
NEW FORM ARCHITECTURE WITHIN MODERN HERITAGE: MODERNIZATION FACTORS IN TRANSPORTATION, INDUSTRY, AND CONSTRUCTION MATERIALS

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ABSTRACT

Modern heritage is understood as a legacy of the past that embodies ways of thinking adapted to contemporary demands. It represents a new type of architecture that emerged between the nineteenth and twentieth centuries, encompassing architecture, urban planning, and landscape design, and is characterized by new modes of thought in which past and future converge, enabling collaboration between designers and conservators. Modern architecture constitutes a new symbolic form that directly expresses contemporary reality rather than continuously reproducing historical references. The characteristics and paradigms developed during the modern period have become an important part of global architectural development, contributing new knowledge and perspectives that give rise to what is referred to as new form architecture. This study aims to provide a new theoretical contribution to the concept of new form architecture within modern heritage, using a qualitative approach with descriptive content analysis. The findings show that modern heritage produces new form architecture derived from nineteenth-century modernism, introducing new building typologies as a result of the Industrial Revolution, which generated new technologies to support nineteenth-century societal activities. The emergence of these typologies is closely related to industrial developments in transportation, industry, and construction materials.

KEYWORDS: building typology, construction materials, industrial revolution, modern heritage, new form architecture

Modern heritage dipahami sebagai warisan masa lalu yang merepresentasikan cara berpikir yang teradaptasi dengan kebutuhan zaman kontemporer. Modern heritage merepresentasikan tipe arsitektur baru yang muncul pada abad kesembilan belas hingga kedua puluh, yang mencakup arsitektur, perencanaan kota, dan desain lanskap, serta dicirikan oleh moda pemikiran baru di mana masa lalu dan masa depan bertemu, sehingga memungkinkan kolaborasi antara perancang dan konservator. Arsitektur modern merupakan bentuk simbolik baru yang secara langsung mengekspresikan realitas kontemporer, bukan sekadar mereproduksi referensi historis secara terus-menerus. Karakteristik dan paradigma yang berkembang pada periode modern telah menjadi bagian penting dari perkembangan arsitektur global, dengan menyumbangkan pengetahuan dan perspektif baru yang melahirkan apa yang disebut sebagai new form architecture. Penelitian ini bertujuan memberikan kontribusi teoretis baru terhadap konsep new form architecture dalam modern heritage, dengan menggunakan pendekatan kualitatif melalui metode analisis konten deskriptif. Hasil penelitian menunjukkan bahwa modern heritage menghasilkan new form architecture yang berakar dari modernisme abad kesembilan belas, serta memperkenalkan tipologi bangunan baru sebagai dampak dari Revolusi Industri, yang melahirkan teknologi-teknologi baru untuk mendukung aktivitas masyarakat pada abad kesembilan belas. Kemunculan tipologi-tipologi tersebut berkaitan erat dengan perkembangan industri di bidang transportasi, industri, dan material konstruksi.

KATA KUNCI: tipologi bangunan, material konstruksi, revolusi industri, modern heritage, new form architecture

INTRODUCTION

Modern heritage is a term formed from two interrelated concepts, namely modern and heritage, each of which carries distinct meanings. Etymologically, modern refers to attitudes or ways of thinking that align with contemporary demands, characterized by novelty and up to dateness, often accompanied by the abandonment of earlier values

(Indonesian Dictionary KBBI, n.d.; Oxford Dictionary, n.d.). Meanwhile, heritage refers to the cultural characteristics of a society, such as traditions, language, or buildings, created in the past, which retain historical significance and are inherited or potentially inheritable by future generations (Cambridge Dictionary, n.d.; Oxford Dictionary, n.d.).

The convergence of these two concepts leads to the understanding that modern heritage is a form of

legacy from the past that simultaneously embodies a way of thinking oriented toward continual adaptation to contemporary demands.

Modern architecture is understood as a new architectural movement that emerged between the nineteenth and twentieth centuries and made a distinct contribution to the field of architectural art (Richards, 1953). Its emergence in the late nineteenth to early twentieth century cannot be separated from its position as a reaction against architectural disorder and eclecticism derived from previous historical styles (Curtis, 1996), as well as a response to public fatigue and the desire for the evolution of architectural styles (Fachrudin & Pane, 2022). This tendency is reflected in how modern architecture transformed both style and meaning, freeing buildings from attachment to historical references (Fachrudin & Pane, 2022). However, the current condition of modern architectural heritage is concerning. As of June 2020, only 13 out of 730 buildings and sites included in the World Heritage List represent modern heritage. This condition underscores the importance of the concept of modern heritage.

Modern heritage is defined as the architecture, urban planning, and landscape design of the nineteenth and twentieth centuries (Oers & Haraguchi, 2003). Its significance in architecture is marked by extraordinary forms, as described by Hans Poelzig in 1906, who emphasized its authenticity as an independent style (Oers & Haraguchi, 2003; Conrads, 1971), as well as through unconventional forms and colors that give rise to new architectural expressions (Cunningham, 2013). The development of modern heritage places greater emphasis on architectural value embedded within cultural processes rather than solely adopting a monumental approach (Oers & Haraguchi, 2003). Thus, modern heritage plays a key role in this development by providing meaningful structures (Torrent, 2018) and serving as a major driver of urban transformation that reshaped social conditions during the nineteenth and twentieth centuries (Torrent, 2018).

Due to globalization, the values and conservation criteria of modern architectural heritage are increasingly overlooked, as considerations of time, aesthetics, and the limited historical documentation of the modern period are often subordinated to other priorities (Gültekin, 2017). Gültekin emphasizes that modern architecture should be understood from a contemporary perspective, whereby every work of architectural art produced yesterday, in this context during the modern era, should still be transmitted to the future along with its embedded cultural heritage values. This concern is not unfounded. In 2000, a group of modern architectural conservation experts discussed the awareness and the anxiety that these values are being destroyed, responding to growing

concerns over modern heritage buildings, often located in high value urban areas, being demolished and replaced for investment driven purposes under globalization (Gültekin, 2017).

In addition to these factors, gentrification and migration have also led to the abandonment of many modern and industrial heritage buildings due to a lack of public appreciation and awareness of these sites (Modern Heritage, n.d.). The Getty Conservation Institute in Los Angeles summarizes several reasons why modern architecture has not been widely preserved or valued to date (Modern Matters, n.d.), including lack of recognition and protection, the absence of consistent analytical approaches, debates between restoration and replacement, and obsolescence in terms of functionality, adaptability, and sustainability. The relatively short time available for evaluating the Modern Movement in historical terms has also influenced conservation approaches.

Patterns of destruction and forced adaptation of modern heritage can be found across the world. In London, for example, the bankrupt and fire damaged Crystal Palace was eventually transformed into a stadium complex, representing an early form of recognition of modern architectural value, albeit through total functional transformation. A similar pattern occurred in India, where a ninety year old soap factory owned by Godrej Properties in Vikhroli, Mumbai, was adapted into a high end restaurant and office space, while a one hundred fifteen year old building in Fort Precinct, Mumbai, was converted into a retail space for the fashion brand Zara. In Indonesia, similar phenomena can be observed in the Rasamadu Gembongan sugar factory, now transformed into the Heritage Palace tourist destination, the Colomadu sugar factory now the De Colomadu museum, and the Banjaratma sugar factory in Brebes now the Banjaratma KM 260B Heritage Rest Area.

The difficulty in associating modern heritage with conventional cultural heritage lies in their differing characteristics. Traditional cultural heritage is generally characterized by strong historical expression, ornamentation, local building materials, and a high degree of eclectic cultural expression. In contrast, modern heritage serves as an icon of a specific era shaped by rapid technological development and unprecedented social and economic transformation. This new character is reflected in how modern heritage architecture incorporates contemporary industrial technologies and materials such as glass, concrete, and steel. These differences underpin UNESCO's definition, as presented in Identification and Documentation of Modern Heritage (Oers & Haraguchi, 2003), which describes modern heritage as the architecture, urban planning, and landscape design of the nineteenth and twentieth centuries.

The emergence of modern architecture stemmed from societal dissatisfaction with the problems inherited from the past and from classical architecture, an unease that ultimately brought significant changes to social life. These changes were widely accepted as society sought a better way of life, prompting technological demands that accelerated industrialization to fulfill modern needs. Technology fundamentally transformed architectural thinking, marked by a shift toward principles of space, construction, and materials that prioritized function, efficiency, and effectiveness. From this shift, modern architecture produced a new form architecture, emerging through the modernization of transportation, industrial processes, and construction material expression.

Previous studies have extensively examined modern heritage, both in terms of its general definition and architectural characteristics (Fachrudin & Pane, 2022; Curtis, 1996), as well as descriptive documentation of heritage sites (Oers & Haraguchi, 2003). However, these studies have not systematically explored how specific modernization factors such as transportation, industry, and construction material systems shape new architectural forms within modern heritage, nor have they sufficiently compared these phenomena across countries. This gap is addressed in the present study by identifying new form architecture as an architectural category emerging from these three modernization factors.

In this study, new form architecture is understood as an architectural expression that directly reflects the technological, structural, or material advancements of its time, rather than imitating previous historical styles. Based on this gap, the study aims to address two main questions: what modernization factors drive the emergence of new form architecture in modern heritage buildings, and how these factors manifest in the architectural characteristics of such buildings across different countries. To answer these questions, the study focuses on modern heritage buildings representing the three modernization factors mentioned above, with case studies distributed across several countries: railway stations in Mozambique, Turkey, Zambia, Tanzania, and Indonesia; industrial buildings in Turkey and Indonesia; and buildings expressing construction material innovation in Turkey, Poland, and Indonesia. This research seeks to contribute a new theoretical understanding of modern heritage, particularly regarding new form architecture in modern architecture. This contribution is expected to enrich the discourse on modern architecture within the broader field of architectural studies and to support the documentation and conservation of modern cultural heritage as part of urban heritage preservation efforts.

Definition and Driving Factors of Modern Heritage

UNESCO defines modern heritage as the architecture, urban planning, and landscape design of the nineteenth and twentieth centuries. This definition is aligned with the objective of modern architecture itself, namely to rediscover the true essence of architecture by exploring forms that genuinely respond to functional needs rather than merely pursuing beauty and conventional forms (Curtis, 1996), while ensuring that buildings remain closely related to the needs they accommodate (Richards, 1953). The emphasis on new construction methods and strict functional discipline (Curtis, 1996) ultimately formed a new cultural configuration aligned with modern ways of life, in which the dominance of aristocratic culture declined alongside the rise of middle class influence (Frampton, 2020). This new mode of thinking positioned modern architecture both as a rejection of the past and as a concept of the future, as well as a developmental point in architecture emerging from earlier cultural traditions (Fachrudin & Pane, 2022).

The strongest driving factors behind the emergence of modern heritage include technological development, the rise of machinery and the industrial revolution, issues within classical architecture, and socio political conditions (Ikaputra, 2020). These factors were influenced by the emergence of new ways of living, namely individualization, democracy, and industrialization (Oers & Haraguchi, 2003), which in turn encouraged the resolution of social problems through rational, functional, economic, and aesthetic thinking (Ikaputra, 2020). In other words, unconventional architectural forms are understood as products of the intellectual conditions of their time, employing rational functional analysis, avoiding excessive ornamentation, and utilizing new technologies to create innovations that respond to societal needs (Cunningham, 2005; Maxwell, 1998).

One of the most significant factors shaping human history in the twentieth century was the development of natural sciences and technology (Frampton, 2020; Cunningham, 2013). The industrial revolution marked a major shift in human history through technological advancement, which also influenced social and economic structures of the period (Henriques et al., 2020). The impact of these technological changes is evident both in general human thought and in architectural thinking in particular (Almajidi & Krikor, 2020). New concepts of architecture that fulfill secular needs became inevitable products of this transformation (Cunningham, 2013), in line with technological change that generated new infrastructure and increased production capacity (Frampton, 2020). The expansion of industrial production became a direct consequence of machine development during the industrial

revolution, and industrialization ultimately became one of the most influential environmental forces shaping modernity worldwide (Oers & Haraguchi, 2003).

The problems of classical architecture during this period led modern architecture to emerge as a revival of architecture as a living art (Richards, 1953). This revival required architectural consideration to shift toward cultural processes rather than approaches aimed solely at monumentality (Oers & Haraguchi, 2003), thereby enabling modern architecture to eliminate outdated practices in architectural production (Richards, 1953). One of the triggers of this shift was the weakening of Renaissance culture, which left a conceptual vacuum that led to numerous adaptations and recombinations of historical forms that were considered inauthentic (Curtis, 1996). Such architectural developments were perceived by society as absurd, irrational, and inappropriate, for example houses resembling miniature castles or buildings imitating Renaissance episcopal palaces, due to their inefficiency (Richards, 1953). Modern architecture emerged to make buildings more responsive to basic human needs while also serving as a social critique of classical architecture, which was considered unhealthy (Loos, 1908) and potentially contributing to urban deterioration (Curtis, 1982).

The problems of classical architecture positioned modern architecture as a unifying agent for societies seeking to break away from eclecticism (Curtis, 1996). Modern architecture introduced construction styles that no longer relied on historical references or eclectic composition (Fachrudin & Pane, 2022), thereby offering new symbolic forms that directly expressed contemporary realities rather than perpetuating historical narratives without meaning (Curtis, 1996). Therefore, functional emphasis became essential, as functionalism aimed to liberate architecture from traditional forms and enable it to respond to functional imperatives and social realities (Cunningham, 2013). This development occurred because society adopted rational and functional thinking (Ikaputra, 2020), where rationality was reflected in continuously evolving intellectual processes aligned with contemporary conditions (Cunningham, 2005 cited in Ikaputra, 2020), leading to rational analysis of architectural function by society (Maxwell, 1998 cited in Ikaputra, 2020). These issues surrounding historical architecture and functional culture ultimately gave rise to new cultural and lifestyle paradigms (Ikaputra, 2020).

Another major factor shaping twentieth century human history was ideology, including dictatorship, nationalism, racism, and religious intolerance (Oers & Haraguchi, 2003), as well as the implementation of the Ethical Policy or *Ethische Politiek* (Yapp, 2020). In this context, modern architecture conveyed new meanings

both aesthetically and progressively, aiming to transform social conditions (Torrent, 2018) and propose alternative ways of living by challenging the dominant status quo of the period (Curtis, 1996). However, modern architecture also produced vulgar followers or imitators who merely pursued economic profit without truly adhering to the values of the modern architectural movement (Richards, 1953). The distinction between authentic and inauthentic modern architecture is clear: authentic modern architecture represents the revival of architecture as an art form that is visually refined, contextually responsive, and artistically valuable, while inauthentic modern architecture consists of superficial tricks that are ostentatious, trivial, and vulgar (Richards, 1953).

Principles of Modern Architecture from Key Figures

Le Corbusier is one of the most prominent figures in demonstrating the shift in architectural values through his five principles, namely pilotis, roof gardens, free façade, free plan, and horizontal window (Corbusier, 2013). Pilotis refers to a construction method that elevates buildings using reinforced concrete structural frames supported by columns and slabs (Corbusier, 2013). Roof gardens represent an attempt to bring nature into architecture, inspired by steamships whose upper structures are elevated above sea level, providing clear views of the surroundings, as applied by Le Corbusier in opening his building roofs toward the landscape while creating an arcadian atmosphere (Corbusier, 2013). Free façade is a consequence of the reinforced concrete frame system, where walls lose their structural role and façades become more flexible. Similarly, free plan allows interior layouts to be designed independently of structural constraints (Corbusier, 2013). Horizontal window or ribbon window is a result of this liberated façade condition and is interpreted by Le Corbusier as an important element in freeing humanity from the negative historicism that had persisted since the Crusades (Corbusier, 2013).

Frank Lloyd Wright also played an important role in the development of modern architecture through characteristics such as open plan, dynamic space, fragmented volumes, natural materials, and integral structure, which form the basic way of thinking in modern architecture (Levine, 1998). The open plan blurs the boundaries between interior and exterior, creating spatial continuity (Payne, 2019), while dynamic form is achieved through innovative structures and materials such as steel and concrete in cantilever construction, radiant heating technology, acceptance of the automobile, and explicit responses to natural settings (Payne, 2019). These elements create rich spatial experiences through contrasts such as compression and openness, light and shadow, rough and smooth surfaces, protection and prospect,

as well as carefully organized circulation paths that deepen the understanding of place (Payne, 2019).

This character emerged as a response to prevailing architectural styles in the United States, which were still based on European historical models. Wright's approach utilized new materials and technologies while also drawing inspiration from nature and other cultural traditions, particularly Japanese design principles (Payne, 2019). The general features of this architecture include geometric abstraction and spatial manipulation to address functional and emotional needs, relationships with natural forms and principles, and the emphasis Wright placed on individual excellence as a fundamental aspect of American society, including new ways of living in the twentieth century (Payne, 2019).

In summary, Wright's modern architecture can be understood as an effort to create architecture that responds to functional and emotional needs through geometric abstraction and spatial manipulation (Payne, 2019). Its three main principles are interconnected: spatial continuity expressed through open plans and blurred transitions between interior and exterior spaces; dynamic form achieved through innovative structural methods and inventive use of materials and technologies; and rich experiential qualities created through contrasts and carefully designed circulation paths (Payne, 2019). At a deeper level, his design is inspired by natural forms and principles, expressed through the integration of design and nature, unity of composition through the integration of parts into a whole, and the intrinsic qualities of materials (Payne, 2019).

Mies van der Rohe introduced a spatial design approach in modern architecture that can be categorized into four evolutionary stages: enclosed space, continuous space, free plan, and universal space (Stach, 2018). Enclosed space refers to conventional spatial arrangements of separated individual rooms with a clear distinction between inside and outside (Stach, 2018). This evolved into continuous space, where interior and exterior spaces become fluid and indistinguishable (Stach, 2018). The free plan stage refers to spatial organization defined only by freely standing walls enabled by separating structural columns from spatial defining elements (Stach, 2018). The final stage, universal space, initially referred only to spatial usability rather than spatial quality (Stach, 2018), and was used by Mies to describe large open spaces enclosed only by glass façades (Stach, 2018).

Beyond spatial evolution, Mies also introduced principles of construction and material expression, including the pursuit of structural clarity, reduction to essential formal elements, construction logic derived from materials, and continuity between interior and exterior spaces (Stach, 2018). The geometric and

ornament free character of his buildings is strongly determined by these principles, resulting in designs that rely on careful material selection, balanced proportions, and precise detailing (Stach, 2018).

Industrialization and Construction Standardization

In the development of modern architecture, the industrial era produced five important milestones in architectural history. Early prefabricators before 1851 emerged from the first large scale use of cast iron and glass, introducing the idea of modular components that could be industrially replicated. Architectural engagement between 1851 and the 1880s marked the period when architects began directly engaging with industrial construction methods, leading to discussions on aesthetics and architectural expression of prefabricated elements. Sub assemblies from the 1890s to 1900s involved the development of building components into larger and more complex units such as panel walls and combined structural elements. Modularization from the 1900s to 1930s introduced systematic approaches with standardized dimensions and planning grids. The final stage, open systems from the 1930s onward, was characterized by flexible building systems that allowed compatibility between components from different manufacturers for the first time (Ågren et al., 2013).

The concept of buildings as sub assemblies refers to the use of cement, steel, and glass in building systems, enabling faster and more efficient construction compared to conventional methods, while also opening opportunities for new architectural explorations that were previously impossible using traditional techniques (Ågren et al., 2013).

Review of Cross National Modern Heritage Case Studies

In addition to the theoretical discussion above, several empirical studies have documented modern heritage case studies relevant to the three modernization factors. In the transportation aspect, Chaves et al. (2022) examined the conservation of Beira Railway Station in Mozambique as twentieth century heritage in Africa, while Kırış (2013) analyzed Sirkeci and Haydarpasa Stations in Istanbul as reflections of Westernization during the late Ottoman period. Song (2022) studied the TAZARA railway line in Zambia and Tanzania from a semiotic and geopolitical perspective related to Chinese development aid in Africa. In the industrial aspect, Yoney et al. (2016) documented the Sümerbank textile factory in Kayseri as Turkish industrial heritage, while Salura et al. (2020) examined colonial sugar factories in Indonesia, including Aula Barat of the Bandung Institute of Technology, as a combination of modern construction technology and local wisdom. In the construction material aspect, Gültekin (2017) discussed the conservation of modern

architecture in Ankara, including exhibition buildings that express reinforced concrete structures directly.

In Indonesia, modern heritage is often found in Dutch colonial era buildings that adapt European modern architectural principles to tropical climate and culture, as reflected in Jakarta Kota Station designed in Art Deco style while still considering ventilation and natural lighting typical of tropical architecture (Heritage KAI, n.d.). Such adaptive patterns that combine modern technology and style with local conditions distinguish the manifestation of new form architecture in Indonesia from other contexts discussed in this study.

From the entire theoretical review, several architectural indicators of new form architecture can be summarized, including the application of new structural systems and materials in an open manner such as free façades and exposed concrete, steel, or glass construction; spatial flexibility and openness such as free plans, continuous space, and open systems; and an orientation toward function and efficiency rather than historical ornamentation. These indicators are used as analytical tools for reading architectural characteristics in the case studies of this research.

The theoretical review above shows that modern architecture emerged from a shift in ways of thinking about space, construction, and materials driven by three main factors, namely transportation modernization, industrial modernization, and advancements in construction material technology. These three factors form the analytical framework of this study in identifying new form architecture within modern heritage.

METHODS

This study employs a qualitative approach using descriptive content analysis as the main method for examining architectural characteristics in the case studies. As explained by Schreier (2012), qualitative content analysis involves classifying textual materials and text like data such as images and audio, and reducing them into categories that are easier to analyze. This approach is consistent with Simister (1995), who defines content analysis as a research technique for producing valid and replicable conclusions through systematic interpretation and coding of textual material. Validity and replicability are the main reasons for selecting this method, as systematic and transparent coding rules allow qualitative content analysis to consider the authenticity of the analyzed texts while also supporting replication by other researchers (Krippendorff and Bock, 2009).

Data collection in this study was conducted through documentary study, namely the examination

of academic documents, conservation reports, and institutional publications discussing each case study, such as the research by Chaves et al. (2022) on Beira Railway Station, Kırış (2013) on Sirkeci and Haydarpasa Stations, Song (2022) on the TAZARA railway line, Yoney et al. (2016) on the Sümerbank Kayseri Factory, Salura et al. (2020) on sugar factories and the West Hall of the Bandung Institute of Technology in Indonesia, and Gültekin (2017) on the Ankara Exhibition Building.

In line with the nature of data in content analysis, the object of this research is not the physical activity of research subjects but rather the ideas produced by the subjects that have been documented in printed or electronic media (Hsieh and Shannon, 2005). The selection of the nine case studies in this research was based on purposive sampling with two main criteria. First, each case study must represent one of the three modernization factors that form the analytical framework of this study, namely transportation, industry, or construction material. Second, each case study must have sufficient academic or institutional documentation to allow for in depth analysis. Based on these criteria, three case studies were selected for each modernization factor, with geographical distribution covering Africa in Mozambique, Zambia, and Tanzania, Asia in Turkey, Europe in Poland, and Southeast Asia in Indonesia, to demonstrate that the phenomenon of new form architecture in modern heritage is cross contextual and not limited to a single geographical region.

The instrument used in this study is an analytical guideline consisting of architectural indicators derived from the theoretical review, including the open application of new structural systems and materials, spatial flexibility and openness, and orientation toward function and efficiency. Based on these indicators, data analysis was conducted through four stages. First, identifying architectural descriptions in source documents for each case study. Second, coding these descriptions according to the established architectural indicators. Third, categorizing findings into the three modernization factor groups. Fourth, interpreting and synthesizing the findings to answer the research questions. The validity of the analysis in this study is supported through source triangulation, namely by examining each case study using more than one type of document, including academic publications, conservation reports, and institutional sources, so that the resulting architectural descriptions are not dependent on a single data perspective.

RESULTS AND DISCUSSION

This section presents the architectural characteristics identified from the nine case studies, organized according to the three modernization factors that form the analytical framework of this study, transportation modernization, industrial modernization, and construction material expression. The detailed interpretation of these findings is presented in the Discussion section that follows.

Architectural Characteristics of Transportation Modernization

Four case studies represent the transportation modernization factor, Beira Railway Station in Mozambique, Sirkeci Station and Haydarpasa Station in Turkey, the TAZARA railway line connecting Zambia and Tanzania, and Jakarta Kota Station in Indonesia.

Beira Railway Station, built in 1958 in Mozambique, was designed by Paulo de Melo Sampaio (1926 to 1968), João Garizo do Carmo (1917 to 1974), and Francisco José de Castro (1923 onward) (Chaves et al., 2022). The station functioned as a strategic transport infrastructure for freight and passengers connecting the Beira port corridor to the sub-Saharan African interior. The building mass is organized into two main functional zones typical of colonial railway stations, the passenger area and the service zone, connected through railway tracks that pass through the entire complex. Its construction combines pitched roofs, curved elements, and steel tie structures (Chaves et al., 2022).



Figure 1. Beira Station
(Source: Chaves et al., 2022)

In Turkey, Sirkeci Station and Haydarpasa Station were built in 1890 and 1909 respectively, on the two sides of the Ottoman capital. Haydarpasa, on the Asian side, was constructed as a gift from the German Empire to the Ottoman Empire for the Baghdad railway project, designed by German architects Otto Ritter and Helmut Cuno in a German neoclassical style resembling palaces and castles. It was later renovated in the early twentieth century to accommodate

increasing passenger numbers. Sirkeci Station, on the European side, began construction in 1888 under German architect August Jasmund, who combined oriental elements such as towers with European classical forms, resulting in the Turkish Neoclassical or Turkish Revival style (Kırış, 2013).



Figure 2. Sirkeci Station and Haydarpasa Station
(Source: Sirkeci Train Station Rail Turkey En, n.d.; Haydarpasa Train Station Rail Turkey En, n.d.)

The TAZARA railway, constructed from the late 1960s, connects Kapiri Mposhi in Zambia with the port city of Dar es Salaam in Tanzania, spanning 1,860 kilometers (Song, 2022). The project was built as part of China's role in constructing major infrastructure in Africa during the Cold War era. Station designs along the line adopted modern elements influenced by Chinese construction aesthetics and techniques of the period, including Western elegant monumental populism, while direct tectonic expression in Brutalism was not adopted (Song, 2022).

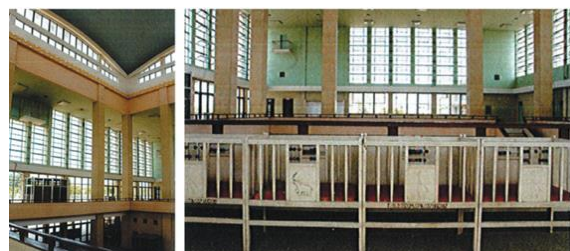


Figure 3. TAZARA Station
(Source: Song, 2022)

Jakarta Kota Station is designated as a cultural heritage railway building based on the Governor of Jakarta Decree Number 475 of 1993, designed by Dutch architect Frans Johan Louwrens Ghijsels. Known formerly as Beos Station, it was constructed in 1926 and inaugurated in 1929, replacing an older station that could no longer accommodate increasing

passenger volumes (Heritage KAI, n.d.). The building combines the Art Deco style with tropical architectural elements, such as a central atrium that enhances natural ventilation and lighting, perforated brickwork above doors, waffle tiles on lower walls, and additional wooden panels functioning as ventilation doors. Structurally, the roof combines gable and flat forms supported by steel construction, while local materials such as temple stone are used on the walls (Heritage KAI, n.d.).



Figure 4. Jakarta Kota Station
(Source: Heritage KAI, n.d.)

Architectural Characteristics of Industrial Modernization

Two case studies represent the industrial modernization factor: the Sümerbank Textile Factory in Turkey and colonial-era sugar factories in Indonesia. The Sümerbank Textile Factory in Kayseri, Turkey, built in the early twentieth century, applies simple geometric forms, reinforced concrete structures, and horizontal ribbon windows to maximize natural lighting in production spaces (Yoney et al., 2016).

Sugar factories built during the colonial period in Indonesia were influenced by Arts and Crafts principles and European industrial architecture, emphasizing structural honesty and material expression on their façades (Salura et al., 2020). These factories generally used steel frame structures with exposed brick walls, with roofs designed to meet ventilation and lighting needs for the sugar production process.

Architectural Characteristics of Construction Material Expression

Three case studies represent the construction material expression factor: the Ankara Exhibition Building in Turkey, Centennial Hall in Wrocław, Poland, and West Hall ITB in Indonesia.

The Ankara Exhibition Building, constructed in 1934, uses reinforced concrete structures with large spans, enabling the creation of expansive exhibition spaces without intermediate columns (Gültekin, 2017).



Figure 5. Ankara Exhibition Building
(Source: Sancar, 2021)

Centennial Hall in Wrocław, Poland, designed by architect Max Berg, features a reinforced concrete dome that was one of the largest domes in the world at the time, with structural expression displayed without decorative covering (Centennial Hall, n.d.). The building is recognized as a UNESCO World Heritage Site for its significance in the history of modern reinforced concrete construction.



Figure 6. Centennial Hall in Wrocław
(Source: Centennial Hall, n.d.)

West Hall ITB, designed by architect Henri Maclaine Pont, combines modern construction technology with local wisdom. The roof structure uses a timber construction system inspired by traditional Indonesian architecture, executed through a rational and modern approach (Salura et al., 2020).



Figure 7. West Hall ITB
(Source: Salura et al., 2020)

Table 1. Summary of architectural characteristics across the nine case studies

Modernization factor	Case study	Country	Year	Key architectural characteristics
Transportation	Beira Railway Station	Mozambique	1958	Pitched roofs, curved elements, steel tie structures
Transportation	Sirkeci & Haydarpasa Station	Turkey	1888 to 1909	Oriental and European hybrid, neoclassical forms
Transportation	TAZARA Railway	Zambia/Tanzania	late 1960s	Chinese construction aesthetics, monumental populism
Transportation	Jakarta Kota Station	Indonesia	1926 to 1929	Art Deco with tropical ventilation elements, steel roof, local stone
Industrial	Sümerbank Textile Factory	Turkey	early 20th c.	Reinforced concrete, ribbon windows, geometric form
Industrial	Sugar factories	Indonesia	colonial era	Steel frame, exposed brick, ventilated roof
Construction material	Ankara Exhibition Building	Turkey	1934	Reinforced concrete, large span, no intermediate columns
Construction material	Centennial Hall	Poland	1911 to 1913	Reinforced concrete dome, undecorated structural expression
Construction material	West Hall ITB	Indonesia	colonial era	Timber roof structure, modern with local wisdom

(Source: compiled by the authors based on Chaves et al. (2022), Kırış (2013), Song (2022), Heritage KAI (n.d.), Yoney et al. (2016), Salura et al. (2020), Gültekin (2017), and Centennial Hall (n.d.))

Based on the findings presented above, this section interprets how the three modernization factors gave rise to new form architecture in modern heritage, situates these findings within the theoretical framework, and compares their manifestations across the three categories.

Transportation Modernization: Local Adaptation as a Dominant Pattern

The four case studies, located in Mozambique, Turkey, Zambia/Tanzania, and Indonesia, demonstrate that transportation modernization consistently produces modern heritage with comparable architectural characteristics despite differing geographical and political contexts. The use of steel structures, curved roofs, and efficient functional organization in all cases reflects principles of free plan and structural expression as emphasized by Le Corbusier and Mies van der Rohe, while also demonstrating how transportation modernization pushed architecture beyond earlier historical styles.

At the same time, transportation modernization most strongly demonstrates tendencies of local and cultural adaptation. This is seen in the combination of oriental and European styles in Turkey, which together represent a key transformation in Istanbul's architectural identity while showing that modernization can occur without eliminating local cultural elements; in the geopolitical and semiotic dimension of TAZARA, where Chinese identity was implicitly conveyed through development aid architecture (Song, 2022); and in the tropical adaptation seen at Jakarta Kota Station, where colonial modern architecture was adjusted to local

climate and culture (Heritage KAI, n.d.). This tendency toward local adaptation is best explained by the social function of railway stations themselves, which serve as the public face of cities, representing both identity and modernity.

Industrial Modernization: Function and Efficiency over Symbolism

Both the Sümerbank Factory in Turkey and the sugar factories in Indonesia demonstrate how industrial modernization consistently generated new building typologies, consistent with the sub-assemblies and modularization stages described by Ågren et al. (2013). The demands of mass production encouraged industrial architecture to emerge as a new form that is honest to its function and structure, while also becoming part of modern heritage that now requires conservation attention.

Compared to transportation modernization, industrial modernization is more dominated by functional and production efficiency considerations, resulting in simpler architectural expressions with minimal symbolic or cultural adaptation. This difference reflects the distinct social function of industrial buildings, which prioritize production needs over public representation.

Construction Material Expression: Structural Honesty as Aesthetic Statement

The three case studies, namely the Ankara Exhibition Building, Centennial Hall, and West Hall ITB, provide the clearest evidence of the principle of structural honesty emphasized by Mies van der Rohe, where structure and material are no longer hidden behind

ornamentation but are instead expressed as the aesthetic value of modern architecture itself. In the case of West Hall ITB, this principle is combined with local wisdom, allowing materials and construction to be expressed honestly as part of the architectural language of the building while still drawing on traditional Indonesian construction (Salura et al., 2020). This pattern complements the local adaptation also found at Jakarta Kota Station.

Among the three categories, construction material expression represents the most explicit and intentional manifestation of new form architecture, where structural honesty is openly displayed as an aesthetic statement rather than merely a technical consequence.

Cross-Factor Comparison

When comparing the three categories, transportation modernization most strongly demonstrates tendencies of local and cultural adaptation, industrial modernization is more dominated by functional and production efficiency considerations, and construction material expression represents the most explicit and intentional manifestation of new form architecture. These three patterns indicate that although all are driven by modernization, their architectural manifestations vary depending on the social function and purpose of each building.

Limitations

This study has several limitations that should be acknowledged. First, the analysis relies on secondary documentation in the form of academic publications and institutional reports rather than direct field observation, meaning that some architectural details not documented in the sources could not be further examined. Second, the limited number of nine case studies, although distributed across six countries, does not fully represent the global variation of new form architecture in modern heritage. These limitations open opportunities for future research to expand the scope of case studies and complement the analysis with direct field observations.

CONCLUSION

This study shows that new form architecture in modern heritage emerges as a response to modernization processes occurring in the nineteenth and early twentieth centuries, driven by three main factors, namely transportation modernization, industrial modernization, and construction material expression, thereby answering the first research question. Modern architecture emerged from societal concerns regarding classical architecture and past eclecticism, and was further driven by technological development, industrialization, and changes in socio

political order during its time. As a result, the new building typologies that emerged no longer merely prioritized conventional forms, but emphasized principles of space, construction, and material oriented toward function, efficiency, and effectiveness.

The manifestation of these three factors, as an answer to the second research question, shows different patterns according to the social function of each building. Transportation modernization, reflected in Beira Railway Station in Mozambique, Sirkeci Station and Haydarpasa Station in Turkey, the TAZARA railway line connecting Zambia and Tanzania, and Jakarta Kota Station in Indonesia, demonstrates a strong tendency toward adaptation to local and cultural contexts, as these buildings function as the public face of cities. Industrial modernization, reflected in the Sümerbank Textile Factory in Kayseri, Turkey, and sugar factories in Indonesia, is instead dominated by considerations of functionality and production efficiency, with minimal symbolic adaptation. Meanwhile, construction material expression, reflected in the Ankara Exhibition Building, Centennial Hall in Wrocław, and the West Hall of the Bandung Institute of Technology, presents structural honesty as the most explicit and intentional architectural statement.

These three factors complement each other and demonstrate that new form architecture is not merely a uniform visual style, but a direct consequence of how architecture responds to technological progress in accordance with the social function and local context of each building. These findings provide a new theoretical contribution to the understanding of new form architecture as part of modern heritage, while also enriching architectural discourse in viewing modern heritage as a distinct category that requires its own conservation approach. This understanding is expected to serve as a foundation for documenting modern heritage across various countries, so that its existence can continue to be preserved and receive attention in conservation efforts as an important part of future urban heritage.

From a practical perspective, the three factor framework and architectural indicators produced in this study can serve as a tool for heritage institutions and local governments in identifying and categorizing modern heritage buildings that may not yet receive recognition or protection, while also addressing one of the main challenges in modern architectural conservation, namely the lack of consistent analytical approaches. The applied conservation strategy should also be adjusted according to the characteristics of each category. Transportation buildings that are still in use require adaptive reuse strategies that maintain their local adaptive elements. Industrial buildings, many of which have been abandoned, can be

repurposed as illustrated by several examples mentioned in the introduction. Meanwhile, buildings with strong construction and material expression require special attention to preserve structural honesty as their primary heritage value, rather than merely maintaining their surface appearance. Future research may expand the scope of case studies or complement these findings with direct field observations to further enrich the understanding of new form architecture in a more comprehensive manner.

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