aspects for the efficient management of human resources in the health sector. Working conditions in the healthcare sector have a direct impact on the quality of health services, so understanding how to improve worker motivation is essential to ensure rapid and effective responses during health emergencies. Public health management must consider these aspects to design not only adequate infrastructures, but also strategies that strengthen the motivation and commitment of healthcare personnel, especially in crisis situations.

Barreto (2022) analyses the effects of overwork on health personnel, a critical issue for public management in health crisis situations. The research highlights the importance of optimising human resources in the health sector, considering the well-being and working conditions of staff. This article provides valuable elements to rethink the way hospital infrastructures should be designed, ensuring that spaces not only respond to the needs of patients, but also to the well-being of staff. The resilience of health systems depends, to a large extent, on an infrastructure capable of maintaining adequate working conditions for those managing emergencies.

The article by Barrios and Rodríguez (2019) addresses urban planning and health emergency management, proposing a comprehensive approach to mitigate the impacts of crises. In a global context of increasing vulnerability to health emergencies, the authors highlight the need for resilient urbanization, where public infrastructure and services are adaptable to unforeseen situations. This approach is essential to ensure that cities can respond effectively to health crises, protecting both the population and critical infrastructure.

González and Vega (2019) present an analysis on urban resilience and infrastructure management in health emergency situations. The article highlights the importance of preparing cities for unexpected crises, focusing on the robustness of infrastructures and their adaptive capacity. Urban resilience, according to the authors, should not only involve recovery capacity, but also proactive planning that contemplates future challenges. This perspective is key to improving public management in times of crisis, guaranteeing basic services on an ongoing basis.

Martínez and Paredes (2018) reflect on the adaptation of educational infrastructures in times of crisis, focusing on lessons learned from the 2017 earthquake. The research highlights how educational infrastructures must be designed to be flexible and resilient to disasters, not only to ensure the continuity of teaching, but also to function as shelters in emergency situations. The authors highlight the importance of integrating these lessons into future planning to better deal with any natural or health crisis.

Pérez and Morales (2018) address the relationship between public infrastructure and its adaptation to climate change in the context of health emergencies. The article highlights the need to redesign infrastructure to be more resilient to the effects of climate change, especially in situations of public health crises. Through a detailed analysis, the authors show how well-planned infrastructure can minimize the impacts of emergencies and facilitate a more effective response, helping communities adapt to future changes and crises.

Espinoza (2022) explores how the organizational climate influences user satisfaction in a municipality, a relevant topic in public management. This article highlights that the quality of user care, especially in emergency situations, depends largely on a favorable organizational climate. User satisfaction in a hospital or educational center, for example, is directly linked to the working conditions and spaces in which these services are provided. The authors propose that public infrastructures should be designed with an approach that also considers organizational well-being, facilitating a rapid and efficient response to emergencies.

Seminar (2022) proposes a socio-critical model for the management of physical activities in university students. This model focuses on the development of physical skills within a social and educational context, highlighting the importance of a comprehensive education. From a public management perspective, this approach can be key to rethinking the design of educational spaces that facilitate physical activity and social interaction in crisis situations. The proposal also suggests that educational infrastructures should incorporate multifunctional spaces that promote both physical education and other social and health needs in times of emergency.

V. Conclusions

That is to say, the adaptability of educational infrastructures for use in the health sector is a viable and necessary strategy, but it requires the active collaboration of experts in both sectors, the design of modular structures and the incorporation of technical improvements in the finishes of the buildings. This integrative vision not only optimizes public resources, but also strengthens the capacity to respond to emergencies, improving the efficiency and effectiveness of educational and health services during critical situations.

Contributions : This study makes important contributions to the way public infrastructures should be planned and designed, suggesting that future investments in educational infrastructures should be

thought out not only for the exclusive use of the educational sector, but also to be quickly converted into health facilities in case of emergency. In addition, it suggests that the versatility of infrastructures should include not only the possibility of adapting spaces, but also the integration of technological and architectural systems that allow

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