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Navigating the Nexus of Global Design Practices and Local Construction Realities. An Exploration into the Collaborative Architectural Endeavors within the Framework of Belt and Road Initiative (BRI) / Carota, F., Montanaro, G. (LECTURE NOTES IN CIVIL ENGINEERING). - In: Advances in the Integration of Technology and the Built Environment. AAB 2024. / Han J., Lombardi D., Cece A.. - ELETTRONICO. - Singapore : Springer, 2025. - ISBN 978-981-96-4749-1. - pp. 264-271 [10.1007/978-981-96-4749-1_31]

Availability:
This version is available at: 11583/2992179 since: 2025-04-28T09:42:45Z

Publisher:
Springer

Published
DOI:10.1007/978-981-96-4749-1_31

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22 November 2026

Navigating the Nexus of Global Design Practices and Local Construction Realities. An Exploration into the Collaborative Architectural Endeavors Within the Framework of Belt and Road Initiative (BRI)

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Abstract. This paper explores the tension between global design practices and local construction challenges in transnational architectural projects, with a focus on Belt and Road Initiative (BRI) developments in selected countries. Over the past two decades, research on "nomadic expertise" and "global experts" has expanded contemporary architectural theory, emphasizing the growing separation of architectural design from its construction due to industrialization and globalization. In this context, managing the design and construction process throughout collaborative practices poses multifaceted challenges. Limited transferability of skills, especially in resource-limited environments, arises from the scale and complexity of contemporary construction projects and the non-site-specific nature of global supply chains. In addressing this complexity, the study employs in-depth case studies investigation of construction projects within the frame of the BRI. It investigates how the global circulation of technologies, expertise, and standards, alongside the evaluation of local conditions, influences design choices in collaborative practices between Chinese architectural and construction firms and their foreign counterparts. In this manner, the study challenges discussions on technological universalism, offering insights into how design firms can navigate the construction of the built environment with pragmatic design and construction practices in complex transnational projects.

Keywords: Transnational Architecture · Supply Chain · Building Standard · Technological Systems · Belt and Road Initiative

1 Introduction

The field of architectural design is currently undergoing a profound transformation in response to the dynamic changes in global landscapes and new transnational movements of practices shaping the built environments. In contemporary political and economic studies, a new concept of "globality" has been acknowledged, signifying competitive

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J. Han et al. (Eds.): AAB 2024, LNCE 593, pp. 264–271, 2025.
https://doi.org/10.1007/978-981-96-4749-1_31

interactions on a global scale among nations and entities [1]. Today's complex circumstances, transnational relations and the movements of diverse forms of architectural expertise have become considerably more intricate. All these global changes are being propelled at an unprecedented pace by the development of global infrastructure networks. Amid this dynamic shift, China's Belt and Road Initiative (BRI) stands as a paramount geoeconomic force catalyzing these transformations [2]. Launched in 2013, the BRI aims to promote trade, exchange, and economic development through the Silk Road Economic Belt and 21st Century Maritime Silk Road initiative. Nowadays, it includes more than 100 countries from China to Africa, Europe, and Oceania. However, the BRI did not appear spontaneously; the gigantic governmental program was based on China's international engagement over the previous 60 years [3]. China's foreign aid programs are implemented through a multitude of construction projects, technical cooperation, and human resources development. These endeavors are paradigmatic of the complexity of contemporary construction projects, marked by scale, complexity and challenges in terms of skills and technologies transmission, especially in environments with limited resources. An emerging body of literature on China's foreign aid project has mainly highlighted the diplomatic and political dimension of these projects, focusing on topics such as the symbolic expression of projects, the tension between local identities and modernist aesthetics, and the historical backgrounds driving their development [4, 5]. The collaborative efforts between design teams from different countries and cultural backgrounds, and the ways in which those teams negotiate design developments with local norms, standards, financial regimes, and technological systems, have been less explored.

This paper explores these complex interplays by adopting an in-depth investigation of three case studies of construction projects overtaken by Chinese firms along the Belt and Road Initiative. As part of a broader research investigating the architectural and urban dimension of the BRI, case studies have been selected from a survey of 50 projects undertaken by Chinese firms within the frame of the BRI from 2014 to the present for their relevance in terms of design and technological exchanges. Selected case studies have been then analyzed through documentary sources and in-depth interview with project managers involved in the construction process. In this manner, the paper aims firstly to reveal what are some of the collaborative practices and strategies undertaken by Chinese companies to deal with local and global construction contingencies. Second, the paper asks whether and how the global circulation of technologies, expertise and standards on the one hand and the assessment of available technologies, construction techniques, materials and manufacturing skills within a given context on the other, are able to influence design choices throughout the entire development process of collaborative practices between Chinese architectural and construction firms and their local counterparts in foreign countries. In this manner, this contribution provides an opportunity to challenge contemporary discussions about technological universalism and plurality of modernization processes, opening up possibilities for redirecting how design firms negotiate the construction of the built environment dealing with more sustainable technological and construction practices "in the making of" [6] complex transnational projects.

2 China's Transnational Architecture Endeavors and Local Construction Challenges

Even if not completely new, the scale and scope of transnational movements in the architectural practice has reached, nowadays, an unprecedented level due to an increasing widespread global logistic infrastructure. In this new form of a globalized world various forces contribute to building construction beyond national boundaries, including the circulation of investment capital, mobility of built-environment professionals, and diffusion of new design technologies and construction practices [7]. In this sense, the globalized production of architecture is no longer just based on "nomadic expertise" and "global experts" [8] but on a broader multidimensionality of the urban production [9]. The negotiated transformation of urban spaces is constructed through networks or assemblages of a multitude of agents, both human and nonhuman [10], which contribute to build up images of the urban with complex descriptions marked by strong substantive particularity [11]. The emergence of a global construction industry makes this network even more complex and poses the dilemma of finding design and constructive solutions that have the inherent ability to articulate local specificities within global processes. While digital technologies have drastically changed architectural workflows, the construction industry, rooted in material contingencies tied to specific contingencies, has been slower to adapt [12]. This issue is particularly pronounced in foreign aid projects, where local supply chains are often based on materials, technologies, construction techniques and workforce expertise often narrated as absent because they do not adhere to modernist and/or global standards derived from positivist design approaches linked to ontologically colonial ideals [13]. This is a reason why within an ever-evolving international market, large architectural and development firms, involved in global strategic projects, such as the ones along the BRI, mobilize entire construction companies with the aim of retaining a control over the quality, financing, timing and costs of the project. However, many times this is not sufficient nor feasible since mobilities must also comply with local building and cultural norms, specification standards, financial regimes, technological systems, and construction-management procedures that evidently require collaborative efforts. In this context the space exists to explore how multidisciplinary and transcultural collaborative teams manage these contingencies in specific locations, what technologies, strategies and practices are involved, whether and how these have an impact on the conception and development of the final architectural object. The following sections explore these aspects through the analysis of three case studies.

2.1 On-Site Collaborative Procurement Practices: The Vocational Training Centre Project in Uganda and the General Hospital of Niger

Designed by the Beijing CIIC Architectural Design Institute under the frame of the BRI, the Vocational Training Center project has been carried out in Uganda. The construction of the center began in May 2019 and has been recently concluded. The financial structure of the project involves a joint venture between the China EXIM Bank and the Minister of Finance from Uganda, underscoring the emphasis on bilateral collaboration from the project's inception, particularly regarding the sourcing of materials and labor to maximize mutual benefits.

In this regard, a strong organizational structure comprising a diverse network of stakeholders was established to deal with the availability of local sources on the one hand and the importation of materials from abroad on the other. The Chinese Design Institute, acting as the core of operations, engaged with requirements from the project owner, local supervisor, local consultant, and government agencies, negotiating each aspect of the future construction. More specifically, an on-site management team made of Chinese and Ugandan designers and project managers was established from the earliest phase of the project with the specific intent to act as the intermediary between the Chinese design institute team and on-the-ground realities.

The centralized procurement team facilitated cost reduction and efficiency enhancement through large volume orders via a dedicated online platform. For instance, all electrical equipment, compliant with Chinese standards, was imported from abroad. Additionally, the on-site procurement team served also to intensify the project development through the establishment of different kinds of collaboration with local suppliers and partners. In this manner the Chinese contractor ensured a major control on its supply chain, an indispensable factor to promote the technical quality and environmental sustainability. Indeed, owing to the local procurement team, CIIC Engineering department required that both general contractors and all their suppliers must achieve different qualification such as the ISO 9001 Quality Management Certification and the ISO14000 Environmental Management System Qualification.

Given the limitations imposed by the local context, the Beijing CIIC Architectural Design Institute opted for a simple and modern design. The building was composed by 32 single-floor prefabricated boxes made of steel structures complying with most advanced Chinese standards and regulations. However, the Ugandan technical task group urged for including in the design local railing systems that comply with national regulations and local windows frames which suits the local arid climate. The final result has been the conception of a neutral tectonic in which the rhythm of prefabricated modules and tight façade windows became means of architectural expression.

A similar approach characterized another Chinese aid project under the BRI in Africa: the General Hospital of Niger. Located 13 km north of Niamey, the hospital was designed by CADI Architects in partnership with CITIC General Institute of Architectural Design and Research Co. Ltd., and was completed between 2014 and 2016. Here though, the on-site procurement team, following a thorough evaluation of the scarcity of state-of-the-art construction technologies and advanced finishing materials complying with Chinese standards, together with the intricacies of safeguarding the project amidst security challenges given by the economic and political instability of the country at that time, foresaw the utilization of locally sourced materials such as river sand and white cement directly workable on site by the local workforce. This pragmatic solution not only addressed technical constraints but also became the defining architectural feature, resulting in earthy ochre-coated facades blending seamlessly with the arid desertic landscape.

These direct connections between the managerial teams overseeing various suppliers, local design institutes serving as design consultants, and the Chinese design team operating with these contingencies, truly transform the figure of the architect into an organizer of resources on-site. Moreover, despite the asymmetric nature of the relations between the African technical task groups and their Chinese counterparts, within these

procurement teams power found itself negotiated, knowledge traversed boundless borders, and different forms of collaboration were established in a "third space" that open up technological possibilities far from the western rhetoric of vernacularity and critical locality.

2.2 Digital Technologies and Information Sharing: The National Library of El Salvador Using 3DEXPERIENCE Platform

In response to the inherent complexities of construction and resource management in the global architecture industry, the integration of advanced digital technologies has emerged as a crucial strategy for enhancing efficiency and effectiveness in architectural projects [14]. A notable example of this shift towards digital transformation in architectural practice within the realm of transnational collaborations is the project of National Library of El Salvador. As the first Chinese foreign aid endeavor to employ digital twin technology, the design process of the library aimed to improve control and communication among diverse teams and stakeholders operating across different countries. The Central South Architectural Design Institute (CSADI), in partnership with the general contractor Yanjian Group Co., Ltd., utilized the renowned French Dassault "3DEXPERIENCE" platform. This software facilitated seamless integration of design and construction information, ensuring efficiency throughout the project lifecycle, from initial design conception to on-site construction. The whole design has been conceived starting from a comprehensive library of products, translated into design elements. Through an iterative process, the software allows the design team to control the supply of local and imported materials, assessing costs and benefits of each single solution in advance. This approach allowed for the development of the building's tectonics based on available architectural materials, primarily steel structures and wooden finishes, utilizing prototypes produced and digitally delivered by local manufacturers.

Furthermore, the software also provided the Chinese architectural team with greater flexibility during the design development phase, particularly concerning the technological envelope of the building. This latter indeed was identified as the main characterizing element of the building and would have been designed to symbolically remind the complex sinuosity of local mountains. Instead of using only prefabricated or pre-assembled large-volume elements, the software allowed a customization of some building components through a parameterized design with installation data provided by different suppliers. During the construction phase, the software was able to produce installation instructions and enabled on-site three-dimensional delivery with a laser pointer, without the adoption of traditional drawings. This approach enabled the realization of the complex double-curved facade without specialized labor, leveraging local workforce, thus reducing costs fostering collaboration between China and the recipient country (Fig. 1).

In other words, the entire construction process relied on a single data model, driving high-precision manufacturing and assembly of architectural elements. Architectural models in this sense, to recall Frampton's studies, are not related to a textile interpretation of tectonics but in general to the process of digitizing the material components from the early starts of project conception. The fact that these components, like in the manufacturing industries, are mainly prefabricated, is less relevant than it seems, in this

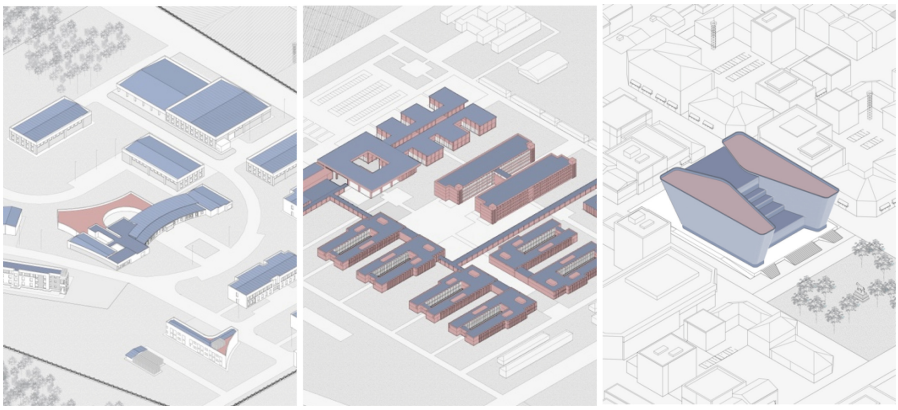


Fig. 1. Axonometric view of Vocational Training Center. (credit: Giulia Montanaro) Fig. 2–3. Axonometric view of the General Hospital of Niger and the National Library of El Salvador. Drawing information source: (M. Bonino, F. Carota, and S. A. Marri 2024. Credit: Sofia Leoni). Drawing adapted by the author Giulia Montanaro)

context. It is more about the introduction of digital objects that aim to reduce the distance between global design practices and local construction realities.

3 Architecture as a Logistical Stance

Previous cases studies of architectural projects within the BRI reveal the intricate network of those "hidden agents", to use the words of Tom Avarmate [15] – such as managers, IT developers, contractors and local architects – that are part of the process not only of construction but also design conception and development of complex transnational endeavors. While similar forms of cooperation and work organization can be surely expanded to many other design contexts, in the cases of the BRI, the institution of both material and digital collaborative platforms finds a renewed emphasis given some of the features that generally characterized this governmental program.

Firstly, the BRI has been rhetorically framed as a political and economic strategy rooted in collaboration and cooperation between countries. Consequently, the sharing of information, design strategies, technological advancements and materials means becomes a fundamental strategy of political legitimization. Secondly, the financial framework of BRI projects often necessitates mutually beneficial investments and returns from all parties involved. Finally, most of the BRI projects take place in several territories where different paths of modernization have led to technological solutions and markets mostly unknown by those design firm operating on a global scale.

In this context, previous case studies show how the collaboration among design teams results in intense, transdisciplinary cross-cultural collaboration and negotiation, addressing every aspect of a project's complexity, including its material realization. Within these exchanges, management practices, primarily concerned with establishing supply chains, transcend mere practical activities to become real sources of meaning. While transnational projects entail increased information management and complexity,

they also demonstrate the potential for merging management practices with design issues and local construction constraints, fostering spaces for creative expression. In this manner, local attitudes toward architecture, such as in the case of Uganda and Niger, are not part of a critical understanding of the context, nor the result of a regional approach to architecture, while they are the fruit of pragmatic instances that try to merge the needs of construction with the complexity of designing in unknown territories. Differently from those Chinese architects who struggle to position their architectural practice in relation to globalization and localization and aim to make an interpretation of "locality" in a contemporary manner [16], the BRI reveals another aspect of local adaptation in which pragmatic instances drive to conceive architectural projects based on the possibility to establish both global and local supply chains. Architecture becomes in this context a logistical stance in which, according to the notion of new materialism [17], the human agency is de-privileged and the conception and focus of design activities relies instead upon how assemblages of animate and inanimate agents work together to shape the built environment.

4 Concluding Remarks

This analysis of selected projects within the frame of the BRI revealed the complex organization of human and non-human agents involved in collaborative design practices, highlighting their pivotal role in driving design innovations and technological advancements in transnational construction endeavors. Unlike approaches focusing solely on the political or symbolic dimensions of transnational architectural exchanges, this essay highlighted that design choices, in a given context, may vary based on the availability of local material sources, technological developments and management tools adopted by collaborative design groups seeking to a gain better control on the quality, costs and timing of a project. This suggests that it is important to put more emphasis on the strategies and behaviors of these organizations, how they interact within a certain transnational framework, and how they negotiate the construction of the built environment within local and global contingencies. More research is needed, however, to understand this complex phenomenon more in depth. Indeed, a huge number of design and construction projects have been completed, and are under development, within the framework of the BRI, and this paper has explored only a few of them in specific places, so it would be desirable to explore the phenomenon on a much broader scale. Further investigations could also lead to practice-relevant findings to deal with the design of complex transnational endeavors in the future. In this regard, a need exists to build a more pragmatic understanding of the theme of technology transmission in global design industry and the concept of architecture as a logistical stance, as well as to determine specifically how they can be adopted to inform practitioners in the field—including not only architects, but also real estate developers, urban planners, contractors, decision makers and all the multitude of agents that nowadays have a prominent role in shaping the nuanced forms of our built environment.

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