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Review paper

STRUCTURAL AND ARCHITECTURAL TRENDS OF CONTEMPORARY CONSTRUCTION IN COUNTRIES WITH DIFFERENT CLIMATIC ZONES: REVIEW STATE OF THE ART

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Abstract

The article focuses on the structural and architectural design of buildings for civic amenities in the city, considering different climatic zones, and maps the current construction in the context of sustainability principles. Construction trends show that society aims to focus on modern construction technologies while applying a comprehensive building design in combination with an appropriate material solution. A meaningful combination of building design, technologies, and material solutions is a motivational tool for contemporary society. The article aims to present new construction trends in selected countries with different climatic zones, based on the State of the Art, and to compare selected aspects of this construction, which then leads to the definition of functional connections creating a common segment for the future of modern construction. Using the example of Iran in Western Asia, a subtropical country with a pronounced continentality, and the example of Europe, which is characterized by three climatic zones, we demonstrate the construction and architectural trends of contemporary construction by describing them. The results show that the countries studied are oriented towards sustainability, the use of new materials and technologies, and emphasize the environmental aspect.

Key words: *Continent, Climate, Construction, Sustainability.*

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1. INTRODUCTION

The construction industry plays a critical role in the economic development of nations, significantly impacting overall growth, infrastructure, and quality of life [1]. Historically a focal point of societal interest, the sector is undergoing rapid transformation driven by advancements in technologies, structural solutions, and material sciences, which align with increasing emphasis on sustainability, energy efficiency, and the circular economy. The adoption of advanced construction technologies delivers numerous benefits, including long-term cost savings, enhanced precision, improved performance, and faster project timelines. These innovations encompass breakthroughs in materials science, architectural design, structural analysis, cost estimation, facilities management, and management studies, collectively reshaping the industry. By integrating these innovative methodologies and technologies, the construction sector is advancing to meet the evolving demands of modern society while promoting sustainable and efficient practices.

The global population, now approximately 7 billion, has grown dramatically over the years, creating an urgent need for new cities to accommodate this expansion. Advancements in industries such as construction, education, and healthcare have enhanced modern lifestyles, making them more dynamic and appealing [2]. As Maslow's "Hierarchy of Needs" suggests, shelter is a fundamental necessity, forming the basis for fulfilling higher-level needs and underscoring the indispensable role of construction in society [3]. Infrastructure, which relies heavily on the construction industry, is vital for a modern economy, as it facilitates economic activities and societal development. Governments worldwide are increasingly focused on developing cities with comprehensive facilities to ensure the well-being of their populations. However, rapid population growth poses significant challenges, particularly in underdeveloped countries, where issues such as inadequate planning, financial constraints, time pressures, and limited access to construction technologies hinder the effective creation of sustainable urban spaces.

Over the years, researchers have published numerous articles on advanced construction technology, smart construction materials, and modern construction methods, contributing to the ongoing development of the field. Ghodawa (2022) explored smart construction materials and advanced construction techniques, offering an overview of the available materials and shedding light on innovative methods and techniques that are poised to drive progress and improvement within the construction industry [4]. Similarly, Kawahata and Murayama (2011) examined advanced construction technologies in the context of Nuclear Power Plant (NPP) projects, particularly focusing on the exceptional construction technology implemented by Hitachi, the main contractor responsible for the entire plant. Their study highlighted how these technologies led to a 25% reduction in peak workload at construction sites through improvements in construction procedures in areas with dense activity. The strategies they employed included: the broader application of large module/block construction methods, open-top and parallel construction methods, the application of floor packaging construction methods, and the full integration of information technology to enhance quality in plant engineering and construction achievements [5].

In 2023, Abdilah et al. conducted a study on the analysis of new advanced technologies and their adaptation within the context of civil engineering construction in Bangladesh. Their research reveals that while Bangladesh has historically embraced advanced construction methods, dating back to the 19th and 20th centuries, the country has not sufficiently developed its environment by fully leveraging these technologies [6]. Additionally, Krupík

(2021) provided an in-depth exploration of advanced building materials, as well as prefabricated and modular designs, as key components of Construction 4.0, with a specific focus on transport construction [7].

The European Union's strategic targets for 2030 and 2050 imply that energy action, CO2 reduction, climate neutrality, and emphasis on the Green Deal strongly highlight the construction industry [8, 9]. This article examines developmental innovations in Europe and Iran that promote sustainability within the construction industry. The analyzed data, along with the findings from a narrative review, are used to assess the current situation and pinpoint the key factors affecting the development sectors in both Europe and Iran.

Europe and Iran are located in different climatic conditions. However, even here it turns out that the structural and architectural approach to modern construction trends has the same basis, which is a highly modern, energy-efficient building that is sustainable and has a positive contribution to circularity.

2. MODERN METHODS OF CONSTRUCTION (MMC): CURRENT APPLICATIONS

Modern Methods of Construction (MMC) is an expression that emphasizes the use of novel building materials, advanced types of equipment, and developed techniques to construct. This technic has been approved by many industries around the world because it suggests a wide range of benefits to builders and consumers. Based on the CIF [10] definition, ''Modern Methods of Construction (MMC) is a term used to cover a range of offsite manufacturing and onsite techniques that provide alternative approaches to traditional construction. Modern construction methods include the following:

- Modern materials
- Modular construction
- Volumetric system,
- Hybrid system (semi-volumetric system)
- Pods
- LSF structures (modular frames)
- Precast construction system
- Sub-assemblies and Component
- Cite-Based
- Mivan Formwork in Construction

Our research focuses on the interpretation of aspects of structural and architectural creation that lead to innovative approaches. The discourse of contemporary creation is significantly influenced by environmental aspects that positively affect the world architectural events, both theoretically and practically. Using the description method, we observe new methods of building design and architectural strategies. The paradigm of innovative creation influences the construction and architectural sector, accelerating the pressure on sustainability. If we observe architectural creation and structural strategies in different climatic zones of the country, the identity of the approach to strengthening sustainability is evident.

Advanced building materials refer to innovative and high-performance building materials that improve durability, strength, insulation, energy efficiency, and sustainability in comparison with traditional building materials. Modern materials are designed to meet the needs of modern construction projects, such as skyscrapers, buildings, bridges, tunnels, and infrastructure developments. Aiming to improve the safety, cost-effectiveness, and environmental impact of construction [11]. Modular construction is a construction method that increases the efficiency and effectiveness of construction using conventional methods with modern mass production procedures [12]. The volumetric methods are also known as Modular construction. In this system, three-dimensional units are made in a factory and then transported to the site for assembly; about 85-90% of the process is done in the factory [13].

Figure 1 shows a mind map that presents a proposed classification framework for modern materials used in MMC. This classification encloses key properties, including sustainable materials, innovative construction materials, smart materials, recycled and low-carbon materials, and high-performance materials. These materials are typically lightweight, durable, and appropriate for prefabrication and modular construction. They consist of precast concrete, advanced composites, engineered timber, high-strength steel, and environmentally friendly alternatives like recycled or low-carbon materials. Modern materials allow faster assembly, promote energy efficiency, and reduce environmental impact, making them necessary for the Methods of Construction (MMC).

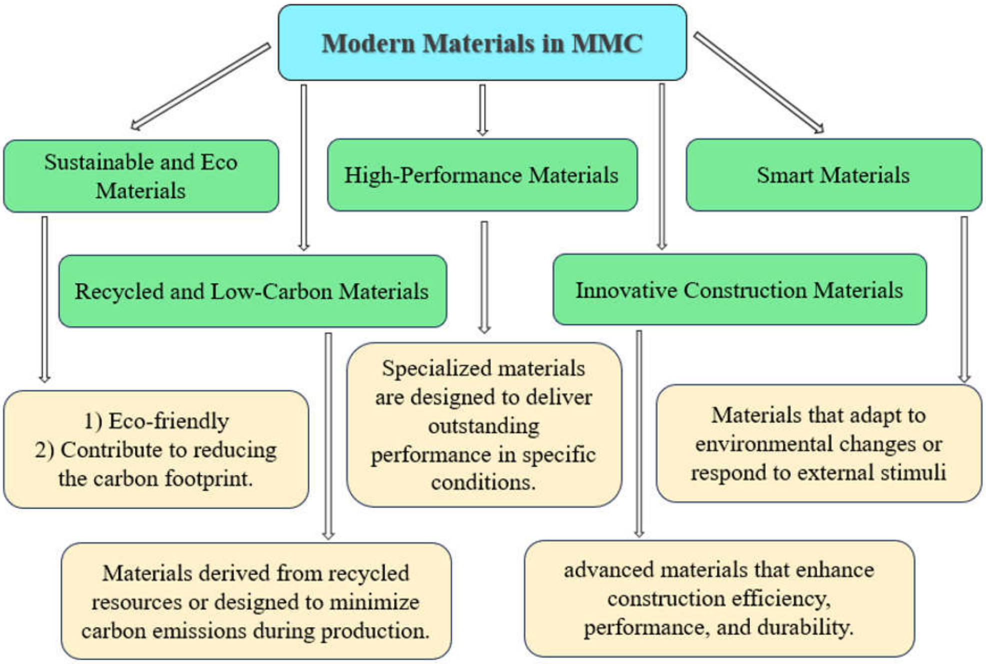

Figure 1. Mind map of modern material in MMC (source: author) [14].

Hybrid building system construction is known as the semi-volumetric method, and it is a building approach that uses both modular and prefabricated elements [15, 16]. The bespoke component assembly is demonstrated to be a real significant shift in the current way of the construction industry, and it has now entered the domain of equipment housing unit [17, 18, 19]. Prefabrication is a highly sought-after and progressive method for the current construction industry, contributing to faster construction, being financially efficient.

Nowadays, Lightweight metal frame structures (LSF) are included in one of the well-known types of walling systems and very ideal solutions for professional architects due to their modular structure in the construction industry. Modularization of buildings can be very essential for increasing the speed of construction management, reducing debris and waste of construction materials, cost savings, and its visual impact from an aesthetic point of view. Many studies have been conducted to present LSF wall systems as more effective and efficient in numerous aspects, like; financial consequences, sustainability, fire and energy performance, also structural performance [20, 21, 22]. In 2022, Rukavina et al. investigated the progress of lightweight steel-framed building systems for nearly-zero-energy buildings, and this article aimed to investigate state-of-the-art major components for such systems to be applied for utilization in nearly-zero-energy buildings [23]. Design and dimension a single-family residential project, using LSF profile dimensioning software was done by Vicente et al in 2023 [24]. Precast is a construction product manufactured using casting in a reusable form, which is then cured in a controlled environment, transported to the construction site, and lifted and set into place. Also, elements of precast buildings and various systems include these items: flat panel system, precast footings, beams, columns, slab, shear walls, partition walls, roofs, and floors, connection between precast elements, concrete foundation, cladding panels, etc. which are made from flat, pre-engineered panels and are assembled on site. panel systems can be separated into two principal classifications, open and closed systems. In open systems structural elements are taken to the site where the rest of the work is done on-site and in closed systems which are more complex different components like windows, doors, insulation, internal finishes, external cladding, etc. can be fitted in the factory [11, 25, 26, 27].

Figure 2. Precast concrete Twin Wall [28].

Figure 2 shows the Precast Concrete Twin Wall, which is a new technology that can be used as a cross-wall construction, and when combined with filigree slabs, a complete monolithic ‘’paint-ready’’ structure is provided [28]. Sub-assemblies and components can be added to existing brick-and-mortar buildings or those built using other modern methods of construction [29]. Innovative approaches to construction are used on-site. They consist of thin joint blockwork and insulated formwork [17]. The progress in build quality achieved from the utilization of the Thin-Joint System includes: improved thermal performance, improved stability during construction, improved build accuracy of finished walls, and reduction of site wastage [30]. Mivan formwork is more likely to be used in Europe, Asia, the Gulf Countries, and other parts of the globe. This innovative solution of work can be appropriate for building houses in large quantities in a short period, using room-size forms to construct walls and slabs in one constant pour of concrete [31, 32].

3. CONSTRUCTION METHODS IN IRAN

Iran has a subtropical climate with a pronounced continentality, while the south has a hot and dry tropical climate. Snowfall occurs in the northern regions of the country and the plateaus in the northwest. Current construction trends are modern, based on traditions, the use of modularity, and also eco-design.

Urban planning, using new technology, design, and architectural aspects in construction, is different from any part of Iran due to the climate, because there has been a noticeable change in seasons and different geographical regions. Another important thing about construction in Iran is the specific weight of the urban population in various zones of Iran. because the community is unevenly distributed, according to Ref. [33], only 30% of the area of land has a relatively sufficient amount of water to provide the inhabitants. Also, population growth in Iran stimulates the progress of construction and will require an increase in the number of housing units, as well as boosting their standard.

Being located in one of the most seismically active zones in the world, Iran has experienced many destructive 26 earthquakes throughout history [34]. Due to this fact, certain attention should be given to architectural and construction recommendations that have an impact on the design of houses in seismically hazardous regions. Apart from the requirements for the new dwellings, in Iran, 3.8 million residential buildings must be reinforced [35]. Achieving this goal using traditional construction methods alone seems almost impossible; traditional methods of construction have not been able to meet the current demand.

3.1. Elementary Construction System

These buildings were built in ancient times, their age reaches more than 200 years, and traditional locally available materials have been used. According to the diverse climate in Iran, the construction materials include brick, stone, wood, mud, and plaster, also their covering is made of brick arches or wooden beams, and vegetable fibers are used. Nowadays, these buildings are known as historical monuments in Iran, and governments should act to preserve these buildings because they can show every culture from all parts of Iran. Figure 3 shows Kolah Farangi Mansion and Masuleh, which are located in the north of Iran. Also, Figure 4 presents an ancient town in a region with a dry and hot climate in Yazd.

Kolah Farangi Mansion is a relic from the Qajar period. It offers eye-catching views, and it is one of the most prominent tourist attractions. This mansion consists of a four-story building. Numerous windows provide suitable lighting and ventilation in the hot seasons of the year. Additionally, it features a stunning summer building with a 360-degree balcony [36]. Both buildings are constructed with local materials. Figures 3 and 4 states that construction has been famous in Iran in the past, and builders according to existing facilities and materials consider details in designing so people who want to live in these places have a comfortable feeling, for example; in both construction, natural lighting, and ventilation were provided in the best way.

Figure 3. Typical House in a Temperate-Humid Climate; Kolah Farangi Mansion, Rasht, Iran [37].

Moreover, in dry and hot climates, a windcatcher or wind tower was used; this traditional architectural component was used to provide cross ventilation and passive cooling in the house. It comes in diverse designs, depending on whether local prevailing winds are unidirectional, bidirectional, or multidirectional, on how they alter with altitude, on the daily temperature cycle, on humidity, and on how much dust needs to be removed [37].

Figure 4. Typical House in a Dry and Hot Climate; Traditional Architecture in Abarkuh, Yazd, Iran (left), and Old Kharanagh village in Yazd, Iran (right) [38, 39].

3.2. Traditional Building System

Buildings with load-bearing brick walls are considered in this classification. Due to the load-bearing walls supporting the building's load, the thickness of the lower layer's walls is increased, which is one of the factors inhibiting the addition of layers or height. Earthquake damage can be lessened by creating actions like horizontal concrete barriers. The height of the building must not be more than 12 meters in this method.

The construction of several buildings in Rasht Square, including the municipal building shown in Figure 8, took place between 1907 and 1922 during the Pahlavi era. Additionally, it represents one of the Conventional Building Systems that remains functional in rural areas.

Figure 5. Modern Heritage in Rasht, Iran (Rasht Municipality Square) [40].

3.3. Advanced Construction

Structures with a steel and concrete frame are considered in this group. The most important equipment used in this type of construction is: concrete preparation machines, fixed and mobile cranes, electric hoists, scaffolds, welding machines, and paint spraying machines. Due to the use of concrete and steel frames, the number of floors and the height of the building can be predicted to be more than 50 floors and the speed of construction operations can be increased to a great extent by using mechanical and electrical equipment.

3.4. Industrialized Building System (IBS)

An industrialized building system (IBS) is a construction approach with centralized practices that comprise techniques, products, and a set of linked elements that proceed concertedly to achieve objectives [41]. IBS can cause MMC in the construction industry.

This technique has been recognized as a suitable method for developing overall construction performance in terms of quality, cost, safety and health, waste reduction, and productivity [41]. IBS practices mainly develop techniques, products, modules, or building systems that incorporate prefabricated elements and on-site installation. In construction, there are five categories of IBS in what is described as the structural classification: precast concrete framing, panel and box systems, steel framing systems, prefabricated timber framing systems, and block/brickwork systems [42]. In 2019, a study about awareness and prevalence of IBS in Iran [43] was conducted applying the mean index and average ranking method. Prefabricated elements like steel formwork systems, prefabricated forms for walls, sandwich panels, permanent forms, prefabricated frames, load-bearing wall panels, ceiling and floor panels, and prefabricated forms for beams and columns were examined. The study expressed that one of the construction problems in Iran is that there is not enough IBS work experience among construction practitioners. According to this research, only 2% of respondents are fully informed about IBS, and approximately 95% of respondents do not have acceptable information about this construction method. The average index of prefabricated component prevalence in Iran is 2.72, and the sandwich panel is the most prevalent IBS component with a mean index of 3.42 [43]. In 2015, a questionnaire survey was conducted to recognize the risks and required measures for obtaining successful application of offsite construction in Iran. 300 questionnaires were distributed among Iranian architects working at consulting companies, which were selected randomly from registered architectural practices; about 100 returned, and 88 were reliable [44]. Table 1 shows that

100% of respondents in the study of Hashemi (2015) were very experienced designers or architects in comparison with the study of Taherkhani & Saleh (2019).

Table 1. General Information in references [43, 44].

Distribution of respondents' general information			
Profile		Taherkhani & Saleh (2019)	Hashemi (2015)
Gender	Male	64%	53%
	Female	36%	47%
Age	Min	24 years	20 years
	Max	60 years	50 years
Occupation	Employer	26%	0
	Contractor	26%	0
	Designer/Counselor	30%	100%
	Academics	19%	0
Work experience	Less than 10 years	76%	60%
	More than 10 years	24%	40%

The study by Hashemi (2015) illustrates that most Iranian architects (56%) are familiar with offsite techniques; nearly 100% of those who were experienced in offsite methods had used panel systems, and about 75% had not used any other systems by the panel system. As a result, except for the panel systems, in general, about 86% of Iranian architects are not experienced in any other offsite methods. In both studies, the panel system is the most prevalent IBS component in prefabricated systems in Iran.

3.5. Lightweight Steel Frame Construction

This construction methodology has received technical confirmation from the building and housing research center and has been officially introduced as one of the new construction technologies in Iran. In this regard, the Office of National Building Regulations prepared and published a regulation titled Industrial Design and Implementation of Buildings (Topics/Code 11) in 2003. According to this standard (Topics/Code 11), using LSF is only a gravity load-resisting system, up to 5 floors or 15 meters high. Also, other standards and books are published for designing and implementing Lightweight Steel Frames, such as standards (publication No.613, 612) and Guidelines for the design and implementation of light steel construction systems [45, 46, 47, 48].

Table 2. Comparison of Different Types of Construction

Construction Types	Construction Speed	Building Weight	Seismic Base Shear	Wasting Materials
Concrete Frame	195 days	318 ton	36 ton	150 kg/m^2
Steel Frame	180 days	210 ton	26 ton	100 kg/m^2
LSF	60 days	87 ton	16 ton	2 kg/m^2

Table 2 is a summary of Ref. [49], which shows the advantages of LSF building in comparison with other kinds of construction. The table illustrates that LSF, apart from building construction speed and less weight, can have suitable resistance against earthquakes.

Furthermore, this method yields less waste in comparison with other common methods of construction in Iran and leads to a more environmentally friendly method. Employing this system provides an economical dwelling for all walks of life.

3.6. Prevalence of Employing IBS in Various Construction

Since, Iran is a great source of oil and gas, marine structures such as offshore platforms and jackets have key roles in oil and gas extraction from the seabed. Because, these structures should be prepared in a short period because of their higher production of wealth, and they should be installed in the depth of the sea also the cost of construction in the sea is very high. As a result, offsite construction methods can be beneficial for these kinds of structures because of higher construction speed; enhanced health and safety; better quality; lower waste and energy consumption; enhanced control conditions; less weather dependence; improved value for money and cost predictability. Figure 13 shows IBS methods in the construction of marine structures in Iran, these structures are built in the factory, and even all equipment is installed on the platform, then after completion, should be carried with a vessel into position, furthermore using advanced cranes are placed in their position. Apart from marine structures and residential buildings, IBS methods have been used in other construction in Iran such as; commercial buildings, bridges, ports, dams, and transportation.

In 2015, an examination was conducted on the prevalence of utilizing prefabricated elements in different sorts of projects in Iran. As a consequence, the most prevalent project category that is implemented using IBS is related to marine structures with a mean index of 3.89 (RI=0.78), followed by bridges (3.32), ports (3.23), and airports (2.62). Continuing this movement, commercial and residential units by 2.13 (RI=0.43), transportation by 1.89 (RI=0.38), and lastly, dam projects by 1.74 (RI=0.35) mean index are at the lowest rate of using IBS implementation [43].

3.7. Reasons for the Failure of Modern Methods of Construction in Iran

From an engineering standpoint, architectural and construction factors such as improper thermal design, bad condition of the roof, uninsulated walls, unprincipled insulation of heating systems, cracks or seams in doors and windows, also lack of use of heating controllers bring about energy loss in the dwelling sector. As a result, reaching to Modern Method of Construction (MMC) is needed for advanced products and materials, since most residential houses are built by individuals’ builders, one of the main barriers to extensive applications of MMC in Iran is the Higher prices of advanced materials products.

According to CABE (2004), the mean price of MMC in the United Kingdom is currently 8–15% greater compared to traditional practices [50]. Additionally, it is reported that similar materials and products could be up to four times more costly in Iran in comparison with other countries [51].

4. MODERN METHOD OF CONSTRUCTION IN EUROPE DUE TO ENVIRONMENTAL CONCERNS

Current trends in Europe show that the main modern direction in structural and architectural design is oriented towards construction and renovation, which place high demands on reducing energy consumption, sustainability, decarbonization, eco-design. Reducing the carbon footprint has become a priority for EU countries to achieve global environmental goals and ensure sustainability. The direction and strategy show that regardless of the climate zone of Europe, structural and architectural design in EU countries is fundamentally the same. This is despite the fact that the climate in Europe is a reflection of its location. The majority of Europe lies in the temperate zone, the south lies in the subtropical zone and the north in the subarctic zone (the farthest north is in the Arctic zone). This is a consequence of legislative and regulatory measures that are set the same for EU member states. Individual member states implement EU legislative regulations into their own legal regulations. Most countries in the world are preparing plans and implementing measures to deal with climate change. The European Union has ambitious objectives in this regard, and within the framework of the European Green Deal [52] and the European Climate Law [53], it has set a goal of lessening net domestic greenhouse gas (GHG) emissions by at least 55% by 2030 compared to 1990 levels and to become climate neutral by 2050 [54]. In consonance with the International Energy Agency, buildings account for 30-40% of energy consumption in Europe, with a supplement of 5 to 10% that is used in the processing and transportation of building components and products. This gives rise to one-third of CO_2 emissions in the area [55]. The building sector consumes approximately 40% of the total global energy. This sector is a remarkable carbon emitter as it requires large amounts of energy for building operations and maintenance, as well as for its notable material use and intensive onsite construction processes. Attitudes towards waste management have been changing in recent years, and simply following the principles of material handling on site has led to more efficient management of the construction process [56].

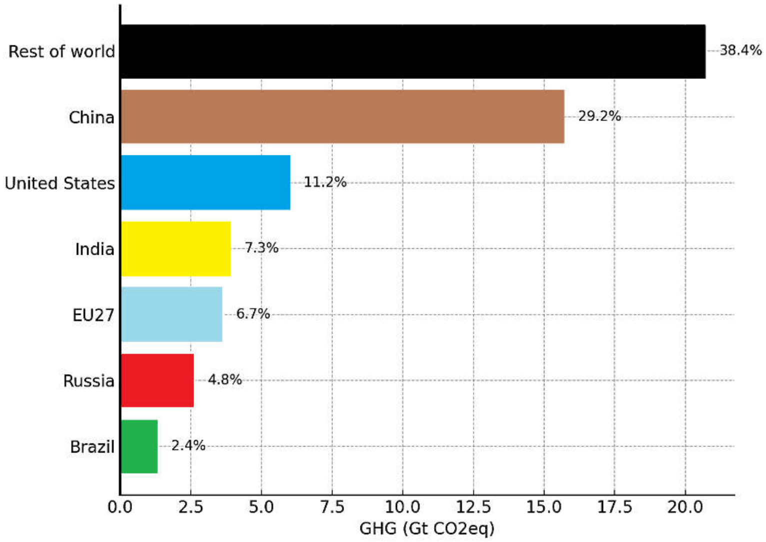

Figure 6. GHG Emissions and Contribution of the Major Emitting Economies and the Rest of the World in 2022 (figure elaborated based on [54]).

Offsite construction has been accepted as being able to address recurrent challenges like environmental sustainability, carbon, and waste through quality, process, and performance. furthermore, transitioning away from many of the obstacles usually associated with traditional construction, such as quality, cost, waste, energy, etc. [57]. In addition, the onsite construction industry and the manufacturing of construction materials also consume billions of tons of natural resources, while producing a large amount of non-recyclable waste [55]. China, the United States, India, the EU27, Russia, and Brazil were the world's six largest GHG emitters in 2022 (Figure 6). Overall, they account for 50.1% of the global population, 61.2% of global gross domestic product, 63.4% of global fossil fuel consumption, and 61.6% of global GHG emissions [56]. Outcomes show that the precast in-situ construction produces fewer GHG emissions compared to the conventional method. Buildings and infrastructure thus represent one of the most significant and cost-effective selections for reducing global GHG emissions [56, 58].

Figure 7 presents a simplified mind map that describes the advantages of modular construction in Europe. It highlights the main benefits, such as sustainability, structural efficiency, design flexibility, cost-effectiveness, and reduced construction time, that help reduce global GHG emissions in the building sectors. Using advanced building technology in the EU, such as modular constructions in residential buildings, will be a primary driver in decreasing greenhouse gas emissions and conserving natural resources. Furthermore, the development of technologies and advanced materials to improve building energy efficiency is a significant instrument for achieving this purpose.

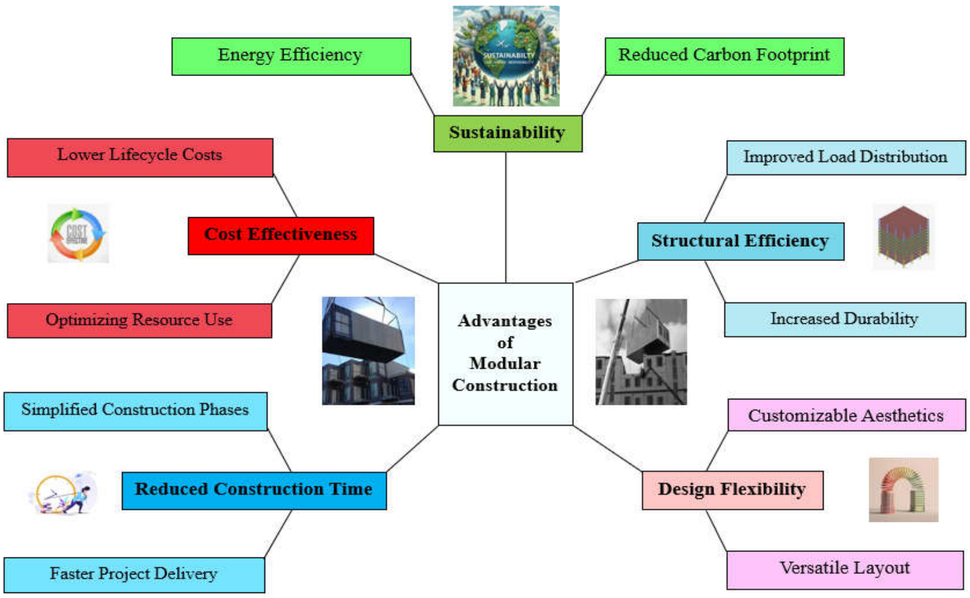

Figure 7. Simplified mind map for the advantages of modular construction (source: author) [14].

5. COMPARISON OF GHG EMISSIONS DISTRIBUTION IN THE BUILDING SECTOR BETWEEN IRAN AND EUROPE

From the knowledge gained so far, it follows that the strategies of the EU Member States emphasize the environmental assessment of structures, materials, and technologies. The same is true for new construction in Iran. In environmental assessment, we focus on the carbon footprint measurement method, which applies exclusively to greenhouse gas emissions. Or we use the Life Cycle Assessment (LCA) method, which provides a more comprehensive view of the entire life cycle of a building within the construction process. However, carbon footprint calculation tools help to identify and reduce CO_2 emissions. The Greenhouse Gas Protocol (GHG) methodology allows for the quantification of emissions, thereby strengthening strategic interdisciplinary decision-making and setting measures that lead to emission reduction. It is a powerful tool that aims to enhance the efficiency of construction and at the same time set priorities across all sectors. In the context of efforts to strengthen sustainable development, it effectively allows for the planning of sustainability strategies. According to the Emissions Database for Global Atmospheric Research (EDGAR) which provides greenhouse gas (GHG) emissions time series for all countries and all anthropogenic sectors from 1970 until 2022, in this study, a comparison of GHG in the Building Sector has been made between the Iran, Eu27 and World in Figure 8.

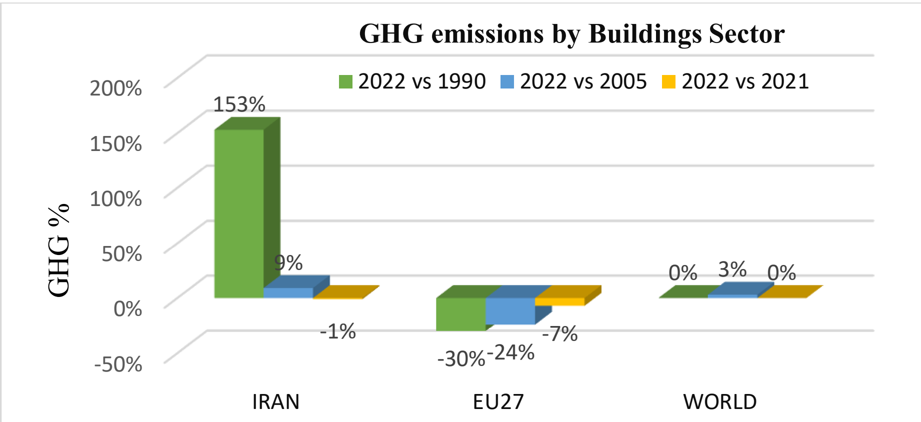

Figure 8. Comparing GHG Emissions of Iran, EU27, and the World by Building Sector (bar chart elaborated based on [54]).

Figure 8 illustrates that the EU27 is preparing plans and implementing actions to cope with climate change in the building sector because it has experienced negative growth (-30%) in GHG emissions from 1990 to 2022. Iran has had a negative growth (-1%) of GHG emissions from 2021 to 2022 in comparison with the world. It can be documented that strategic measures are demonstrable across countries not only on different continents, in different climate zones, but also in different geopolitical arrangements.

6. CONCLUSION

Since Iran has a long history in construction, structural and architectural aspects of ancient buildings such as Kolah Farangi and Abarkuh show that designers try to apply natural lighting and ventilation in their designs. Although, some codes and standards are published related to industrial design and implementation of buildings in Iran, unfortunately, the construction of prefabricated and industrial buildings is not common in Iran because there are no required factories for the production of advanced material for this large volume of construction in Iran, and importing this material into the country increases the cost of construction. On the contrary, the construction sector is supported by European governments to enable it to address both environmental and social challenges. Further, efforts have been made through cooperation across disciplines in academia and business to develop new types of building materials with prominent properties: environmentally friendly, more secure, solid, durable, recyclable, and energetically efficient. Using advanced methods of construction and advanced materials can help less waste and more recycling of materials, speed of installation, higher productivity, reduced disruption during construction, fewer transport movements, and more reliable thermal performance in comparison with more traditional construction; thereby increasing profitability and overall, favourably impacting the environment which leads to reduces GHG emissions.

A comparison of construction processes and structural and architectural creation in Europe and Iran shows that modern trends in accordance with sustainability are similar. Modern architecture on both continents often has the character of modularity and prefabrication, with a strong emphasis on sustainability. Modern construction in Iran has elements of differentiation and relates to traditions. A number of new and modern buildings in Iran reflect the tradition of historical construction (for example, the building of the New Construction Authority in the city of Mashhad, which reflects the tradition of Iranian bridges, i.e., the creation of shaded terraces and community support).

Europe emphasizes sustainability, low-energy standards, eco-design, the use of modular elements, and prefabrication.

The paradigm of contemporary construction processes, which relates to the basic principles and approach to construction, is similar in both continents. It focuses on technological innovation and sustainability, social needs. The adaptation of buildings focuses on the needs of the relevant cultural community. Innovative processes and flexibility are an integral part.

REFERENCES

[1] Islam, M.: **Evaluation and Comparison of Building Construction Technologies in Two Major Cities of Bangladesh**. *International Journal of Structural and Civil Engineering Research*, vol. 1, no. 1, 2012.

[2] Mustafizur, R.: **One Platform-Different Cities: An Automated Plug and Play Modular Building Construction & City Planning System**. *International Council for Research and Innovation in Building and Construction, Laboratory of Building Realization and Robotics Technische Universität München (TUM), Germany*, 2014.

[3] Grisales Pachon, A. and Jacob, J.: **Necessity of a Disruptive Change in the Construction Industry – Analysis of Problematic Situation**. *International Council for Research and Innovation in Building and Construction, Laboratory of Building Realization and Robotics Technische Universität München (TUM), Germany*, 2014.

[4] Patil, S & Choudhary, A & Pawar, M, & Patil, K, & Pawar: **An Overview of Study on Smart Construction Materials and Advanced Construction Techniques**. *International Journal of Engineering Science, Advanced Computing and Bio-Technology*. 12. 29574 -29576, 2022.

[5] Kawahata, J., Murayama, K., & Akagi, K.: **Advanced Construction Technologies and Further Evolution Towards New Build NPP Projects**. *International Atomic Energy Agency (IAEA): IAEA*, 2011.

[6] Abdilahi, H., Chara, A. H., Prova, N. B. F., & Naher, N.: **A Systematic Analysis on Adaptation of Modern Construction using Advanced Technology: The Perspective to Bangladesh**. *International student symposium*, 2023.

[7] Krupík, P.: **Advanced building materials - prefabricated and modular designs as part of Construction 4.0 with a focus on transport constructions**. *IOP Conference Series: Materials Science and Engineering*, 2021.

[8] Kubečková, D., Kubenková, K., Afsoosbiria, H., Musenda, O. K., & Mohamed, K.: **External Thermal Insulation Composite Systems—Past and Future in a Sustainable Urban Environment**. *Sustainability*, 16(19), 8500. https://doi.org/10.3390/su16198500, 2024.

[9] Afsoosbiria, H., Kubečková, D., Musenda, O. K., & Mohamed, K.: **Variability of Material Solutions for the Perimeter Walls of Buildings in Post-Industrial Settlements as Part of Energy Rehabilitation and Achieving Carbon Neutrality**. *Energies*, 17(24), 6236. https://doi.org/10.3390/en17246236, 2024.

[10] **Modern Methods of Construction, Construction Industry Federation**. Report-*v4*, 2021. https://cif.ie/wp-content/uploads/2022/01/1271-CIF-Modern-Methods-of-Construction-Report-v4.pdf. (4/8/2025)

[11] **Global Advanced Building Materials**, *Market Research Report*, 2023.

[12] Uddin, M.: **An Automated Approach for Installing Building Modules**. *Proceedings of the CIB W119 CIC 2013 Workshop Advanced Construction and Building Technology for Society,* November 2013, Munich, Germany.

[13] Hashemi, A.: **Modern Methods of Construction (MMC) in the UK housing industry**. *Second Research Student Conference held at the Welsh School of Architecture*, Cardiff University, 2006.

[14] Afsoosbiria, H.: **Structural Aspects of Building Conversions in Industrial Areas, Doctoral State Exam**, *Dissertation Thesis, VSB - Technical University of Ostrava, Faculty of Civil Engineering*, Department of Building Construction, 2025.

[15] Ross, K.: **BRE Construction Division. Modern methods of house construction: A surveyor's guide**, 2005.

[16] **Hybrid building design and its advantages**, https://constrofacilitator.com/, 2020. Available online 01.04.2025

[17] **Modern methods of construction: Views from the industry**. *Published by IHS BRE Press on behalf of the NHBC Foundation*, 2006.

[18] National Audit Office. **Using modern methods of construction to build homes more quickly and efficiently**, London: National Audit Office, 2005.

[19] Khan, H., Khan, M.: **Modern methods of construction**, IJARIIE-ISSN(O)-2395-4396, vol-5 issue-4, 2019.

[20] Mashhadifarahani, S.: **Lightweight Steel Frames vs. Common Building Structures - Structural Performance Evaluation**, *American Academic Scientific Research Journal for Engineering, Technology, and Sciences*, 2015.

[21] Rajanayagam, H., Upasiri, I., Poologanathan, K., Gatheeshgar, P., Sherlock, P., Konthesingha, C., Nagaratnam, B., Perera, D.: **Thermal Performance of LSF Wall Systems with Vacuum Insulation Panels**. *Buildings*, 11, 621. https://doi.org/ 10.3390/buildings11120621, 2021.

[22] Tung Vy, S., Mahendran, M.: **Experimental study of load-bearing LSF wall panels made of built-up CFS channel studs at ambient and elevated temperatures**. *Proceedings of the Cold-Formed Steel Research Consortium Colloquium*, 17-19 October 2022 (cfsrc.org), 2022.

[23] Jelcic Rukavina, M., Skeji´c, D., Kralj, A., Šcapec, T., Milovanovi´c, B. **Development of Lightweight Steel Framed Construction Systems for Nearly-Zero Energy Buildings**. *Buildings*, 12, 929. https:// doi.org/10.3390/buildings12070929, 2022.

[24] Vicente, A., Flôres, E., Vicentini, A., Zadorosny, L.: **Design Modeling and Dimensioning of A Building In Light Steel Framing Construction System**. *Unifunec Científica Multidisciplinar*, ISSN 2763-5783, 2023.

[25] Burwood, S., Poul, J.: **Modern Methods of Construction: Evolution or Revolution: A BURA Steering and Development Forum Report**. *London: British Urban Regeneration Association*, 2005.

[26] Shah, S., Jain, M., Mehta, R.: **Report of Precast Building System**, 2016.

[27] Ely, A.: **Modern Methods of Construction compatible with best practice urban design**, *Waterfront Conference on MMC*, 2005.

[28] Somesh, M. Shivani, G. Raskshita, K.: **Twin Wall Technology**, 2023.

[29] **A Short Guide To Modern Methods Of Construction (MMC)**, https://www.hlnengineering.co.uk/. Available online 01.04.2025

[30] **Thin-Joint System, H+H Product Datasheet**: https://www.hhcelcon.co.uk/, 2023. Available online 01.04.2025

[31] Jangid, Y., Khan, A., Mohite, G., Narvekar, A., Gurav, K.: **Mivan Formwork in Construction**, *International Research Journal of Engineering and Technology (IRJET)*, Volume: 10 Issue: 04, 2023.

[32] Patekar, N., Shaikh, A.: **Assessing the impact of conventional formwork and Mivan formwork on construction productivity and efficiency**, *World Journal of Advanced Engineering Technology and Sciences*, 09(01), 240–247, 2023.

[33] Kazarnovskiy, V., Hadavi, M.: **The Main Factors Affecting the Character of Housing Construction in Iran,** *International Scientific Conference Environmental Science for Construction Industry, Sustainable Strategies of Urban Planning*, https://doi.org/10.1051/matecconf/201819301021, 2018.

[34] Ashtiany, M., Motamed, H.: **Earthquake Insurance in Iran: Solvency of Local Insurers in Light of the Current Market Practice,** *Natural Hazards, and Earth System Sciences*, DOI: 10.5194/nhess-2023-81, 2023.

[35] Financial Tribune. First Iranian English economic daily. https://financialtribune.com/articles/economy-business-and-markets/79384/iran-5m-new-homes-needed-by-2027. Available on-line 01.04.2025

[36] Tap Persia Travel Around Persia, https://www.tappersia.com/mohtasham-garden/. Available online 03.04.2025.

[37] https://www.pinterest.com/pin/372109987934243427/. Available online 03.04.2025.

[38] Saadatian, O., Haw, L., Sopian, K., Sulaiman, M.: **Review of windcatcher technologies**. *Renewable and Sustainable Energy Reviews*. 16 (3): 1477–1495. doi:10.1016/j.rser.2011.11.037, 2012. Available online 01.04.2025.

[39] https://www.dreamstime.com/editorial-stock-photo-old-kharanagh-village-yazd-iran-photo-was-taken-city-july-th-virtually-deserted-crumbling-mud-brick-image59666338. Available online 03.04.2025.

[40] Iran Tourism and Touring Organization (NGO), https://itto.org/iran/attraction/rasht-municipality-square/. Available online 01.04.2025.

[41] Al-Awag, A., Alaloul, W., S. Liew, M., Baarimah, A., Musarat, M.: **The Potential Role of Industrialized Building Systems (IBS) in Malaysian Sustainable Construction: Awareness and Barriers**. *The 2nd International Recent Trends in Engineering, Advanced Computing and Technology Conference (RETREAT) AIP Conf. Proc*. 2608, 020015-1–020015-9; https://doi.org/10.1063/5.0128035, 2021.

[42] Akah, E., Bassey, L., Oguike, M.: **Industrialized Building Systems (IBS) Algorithm: Merits, Demerits and Implementation Barriers in Nigeria**, *The Artist Journal (TAJ) Volume*. 6, no. 1, 2023.

[43] Taherkhani, R., & Saleh, A. L.: Awareness and prevalence of industrialized building system (IBS) in Iran. J. Teknol, 81(6), 13-23, 2019.
[44] Hashemi, A.: **Offsite manufacturing: a survey on the current status and risks of offsite construction in Iran**. *Journal of Civil Engineering and Architecture*, 9, 141-152, 2015.
[45] **Design and industrial implementation of buildings (topic 11)**. *Second edition, National building regulations (language, Persian)*, 2013.
[46] **Code of design and implementation of cold-rolled steel structures (non-structural part of the structure).** *Publication No. 613. Building and housing research center. Vice President of Planning and Strategic Systems.* (language, Persian), 2012.
[47] **Code of Design and Implementation of Cold Rolled Steel Structures (Section of Structures).** *Publication No. 612. building and housing research center. Vice President of Planning and Strategic Systems* (language, Persian), 2014.
[48] Ghaderi, R., Karimian, M., Khorasani, M.: Guidelines for the design and implementation of light steel construction system, (language, Persian), 2014.
[49] Ghasemzadeh, H.: **Lightweight (Light gauge) Steel Frame**. *K.N. Toosi: University of Technology*, (language, Persian), 2015.
[50] **Design and modern methods of construction**, CABE, Research outcomes: 5, Commission for Architecture & the Built Environment, London, 2004.
[51] Hashemi, A., Noguchi, M., Altan, M.: **Feasibility of Application of Modern Methods of Construction in Iran**, *ZEMCH 2015 International Conference*, 22-25 September 2015, Lecce, Italy.
[52] **Communication from the European Commission on the European Green Deal**: COM (2019) 640 final.
[53] **Regulation (EU) 2021/1119 European Climate Law European** Union (2020).
[54] Crippa, M., Guizzardi, D., Pagani, F., Banja, M., Muntean, M., Schaaf E., Becker, W., Monforti-Ferrario, F., Quadrelli, R., Risquez Martin, A., Taghavi-Moharamli, P., Köykkä, J., Grassi, G., Rossi, S., Brandao De Melo, J., Oom, D., Branco, A., San-Miguel, J., Vignati, E.: **GHG emissions of all world countries, Publications Office of the European Union, Luxembourg**, doi:10.2760/953332, JRC134504, 2023.
[55] Probst, L., Monfardini, E., Frideres, L., Moujahid, S., Luxembourg, P.: **European Union,. Smart Living: Advanced building materials**. *Business Innovation Observatory Contract No 190/PP/ENT/CIP/12/C/N03C01. Coordination: Directorate-General for Enterprise and Industry, Directorate B "Sustainable Growth and EU 2020"*, Unit B3 "Innovation Policy for Growth", 2014.
[56] Yingbo, J., Kaijian, L., Guiwen, L., Asheem, S., Jinxi, J.: **Comparing greenhouse gas emissions of precast in-situ and conventional construction methods**, *Journal of Cleaner Production*, Volume 173, Pages 124-134, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2016.07.143, 2018.
[57] Ashayeri, I., Goulding, J., Heesom, D., Arif, M., Moore, N., Obi, L., Ahmed, N, and Saini, M.: **Implementation of a novel data-driven approach to optimise UK offsite housing delivery**, *IOP Conf. Ser: Earth Environ*. Sci. 1101 042029, DOI 10.1088/1755-1315/1101/4/042029, 2022.
[58] Robert, H.: **Greenhouse Gas Emissions of Global Construction Industries, Crawford**, *IOP Conf*. Ser..: Mater. Sci. Eng. 1218 012047, 2022.