



Venezuela: Construction problems and sustainable construction. Collecting data to put the puzzle together. Part 1

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HIGHLIGHTS

- Knowledge about sustainability issues is not equally distributed in all geographic environments.
- In some contexts, the daily challenges make it harder to identify the importance of relying on the sustainability path to find long-lasting solutions for society.
- Venezuela is one of the countries where there is insufficient diffusion about the importance of sustainable practices.
- This research is part of a project oriented to identify the existing competitiveness and quality of life problems in Venezuela
- Education for sustainable construction is presented as proposal to reduce the Venezuelan problems.

ABSTRACT

The Venezuelan construction sector faces complex problems from multidisciplinary causes. The severe consequences keep the country far from the sustainable development goals established by the UN by 2030. With the certainty that education is fundamental to finding long-lasting global solutions and the aim to address Venezuela into the sustainable path progressively, the article adds new data about the main problems that confront the construction sector and the fundamentals of sustainable construction education performed in Venezuela. With the participation of some construction stakeholders and public data, the authors try to progressively assemble the puzzle of the Venezuelan case in an attempt to help to develop a consciousness about the importance of improving education, with an emphasis on construction, incorporating sustainability concepts from the basic processes to be able to identify opportunities, risks and to be resilient, evolve and succeed in the current changing and unpredictable world.

Keywords: *Construction Sustainability, construction problems, education, Venezuela*

1. INTRODUCTION

The complexities existing in Venezuela and the contradictions made evident by the abundance of resources, and at the same time, the extended poverty that places 96.2% of the Venezuelan population in the rank of total poverty and 79.3% in the rank of extreme poverty [1] make the performance of this country a case that needs to be studied.

The extreme consequences that the country faces in terms of loss of production, poverty, energy poverty, and the progressive deterioration of the quality of life have piloted the authors to perform various research on related matters. In consequence, in the last years, they have approached the Venezuelan case from diverse perspectives that include competitiveness, public policies, energy, construction problems, infrastructure deficit, poverty, sustainability, public services, education, knowledge management, and Covid 19 impact, among other.

The identification of the world benchmarks of competitive countries in terms of education, sustainable construction, knowledge management, renewable energy, sustainability efforts, the value of ancient knowledge and lessons learned, and the attempts to succeed in the recovery of normality in the COVID 19 Pandemic era, are part of the framework used to compare what happens with the Venezuelan case. This is mandatory to understand the

fundamentals of the national situation, identify its roots and cross variables, collect the pieces needed to describe the case, analyse it, and propose some actions that may help improve the current Venezuelan conditions.

In a recent article [2], we revised twenty-five engineering and architecture career programs of Venezuelan and foreign universities to see if they were mostly related to technical and professional matters or included sustainability and global knowledge notions. The conclusions show a wide variety among the curricula, as some universities have a sustainable and global knowledge perspective. In contrast, others are concentrated on academic and technical matters and miss to make specific links with the teachings of the past, the heritages of antique learning, and the current lessons learned from the global social, economic, environmental, and cultural variables related to sustainability, that are fundamental to face the challenges of recent times.

The present research continues on the track of such aspects and tries to evaluate Venezuela's current construction problems and identify the primary sustainability education received by its stakeholders. The research was performed considering the perspective of the members of the Cámara de la Construcción del Estado Zulia (CCZ) (Zulia State Construction Chamber) [3] and with support of the Consejo Venezolano de Construcción Sostenible (Venezuelan Council for Sustainable Construction, CVCS) [4]. The

information from such direct construction stakeholders is complemented with public data related to the Venezuelan infrastructure and educational conditions from diverse academic and institutional sources.

The information collected is intended to profile the Venezuelan case better and help put the puzzle together and supplement the Venezuelan statistics. This is needed to help build a comprehensive database that may help better understand the case and address some root solutions.

2. THE MILLENNIUM GOALS. EDUCATION AND SUSTAINABLE CONSTRUCTION FRAMEWORK.

Education has been a pillar of society's evolution since the early ages, described as the formal processes that have been designed to support the transmission of knowledge, values, and principles of society, starting with the primitive cultures as the way to help their individuals to become good members and be prepared to be able to perform their role in society. The children learn by observing and performing the basic practices in their close community [5].

Since the beginning of time, the evolution of education has been impressive. Starting from the knowledge of early prehistoric civilizations, education was transformed by the progressively more developed and profound teachings and institutions developed by Egypt, Mesopotamia, China, Maya, Aztecs, Incas, ancient India, Hebrews, Greeks, Romans, Persian, Byzantine, Russian and Islamic civilizations, Africa, Oceania, Japan, and many other countries. The signs of progress with education have been huge, including the development of schools and philosophers, the creation of universities such as Bologna, Oxford, Salamanca, the education during the renaissance and reformation, the education for vocational and industrial purposes, among others. Altogether, it has supported the evolution of humanity while making easier the integration of complex cultural diversities, strengthening personal and social cohesion, and giving more opportunities for growth, development, and equality [5].

During its evolution, humanity has progressively included studying its critical aspects in education. This is the case of environmental and sustainable concerns studied since early times. There are references from the Greek philosophers during their philosophical thinking [6].

Deforestation, illness, soil erosion, production decline, and climate changes, among other consequences, were acknowledged and described as a manifestation of the damages caused by society to the environment and thus created essential knowledge still valid [7].

The traces of more formal environmental sensibility and education can also be found in the studies of other philosophers and scientists as Rousseau (around 1760) and Agassiz (about 1830), who sustained that education should maintain attention to the environment and the students should learn more directly from nature [8].

From such times the awareness of the need to incorporate sustainable and integral perspectives in all social processes has been growing and extending to diverse backgrounds. In 1987, the World Commission for Environment and Development (WCED) published "Our Common Future," known as the Brundtland Report. In such a document, the Commission warned that environmental problems arose because of the imbalances and poverty that prevailed in the southern countries, along with the unsustainable patterns of production and consumption existing in the North. The Brundtland report promoted multilateral strategies to achieve development coordinated with the environment [9]. These efforts permitted us to define the term sustainable development and the basic sustainability concept and principles that we refer to currently.

In 2002, the United Nations General assembly released a resolution declaring 2005-2014 the decade for education for Sustainable Development [8]. Since then, sustainability has

been the priority of many nations in all areas of life and productive activity, including education and the construction industry.

In 2015 the Members of the United Nations integrated their diverse perspectives about sustainability and promoted the Sustainable Development Goals (SDGs) as the road to creating a more balanced lifestyle. Table 1 describes the seventeen goals proposed [10].

Table 1. *United Nations. Sustainable Development Goals*

Goal 1. No poverty.
Goal 2. Zero hunger.
Goal 3. Good health and well-being.
Goal 4. Quality education.
Goal 5. Gender equality.
Goal 6. Clean water & sanitation.
Goal 7. Affordable & clean energy.
Goal 8. Decent work & economic growth.
Goal 9. Industry, innovation & infrastructure.
Goal 10. Reduced inequalities.
Goal 11. Sustainable cities & communities.
Goal 12. Responsible production & consumption.
Goal 13. Climate action.
Goal 14. Life below water.
Goal 15. Life on land.
Goal 16. Peace, justice & strong institutions.
Goal 17. Partnerships for the goals.

[10]

These Goals were set as guidelines to promote joint efforts to reach for balanced social, economic, and environmental sustainability as the path "to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030" [10].

Based on such parameters, all the nations are invited to invest their knowledge, technology, and all the resources needed to reduce to zero hunger and the existing socio-economic and environmental unbalances to improve the quality of life for humankind.

The relationship between education, construction, and sustainability is very tight. Therefore, the United Nations declared Quality and Equitable Education as the 4th Development Goal to be accomplished, highlighting the

importance of improving education as a fundamental element for sustainability [10].

The United Nations also included the following aspects as goals to be reached by the construction and infrastructure sectors to offer the society a built environment suitable to support the balanced development expected. Therefore, they emphasize the importance of Clean Water and Sanitation; Affordable and Clean Energy, Industry, Innovation, and Infrastructure, Sustainable Cities and Communities, Life on Land [10].

The European Student Union [11] proclaimed a statement highlighting the importance of studying sustainability holistically and the climate and sustainable development goals to include all the different dimensions.

They proposed the creation of an added valued education to back new sustainable ecological, environmental, political, economic, production, and consumer attitudes of society. The aim is that such education becomes the basis for balanced, sustainable communities living with social justice. They warn that many people are still not yet involved with these processes, and thus, the educational environment has much idle capacity and needs changes to become an active part of the sustainability struggles [11].

Regarding the relationship between construction, environment, and education, the American Society for Engineering Education (ASEE) generated a statement on Sustainable Development Education [12]. They indicated the need to provide engineering students with a comprehensive educational curriculum to prepare them to understand and support sustainable development fully.

The ASEE [12] considers it compulsory to develop an integral education that includes ethics, understanding other nations and cultures, and forming interdisciplinary teams to study sustainable engineering design and construction techniques, systems, clean technologies, economies, and their global interconnection. Moreover, they propose incorporating case studies and evaluating the relationship between society, environment, and engineering to make viable and usable the

sustainability concept and policies viable and usable. This will also help engineering students and related parties use such knowledge in their corresponding communities to support their evolution into a global perspective.

As part of the ASEE, Minerick [13] warns that engineering practices and education need to be adapted, so the engineering world can optimally sustain the progressive global evolution. By these means, she proposes to revise engineering approaches and culture to be able to develop new processes valuable to support current changes and needs.

Intending to improve construction education, Wang [14] proposed the incorporation of sustainability into engineering teaching. This author stands that sustainability issues must be involved in all engineering knowledge areas and overall phases of education. This demands profound changes in the traditional construction and management paradigm, the revision of education methodology and content, and the development of adequate education for the instructors, students, and all related parties to make them sensitive to support the changes needed to promote genuinely sustainable education and become part of the solutions.

Other experts propose the development of the sectoral participant's potential to make innovative changes to improve the building's environmental performance. They propose to perform sustainable design and operations in an integral virtuous circle that optimizes water, energy, and materials, minimizes waste, and reduces the carbon footprint. At the same time, this process enriches the history, art, and anthropological heritage of humanity [15]

Pradhananga, Elzomor, and Santi [16] refer to previous research of Elzomora et al. [17], Pauw et al. [18], Olivieri [19], and Owens [20] and state that developing countries - Venezuela among them - present limitations in their possibility to have sustainable built environments. This is due to the severe environmental consequences caused by unsustainable construction practices such as the use of non-sustainable materials,

solid waste mismanagement, and lack of sustainable energy supply. These authors consider that such problems arise, among other causes, to the lack of sustainability education and limited activities in research and development. An integral perspective and improved educational sustainable approaches are fundamental to tackling the current environmental issues in developing countries. The authors highlight the need to improve environmental education and training in Venezuela from the communities and global and local environment to increase environmental awareness and efforts in the construction industry and include sustainable practices. They consider that women are fundamental because of their awareness of sustainability issues. They foresee improving opportunities in higher education and research to progress in sustainability practices in Venezuela.

From a complementary perspective, Pietrosemoli, Rodríguez-Monroy, and Nuñez [2] alert that the construction sector confronts severe challenges and disruptions that make it hard to reach the planned project performance terms of quality, project duration, or costs. The risks and disruptions are so frequent that it forces stakeholders to react promptly to changes to perform better, be competitive and follow sustainability principles. To be able to do so, the stakeholders require proper construction education. In their research, based on engineering and architecture programs, they wonder if the current construction education - moreover to technical issues - also includes sufficient references to past knowledge, notions of sustainability, and global matters to allow its participants to match past, present, and future and thus identify challenges and risks, giving them the tools to act appropriately. Their findings, including some Venezuelan results, showed different construction education perspectives, with some cases of integral technical sustainable construction education and others limited to technical and academic matters. They propose incorporating critical analysis and comparisons with data and cases from diverse successes, disruptions, or errors as

required education innovation to support this industry's competitiveness and sustainability.

The described framework makes evident that the global construction sector faces complex challenges that can be better addressed with the support of integral education capable of preparing all stakeholders to evolve and act appropriately in front of disruptions, challenges, risks, and new realities. Global education should promote global and sustainable attitudes that support a better competitive, sustainable, and balanced world.

3. VENEZUELA. MAIN ISSUES AND SUSTAINABILITY OPPORTUNITIES

The previous parameters are set as benchmarks to evaluate the fundamental issues regarding sustainability in Venezuela and the current opportunities to improve its performance via education and sustainable construction efforts.

In general, the global sustainability efforts of the nations are measured from the perspective of the country's performance compared with the seventeen Sustainable Development Goals established by United Nations indicated in Table 1. Such seventeen goals are set as formal guidelines for every nation. In Practice, it is not easy to fully understand the actual evolution of each country regarding such goals since the lack of reliability of objective data may be a fundamental limitation in evaluating the performance of some countries [21]. This is one of the constraints existing in Venezuela's research as official data is not available or it is not accurate.

In previous studies, the authors have analyzed diverse aspects of the current Venezuelan conditions and the evolution of the energy, infrastructure, and public services performances. Such studies have gathered evidence of the country's consequences because of the energy, construction, competitiveness, and public services problems in terms of deterioration of the

quality of life and thus the sustainability opportunities that challenge the country.

In a recent article, the Inter-American Development Bank (Banco Interamericano de Desarrollo) [22] defined the current Venezuelan firms and called the ones that were able to stay operative until 2021 "the survivors of the deepest economic contraction of modern history". This describes the country's consequences because of various policies that were not able to succeed and thus the incapacity to take advantage of the enormous energy potential and vast resources available in the country. In the current article, the authors provide additional data that may help understand the basis of such a situation.

The Venezuelan energy potential and mineral richness are known from pre-Hispanic times. Such discoveries progressively conducted to the

Venezuelan energy tradition that started at the end of the ninetieth century, with the beginning of the commercial oil exploitation that opened the country's opportunities for growth and development [23].

From such times, the various policies applied - most of them based on short term political perspectives - created erratic performances in the country with stages of growth, investments, and modernity, with quality-of-life improvements, followed by other of a high degree of intervention, disinvestment, production, and exchange decrease. The current stage, characterized by an interventionist model with control policies of the social and production system, the consumer prices, the foreign exchange, and labor markets, along with the control of some private productive assets, progressively led to the increase in poverty, the deterioration of the quality of life of the population, lack of fuel & electrical service, severe ecosystem damages and the highest inflation in the world [22].

To construct a whole perspective about the current state in the sustainability field, in the following tables, the researchers provide some additional data about the fundamental issues

affecting Venezuelan performance. From the viewpoint of general development, the country presents the indicators shown in Table 2.

Table 2: Venezuelan Indicators - Competitiveness, Investments & Economic performance

Indicator	Source	Position	Reference parameter
Competitiveness 1	WEF 2019	133	Best: 1. Worst: 141. Data 2019. In 2005: 84
Competitiveness 2	IMD 2021	64	Best: 1. Worst: 64. Data 2021
Attractiveness for investments in oil & gas exploration and production	Fraser Institute, 2018	1	Worst barriers for investments in oil and gas
GDP Reduction 2014-2020.	ENCOVI 2021	74%	Reduction of production & productivity
Inflation 1	World Population review 2022	958600%	Highest inflation in the World. Data 2019
Inflation 2	Statista 2022	2355.15%	Highest inflation in the World. Data 2020
Venezuelan firms capacity utilization	The venezuelan enterprise, 2021.	22.10%	In 2010: 75.8%

The country's oil and energy production, which are fundamental variables for the competitiveness and macroeconomic variables indicated in the previous table, have shown a severe setback in the last decades, as shown in Table 3.

Table 3: Venezuelan Indicators - Energies production & Consumption

Indicator	Source	Position	Reference parameter
Oil production. (Thousands of barrels per day)	BP 2021 [30]	540	Oil Production in 1965: 3503 Tbd/ In 2010: 2842/ in 2013: 2725 Tbd
Natural gas production. (Billion cubic metres)	BP 2021 [30]	19	Natural gas Production in 2010: 30.5/ in 2013: 30.6. Data 2020
Renewable energy Solar, wind, biofuels production capacity and consumption capacity	BP 2021 [30]	N/A	N/A
Electricity generacion. Terawatt-Hour	BP 2021 [30]	58.40	In 2010: 116.7 Terawatt-hour/ in 2013: 130.0 Terawatt-hour.

As indicated in the Sustainable Development Goals, education is a fundamental variable for developing a country and its quality of life. In this respect, the Venezuelan indicators show an inadequate performance due - among other conditions - to restrictions in educational coverage and the computers and internet access at home. This occurs mainly in poorer sectors. These limitations, along with the low proportion of people dedicated to Research and Development, as indicated in Table 4, show some of the Venezuelan education breaches that keep the country far from the SDG 4 Quality Education.

Table 4: Venezuelan Indicators - Education & R&D

Indicator	Source	Position
Educative coverage (2018)	ENCOVI 2019	70%
Scholarized population that regularly assist to educative institutions.	ENCOVI 2019	50%
Children attending school (1Q group, Poores) (2019)	ENCOVI 2019	92%
Head of household with high school and other studies (1Q group, Poores)	ENCOVI 2019	21%
People with Internet access at home (1Q group, Poores)	ENCOVI 2019	17%
People with computer at home (1Q Group, Poores)	ENCOVI 2019	72%

The quality and availability of infrastructure and services are other variables related to each country's performance because they support economic growth and quality of life. Table 5 describes some indicators that explain the conditions of Venezuelan infrastructure and the setback that took place in the last decades from the advances reached previously.

Table 5: Venezuelan Indicators - Infrastructure

Indicator	Source	Position	Reference parameter
Quality of Overall Infrastructure	Worldbank 2022	125	Best: 1. Worst: 137. Data 2017
Infrastructure construction Ranking	Index Infrastructure . Kiel 2014	81	Best: 1. Worst: 140. Data 2014. In 2010: 68
Electricity Infrastructure. Hydropower & Thermal Installed capacity vs availability	Crisis de los Servicios Públicos. 2019	Available: 13.020MW	Installed capacity 36.752MW.
Roads/Airports Infrastructure quality	Ranking mundial Infraestructura 2017.	119/131	From 137 economies. Best: 1. Worst: 137.

Figure 1 shows the international measurements of the quality of the overall Venezuelan infrastructure.

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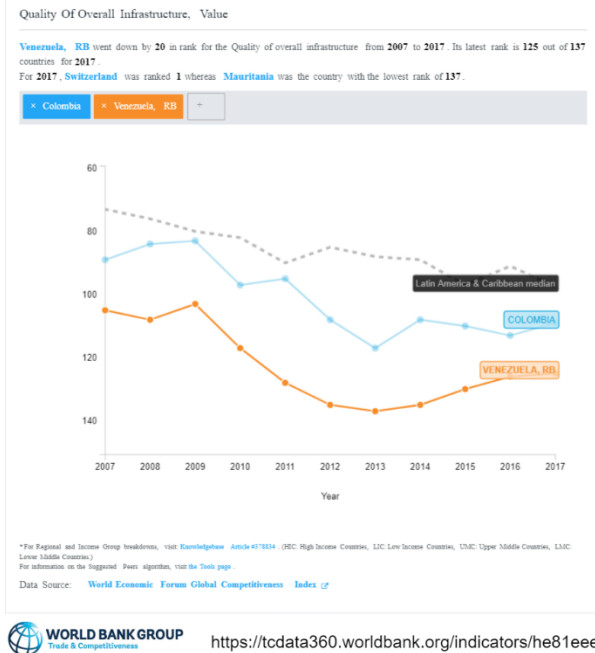


Fig. 1: Quality of the Venezuelan infrastructure. [35]

The complex macroeconomic and infrastructure conditions and the public policies that govern them have led to the Venezuelan public services crisis outlined with the indicators mentioned in Table 6.

Table 6: Venezuelan Indicators - Public Services

Indicator	Source	Position
Electricity Structural deficit. % of country that suffer Blackouts	Crisis de los servicios publicos. 2019	35%
Households with deficit of public services	INSO-ENCOVI 2022	71.2%
Population that experiences interruption of electricity	The venezuelan enterprise. 2021.	84%
Population that experiences interruption of water services	The venezuelan enterprise. 2021.	44%
Proper water & sanitation services coverage: % of the population/ % of sewage that is treated	Crisis de los servicios publicos. 2019	18%/5%

The Venezuelan sustainability gaps can also be evaluated from the perspective of the quality and availability of households. In this respect, Table 7 presents some indicators that show the country's weakness to offer safe and healthy homes for its citizens, as the country presents one of the highest household deficits in Latin America.

Table 7: Venezuelan Indicators - Households

Indicator	Source	Position	Reference parameter
Household deficit in 2016 (Total)	CVC 2019	2,442,987	Deficit in 1980: 883,083
Portion of households requested to substitute slums, irregular settlements & overcrowded units	CVC 2019	1,800,000	
Portion of households that need deep improvements and services	CVC 2019	642,987	

The data indicated in Table 8, based on statistics collected from international institutions, show that the country is underperforming in attaining the 17 SDG established by the UN and thus present a significant sustainability gap.

Table 8: Venezuelan Indicators - Sustainability

Indicator	Source	Position	Reference parameter
Commitment to sustainability	World Bank 2022	130	Best: 1. Worst: 141. Data 2019
The 2020 Sustainable Development Goals Index Position/Rank	Sustainable Development Report. 2020	118	Position: Best: 1. Worst: 166.
Sustainable Development Goals Index Score	Sustainable Development Report. 2020	61.7	Best: 100
Sustainable Development Index Position/ Rank	Sustainable Development Report. 2021	122	Best: 1. Worst: 165.
Sustainable Development Index Score	Sustainable Development Report. 2021	59.3	Country's total progress towards achieving all 17 SDGs. % of SDG achievement. In 2012:

Figure 2 shows such performances

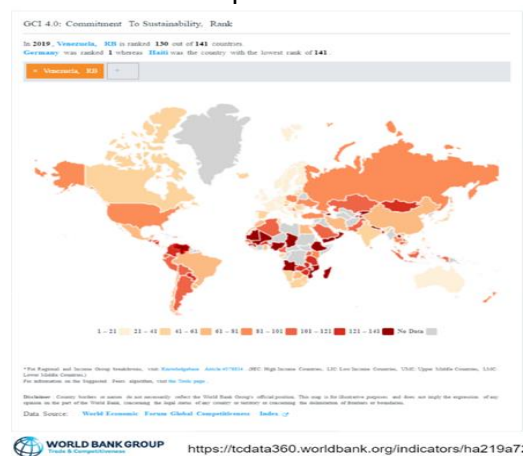


Fig. 2: Commitment to sustainability. [39]

According to such measurements, the Sustainable Development Report 2020 [21] describes that Venezuela was the country with the SDG Index that decreased most globally since 2015, and this same performance continues in the following measurement realized in 2021 [38].

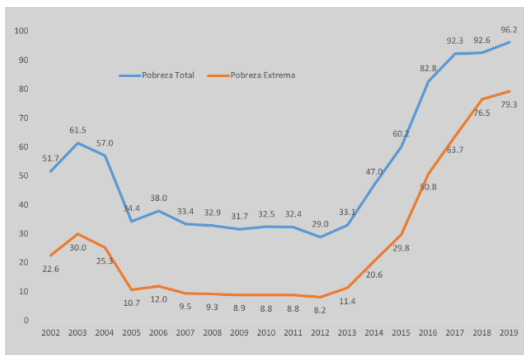
The previous indicators show some of the critical issues that limit the Venezuelan possibilities to

offer its citizens progressive improvements and a sustainable way of life. However, an indicator can explain the dramatic circumstances that suffer a large part of the Venezuelan population and many of the current sustainability gaps. This is the Poverty level. As shown in Table 9, the poverty problem affects almost the entire Venezuelan population.

Table 9: Venezuelan Indicators - Poverty

Indicator	Source	Position
Total Poverty (% of population)	Proyecto Encovi 2019	96.2%
Extreme Poverty (% of population)	Proyecto Encovi 2019	79.3%
% of homes without Food Insecurity	Proyecto Encovi 2019	3%
Recent Poverty	Proyecto Encovi 2019	54%
Consumption poverty	Proyecto Encovi	68%
Chronic Poverty	Proyecto Encovi	41%

Figure 3 displays the poverty in Venezuela.



— Total Poverty — Extreme Poverty

Fig. 3: Poverty line in Venezuela[40]

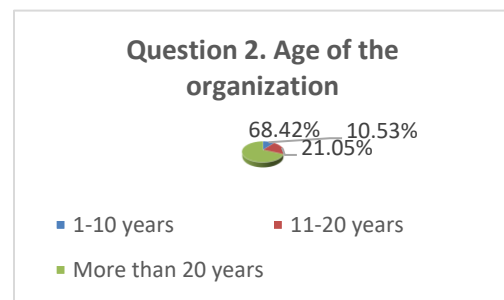
These results are particularly shocking because the Venezuelan performance is contrary to the positive trend of global poverty diminution that was a global achievement of the last decade before the Covid 19 impact. In fact, before the pandemic, in 2019, there was a 1.4% global reduction of people living in extreme poverty since the adoption of the Sustainable Development Goals in 2015 [38]. The Covid-19 pandemic established a severe setback in the global improvement of the poverty and unemployment levels reached in the last decades. Still, most nations struggle to reduce

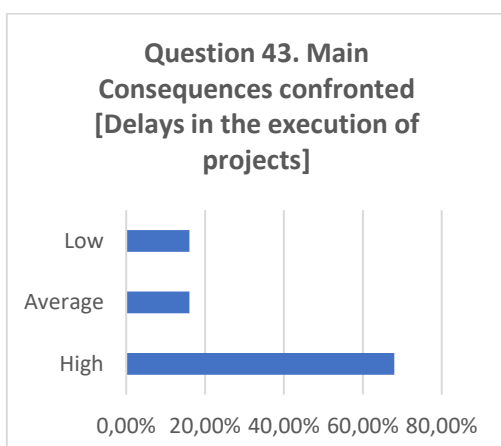
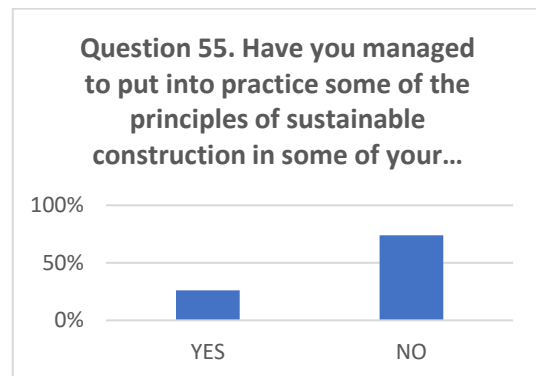
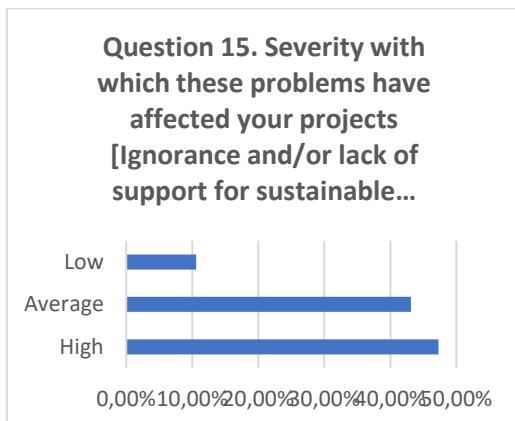
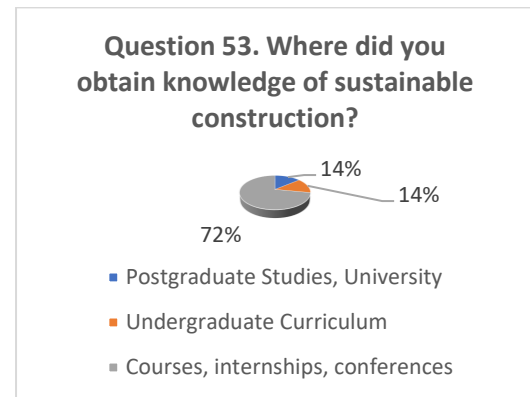
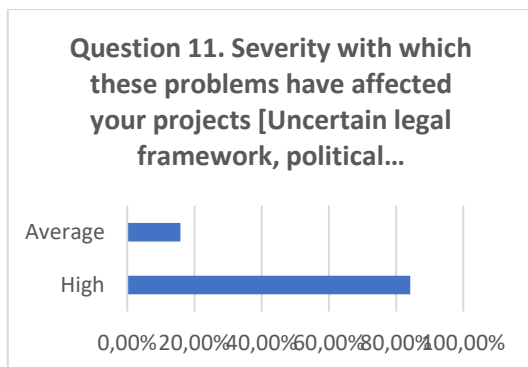
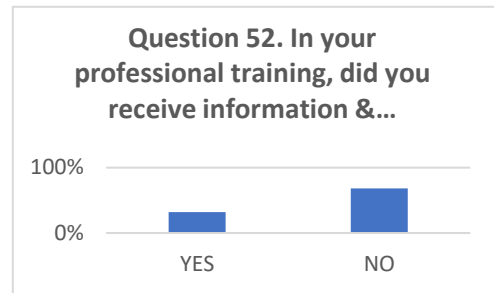
poverty and unemployment levels and keep on track with the 6% reduction established to be reached by 2030.

The mentioned indicators show the Venezuelan case's complexities and illustrate the country's distance from achieving all the 17 SDGs by 2030. The data presented show the road that Venezuela must travel to progressively address the path of sustainability.

4. STUDY PERFORMED AND RESULTS

To continue building the database related to the Venezuelan case, in the current research, the authors looked for additional information regarding the fundamentals of sustainable construction education performed in Venezuela and the main problems that confront the construction sector. Using Google forms was created, verified, and sent a questionnaire to the company representatives participating in the Cámara de la Construcción del Estado Zulia (Chamber of Construction of the Zulia State) as affiliated and members of the board of directors. This guild aggregates more than five hundred members, but in 2022 only forty-five companies are active in the chamber. The questionnaire was sent in December 2021. Only nineteen answers were received. Responses may correspond to the same organization, coming from different representatives. Some of the main results found are presented below.





The low number of responses is a limitation that does not permit a realistic overview of the sectoral situation. Nonetheless, the authors found some interesting facts.

Most persons that participated in the survey were employed in consolidated firms with more than 20 years of activity. Seventy-four percent of the surveyed companies have formal quality assurance processes, and 58% of them have certified their quality assurance system. This means that most participants work in mature companies with processes formally established. More than 63% of the respondents developed their professional careers in 1980-2000. 73.68% of them studied only in Venezuela, and 26.32% studied in Venezuela and abroad. Regarding the

problems related to public policies and the general environment, most respondents acknowledge the severity of cases of expropriations, riots, civil commotion (42%); the uncertain legal framework and political and economic framework (84%), and corruption (58%) as the most impacting problems in their activities.

Inflation (79%), the lack of investment in urban development (74%), and the ignorance or lack of support for sustainable construction (47%) are recognized as the main problems affecting their performance. The respondents consider that the most significant consequences of such issues are the quality deviations among the planned and executed (56%), the delays in the execution of projects (68%), and financial problems (69%).

Regarding sustainable knowledge, 68% of respondents said they did not receive formal knowledge concerning sustainable construction during their education. Of the 32% that declared that they received information about sustainable construction, 72% got it from extra-curricular sources such as courses, internships, and conferences, 14% got them from the undergraduate curriculum, and 14% got them from postgraduate studies.

These particular results reinforce the authors' hypothesis that general education and, in particular, construction education in Venezuela lacks the incorporation of formal knowledge about sustainability, especially in undergraduate and postgraduate construction, engineering, and architectural studies. Such educational weakness is considered one significant limitation that may be one of the variables behind the Venezuelan sustainability underperformance. The information gathered facilitates the continuation of the research in such a field.

5. VENEZUELA. SOME STEPS IN THE SUSTAINABLE DIRECTION

Despite the complex conditions described, part of the Venezuelan society struggles to address

the country on the path to sustainability. In fact, notwithstanding the adverse conditions in the country, there are some initiatives about incorporating sustainability principles in some areas such as energy production and construction, mostly coming from academia and private sectors.

In this regard, in 2007, Acosta and Cilento [41] highlighted the sustainability problems existing in Venezuela and the importance of reaching for balanced development. They proposed some strategies for sustainability that include incorporating public policies to promote sustainability and an R&D agenda for the built sector to offer buildings developed to correct the impact of decades of precarious and environmentally damaging constructions in Venezuela.

Solano [42,43] refers to Venezuela's critical gaps in sustainability in areas such as poverty, health, education, and services. The author indicates that the country also presents important planning and urban management gaps regarding the built sector. To solve such problems from their causes, the research team promotes a systemic perspective for developing constructive guidelines to be followed by promoters, builders, and consultants in an alliance between the construction and the real estate sectors to achieve urban sustainability. Among other efforts, they created a private sustainability unit to share knowledge, teach and give advice to incorporate those principles, standards, and certifications in the built sector.

De Paola [44] 2016 refer that even though Venezuela has a tradition of modern architecture and building innovation, with some examples of municipal authorities that promote sustainable construction, in general, the country presents significant backwardness in such field concerning the progress of the construction sector in many other countries. Based on the Vector Verde project developed on Margarita Island, she evaluated the whole LEED certification process from the actors' perspective during the

construction stage. The Vector Verde certification is the pioneer case in the sustainable construction certifications in the country. De Paola found that even though the project was built in the exceedingly complex and adverse socio-political and economic Venezuelan circumstances, the additional challenges to meet the sustainability goals were faced appealing mainly to the actor's attitude. According to the perspective of the different actors, the experience was positive. It showed that it is possible to implement construction sustainability criteria in Venezuela despite the adverse circumstances and keep innovating and progressing efforts.

De Paola [44] also identifies the orientation in Venezuela toward the LEED certification, which recognizes it as very complete and inclusive in terms of comprehensive sustainability but warns that it was created in frameworks that were quite different from Venezuela. Therefore, she proposes the need to evaluate the use of certification systems more suitable for the local conditions. As the research was developed during the construction stage, she also proposes to evaluate the Vector Verde project based on the operation stage to confront the theoretical certification perspective with the practical one.

In their recent research, Pradhananga, Elzomor, and Santi [16] studied the sustainable construction practices in Venezuela. The study was based on the literature review and a survey applied to some construction stakeholders working in the central area of Caracas. Even though this survey does not represent the whole perspective of the Venezuelan complexities - as the reality of the inner country is quite different from the capital zone - this study presents interesting information about the construction practices. The authors based their research on five hypotheses about the Venezuelan Construction Industry 1) Unstable political environments delay the integration of

sustainable construction practices, 2) Construction companies are reluctant to incorporate new sustainable trends in a turbulent economic environment. 3) Low utility costs and lack of incentives reduce the demand for sustainability features and practices, 4) Increasing environment awareness fosters the inclusion of sustainable construction practices, and 5) Sociodemographic status impacts the perception and need for sustainable construction practices.

The authors concluded that in Venezuela, there are very few cases of buildings certified based on international ratings about sustainability and energy efficiency because of the main impediments affecting the construction industry. The survey found that the most common sustainable Practice used in their area is incorporating rainwater collection systems (RCS) and converting a prior developed site (CPDS). The authors found that the respondents were not as knowledgeable regarding other common sustainable construction processes as the use of low water usage plumbing fixtures (LWUP), the practice of reflective coating in the exterior of a building (RCE), building site positioning to take advantage of energy efficiency (SP), designing buildings to take advantage of daylight and natural ventilation (DB) the use of alternative sustainable materials (ASM) and the use of renewable energy sources (RES). Among the barriers to the integration of sustainable construction practices in the Venezuelan construction industry, the authors found: Lack of environmental awareness (EC), poor public education (PPE), weak innovative culture (WIC), and lack of sustainable regulations (SR).

Other barriers resulting from the research were found in the low utility costs (UC), inflation (I), political crisis (PC), corruption (C), construction material shortage (CMS), water and electricity shortage (WES), safety negligence (SN), lack of qualified professionals (QP), unskilled workforce

(UW), and stealing of materials and equipment (SM). The centralization and absence of leadership, the insecurity, and the instability caused by the humanitarian crisis are tight with the described barriers. The authors highlight the need to improve the Venezuelan sustainable education and the implementation of construction sustainability practices since the project designing and during all the projects phases to address the construction industry into the sustainability path [16].

To solve such a gap, they propose designing and developing an innovative educational framework to involve the Venezuelan communities in sustainable issues to make them conscious and part of the environmental practices and efforts. They propose that such modules could be shared via higher education institutions, the Internet, and construction companies to make society and policymakers aware of their duties about a more sustainable built environment [16].

One of the pieces of evidence that show that despite the adverse circumstances, Venezuela continues to bet on progress is the creation of Consejo Venezolano de Construcción Sostenible (CVCS) (Venezuelan Council of Sustainable Construction) [4]. Formally created in 2016, and after a recess, in activities again since 2021, it has the aim to promote and stimulate sustainable construction in Venezuela, supporting initiatives to reduce the impacts of buildings on the environment, improve the quality of life of communities contributing to the progress of the country. Their activities include promoting and encouraging sustainable construction, generating, sharing knowledge, learning, and social changes concerning sustainable development and construction projects.

The CVCS includes diverse professionals from the architecture, engineering, building, real estate, academic, private, and some public sectors that want to help change current Venezuelan conditions and insert Venezuela into the path of

Sustainable Construction. They have already supported important initiatives. An example is the Maneiro Municipality, Nueva Esparta State, which in February 2022, subscribed to the Building Efficiency Accelerator program [45] that aims to improve the energy efficiency in the city buildings and thus support the attainment of the 2030 Energy for All Sustainable Development Goal and the progress into sustainable communities in Venezuela. The Maneiro Municipality aims to be the first sustainable municipality in Venezuela, and its efforts are promoting similar processes in other Venezuelan localities. Beyond such advice, other CVCS activities include creating networks to promote Sustainable Construction principles and goals in Venezuela and creating and disseminating knowledge via databases, webinars, courses, and training.

The different initiatives mentioned show that despite the challenging environment in which they act, some construction industry actors are aware of the challenges and take some tangible steps toward sustainability.

6. PROPOSALS

Even if the research is still preliminary, the authors propose some basic guidelines for what they consider should be the steps into the path of sustainability in Venezuela.

- Continue the research in this field to complete the data required to understand the problem and its implications thoroughly.
- Based on a new global perspective, promote the significant changes in the Venezuelan socio-political framework to make it oriented to the long-term balanced sustainability trend based on solid and positive governance.
- Promote the changes in the public policies needed so Venezuela can support the Six Major transformations required to

reach the Sustainable Development Goals [38]. That includes:

Transformation 1 Education Gender and Inequality (SDG 4)

Transformation 2 Health, Well Being and Demography (DDG 3)

Transformation 3 Energy Decarbonization and Sustainable Industry (SDG 7,12 and 13)

Transformation 4 Sustainable Food Land Water and Oceans (SDG 2, 14, and 15)

Transformation 5 Sustainable Cities and Communities (SDG 6, 9, and 11)

Transformation 6 Digital Revolution for Sustainable Development (DDG 9)

- Promote the incorporation of sustainability notions since the Venezuelan primary child education
- Evaluate the Venezuelan engineering architecture and construction curricula to identify the general and particular sustainability notions they already include and identify their improvement areas. Propose the curriculum changes to fulfill such gaps.
- Promote the incorporation of sustainability principles in all public and private construction projects
- Continue the research in such knowledge areas.

7. CONCLUSIONS

The current research demonstrates that the Venezuelan problems are multidisciplinary, and they have causes deeply rooted in non-sustainable and extended social behavior.

The indices described evidence of the complex challenge that the country faces in terms of sustainability. The public policies, the educational gap, the irregular production modes, the environmental damages, the severe poverty, the energy shortages, and the general crisis make sustainability a goal to be reached that in Venezuela can still be seen from an early stage.

The educational gap is a relevant variable in this respect. Moreover, to the limited coverage,

absenteeism, or the schools' infrastructure and services conditions, the survey demonstrated that only 26% of the surveyed have been able to put into practice some of the principles of sustainable construction in their projects. This means that even people who go to the university have limited access to sustainability knowledge, in this case, regarding sustainable construction.

Regarding construction problems, the incidence of a weak legal framework, takeovers, riots, civil commotion, the political and economic uncertain environment, corruption, inflation, and lack of support for urban development and sustainable construction are acknowledged as the main problems affecting the sector. The consequences are described in terms of delays in projects' execution of projects, quality deviations, and financial damages.

For most of the 96% of the Venezuelan population that unfortunately lives in poverty, sustainability is an abstract concept that cannot be understood as a solution for their needs. Having such a dramatic reality in mind makes it mandatory that those who have the knowledge and the capacity to make positive changes transform them into actions that can make a real difference in Venezuela and the developing world.

In this respect, it is hoped to know that groups are working to change the current state of the art and transform sustainable theory in Venezuela into tangible actions. More research is needed in this respect, but there is an improvement opportunity in such fields. The educational sector and the construction industry must work together to make such changes happen.

The emphasis must be placed on the educational and construction sector. The data and the

proposals presented are intended to help assemble the Venezuelan puzzle finding the missing pieces that constrain reaching the sustainability goals. This is intended to make all individuals - in particular, the construction stakeholders - to be able to identify opportunities risks and be resilient, evolve, and succeed in the current changing and unpredictable world. This approach may lead Venezuela to make the best and most sustainable profit from the vast country's resources.

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