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Sustainability Assessment in Housing Building Organizations for the Design of Strategies against Climate Change

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Abstract

One of the biggest problems facing humanity is climate change, and the construction industry is one of the sectors causing the greatest impact. Therefore, design strategies accompanied by new methodologies are necessary. In this sense, this paper aims to assess sustainability for the design of organizational strategies against climate change, based on a holistic and systemic approach to sustainability development, in order to contribute to the decision-making in housing building organizations. The assessment was based on: 1) climate change indicators were selected from a case study; 2) a survey based on climate change indicators was designed and applied to 21% of the total organizations under study; and 3) critical indicators were identified. The result shows that 58% of the climate change indicators are critical and give evidence of the negative outlook that housing building organizations have in terms of sustainability. About 69% of these indicators belong to the cultural dimension. This demonstrates the lack of knowledge, customs, habits, and commitment to implementing sustainable strategies against climate change in these organizations. Finally, the results can contribute to designing strategies to promote sustainable building by the local government, and thus achieve more sustainable organizations that contribute to reducing their impact on climate change.

Keywords: Climate Change; Sustainable Building; Organizational Strategies; Sustainable Assessment; Holistic and Systemic.

1. Introduction

At present, one of the biggest environmental problems on a global scale that humans face is climate change, caused by the high concentration of greenhouse gases (GHG) in the atmosphere from fossil fuels and industrial processes [1]. According to the Kyoto Protocol [2], the GHGs of anthropogenic origin that must be reduced are 6: carbon dioxide (CO_2), methane (CH_4), nitrogen oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC) and sulfur hexafluoride (SF_6). In this sense, CO_2 is the main anthropogenic GHG, with an approximate 76% of the total GHG considered by the Kyoto Protocol [1].

The energy sector contributes the most GHG emissions worldwide, with approximately 35% of the total [1]. In Mexico, the energy sector contributes 70% of the total GHG [3]. According to the International Energy Agency (IEA), the total final energy consumption in 2015 was 9,384 Mtoe (Megatons of oil equivalent), and the industrial sector was the biggest consumer of energy worldwide with 37% of the total, followed by transport (29%), residential (22%), agriculture (2%) and other unspecified sectors (2%) [4]. In Mexico, the industry is the second sector with the highest consumption (31.4%), below the transport sector (46.4%) [5].

In this sense, the construction sector, considered as a large organization belonging to the industrial sector, is responsible for 30% to 40% of energy consumption worldwide [6]. Approximately 10% of world energy consumption

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is used for the manufacture of construction materials [7]. In Mexico, the construction sector was responsible for 17% of the total final energy consumption in 2013 [8], which led the construction industry to be one of the biggest consumers of energy [7], and to be one of the sectors with the greatest environmental impact, contributing significantly to climate change due to the large amounts of energy that it demands, mainly from non-renewable energy [9].

The GHG emissions from the burning of fossil fuels as a result of the energy consumption of the construction industry represented the 19% of the total GHGs worldwide in 2010 [10] and in Mexico this emissions represented the 13% of the total GHGs emitted in 2010 [3]. Regarding CO_2 emissions, as mentioned at the beginning, they represent 76% of GHGs of anthropogenic origin, and until today, CO_2 emissions from fossil fuels continue to increase and accumulate mostly in the atmosphere [11].

In addition to emitting big amounts of GHG and CO_2 mainly, the construction sector is a big consumer of raw materials [9], for example, natural aggregates used as a raw material for the manufacture of concrete and mortars are some of the materials that are most used in construction [12], as well as Portland cement [13] and concrete [14]. In this sense, in addition to the impacts, the construction sector generate millions of tons of construction and demolition waste (RCD), for example, only in Europe, the construction industry is responsible for the 36% of the total waste generated [15]. Finally, the construction sector is also responsible for other environmental problems such as water and air pollution, which arise from the use of harmful materials and unsustainable processes [7].

Based on the above, these impacts have led to the generation of new changes in the construction industry, such as the adoption of sustainable techniques to replace traditional construction techniques [7]. This change has also been promoted by international agreements such as the Paris Agreement, established in 2015. It forces to keep the global average temperature below 2º C above pre-industrial levels and to pursue efforts to limit the increase in temperature at 1.5º C. Following this agreement, a growing number of organizations are adopting carbon reduction objectives in their projects. Current scenarios such as until now project global temperatures increases of 3.2º C to 5.4º C by the year 2100, and even the fulfillment of all strategies determined in the Paris Agreement would imply a median warming of 2.6º C to 3.1º C in 2100 [16].

1.1. Sustainable Assessment and Management Strategies in Building Organizations

Many researchers have developed strategies based on frameworks, methods and models to assess sustainability in different areas of the construction sector, with the aim that these organizations in the construction sector can determine and design the best practices to reduce its impact on climate change and the environment in general.

Among these strategies, the following stand out: the framework to assess the sustainability of residential buildings [17]; the framework for sustainability assessment of construction materials [18]; the framework for sustainability assessment of urban neighborhoods [19]; the framework for sustainability assessment of cities [20]; the simplified method for the assessment in the rehabilitation of old buildings in urban centers [9]; the framework for sustainability assessment in the construction sector based on a Life Cycle Sustainability Assessment [21]; the analysis framework based on a SWOT-ANP analysis [22]; and the Nature-Organization-Product methodology based on the NOP model [23]. The NOP methodology serves as an instrument to carry out a holistic and systemic diagnosis in organizations from a four-dimension approach of sustainable development (economic, environmental, social and cultural), which can be visualized in organizations through four subsystems: Nature, Resources, Human Factor and Ideology, each subsystem accompanied by for components.

Finally, among the different alternatives that stand out for the design of strategies in organizations in the construction sector is the Design of Organizational Strategies for Climate Change methodology (DEO-CC, by its acronym in Spanish) [24], which is based on the NOP methodology. The DEO-CC methodology considers new sections that facilitate the diagnosis; in other words, the DEO-CC methodology considers a specific section to design indicators and parameters of climate change, in addition to considering their application to assess the organizations under study, and thus obtain results that help to design strategies from a holistic and systemic approach to sustainable development. The DEO-CC methodology us based on the product of an organization, visualized throughout its life cycle: extraction, transport, manufacture, use and disposal (from cradle to grave); it considers the ISO 14040 Standard and the objective 13 Climate action, which belongs to the 17 Sustainable Development Goals (SDG) adopted by the United Nations. The DEO-CC methodology considers in a general way, four steps: 1) Objective and scope; 2) Approach to the organization; 3) Analysis of interrelationships and, 4) Assessment.

However, after analyzing the frameworks, methods and models mentioned above, it is inferred that they do not make an holistic and systemic sustainability assessment, so, the do not use sustainability approach conceptualized in four dimensions (environmental, economic, social and cultural) [25], except for the NOP methodology [23], the simplified method [9] and the DEO-CC methodology [24]. However, one of the limitations of the NOP methodology is that it does not have indicators to assess organizations, and the simplified method ceases to be holistic as it does not consider ideological factors of the organizations such as: mission; vision; values; standards, policies, guidelines; knowledge and worldview (customs and traditions).

So, if global warming is limited to the Paris Agreement, substantial reductions in GHG emissions are required in the coming decades [26]. That is why organizations in the construction sector must have a methodology that considers a different approach to the traditional one, in such a way that it allows them to obtain a diagnosis and a sustainability assessment of the organization and contribute to making the best decisions to significantly reduce CO_2 emissions; a possible solution to this could be to consider actions or strategies that arise from a holistic and systemic approach.

Therefore, this paper aims to assess the sustainability of the single-family housing building sector in the state of Nayarit, Mexico, based on a holistic and systemic approach to sustainable development, to the design of organizational strategies against climate change in order to contribute the decision-making in housing building organizations. The object of study for this research and to carry out the analysis is the product of this kind of organizations: a single-family house of social interest of 54 square meters of construction surface, considering traditional construction processes: foundations, brick walls, concrete structure, flattened with mortars, and 50 years of useful life. The object study is limited only to the construction phase of the life cycle and it considers only CO_2 emissions.

2. Materials and Methods

To accomplish the objective, the framework of 45 climate change indicators for housing building organizations was used [25]. These climate change indicators and the methodological process of this research were designed based on the DEO-CC methodology [24] (Figure 1).

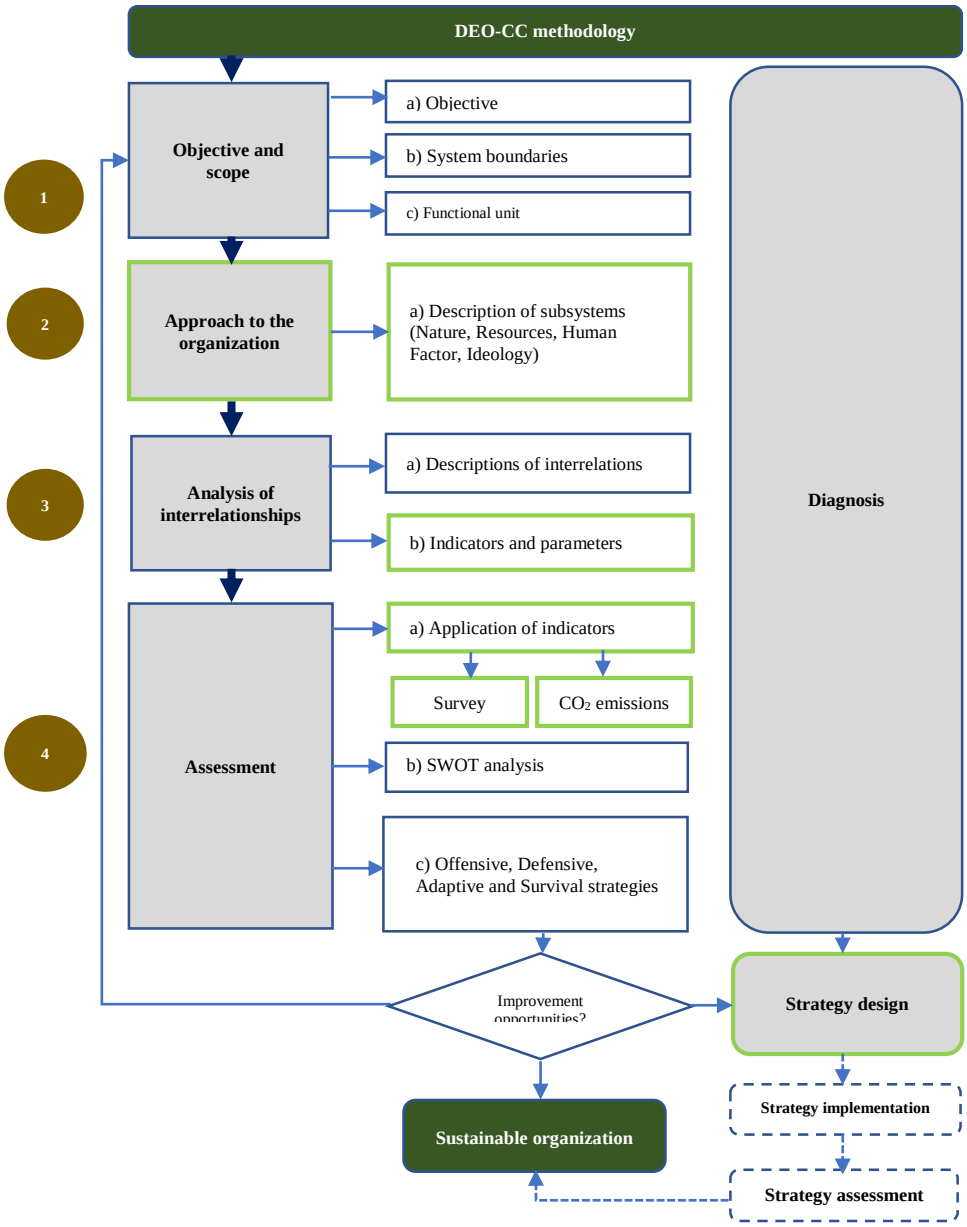

Figure 1. DEO-CC methodology

The DEO-CC methodology consist of including new adaptions to the NOP methodology. As mentioned above, the NOP methodology remains at very general level and does not have a specific indicators for assess the organizations under study, therefore, new sections are included that are more specifics and that facilitate the realization of a diagnosis, mainly a new section to design indicators and parameters, it also includes the application of the indicators to assess the organizations under study and thereby obtain results that help to design strategies from a holistic and systemic approach to sustainable development.

The DEO-CC methodology is based on the product of the organization, visualized throughout its life cycle: extraction, transport, manufacture, use and disposal (from cradle to grave); it considers the ISO 14040 Standard and the objective 13 Climate change action, which belongs to SDG adopted by the United Nations. The DEO-CC methodology considers in a general way, four steps: 1) Objective and scope; 2) Approach to the organization; 3) Analysis of interrelationships and, 4) Assessment.

The new sections included in the DEO-CC methodology are: section two, called Approach to the organization, which includes the description of the four subsystems of the NOP model (Nature, Resources, Human Factor and Ideology). In section three called Analysis of interrelationships, it is proposed to include indicators and parameters to assess organizations. The NOP methodology originally does not have any type of indicators or parameters.

In section four called Assessment, it is proposed as a new adaptation to apply the 45 indicators considering the following: 44 indicators trough the design of a survey and one indicator to determine and analyze the CO_2 emissions, in order to find opportunities for improvement in the organization that promote the design strategies.

In this sense, the present case study is only limited to considering the four-section called Assessment and the application of the 44 indicators from the design and application of the survey. The other missing indicators (CO_2 emissions) has already been applied and analyzed for the same case study [27]. Therefore, it is important to highlight and remember that the general Assessment section aims to: a) assess the climate change indicators from the design of a survey and, b) analyze the CO_2 emissions associated with the consumption of fossil fuels in the phase or phases of the life cycle of the product or functional unit.

Figure 2 shows in a general way the methodological process that will be used in this case study: the housing building organizations in Nayarit [24].

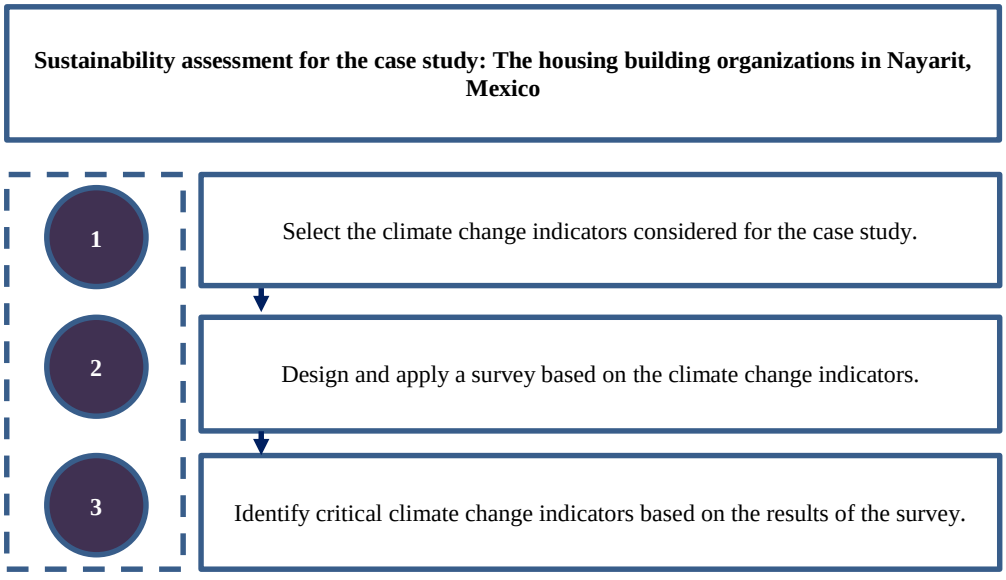

Figure 2. Methodological procedure based on the DEO-CC methodology

2.1. Selection of Climate Change Indicators

The framework of climate change indicators is made up to 45 indicators distributed as follows: 2 indicators for the Nature (Environmental) subsystem; 6 indicators for the Resources (Economic) subsystem; 12 indicators for the Human Factor (Social) Subsystem; and 25 indicators for the Ideology (Cultural) subsystem (Table 1). As mentioned above, this case study is only limited to considering the application of 44 indicators (from 2 to 45).

Table 1. Climate change indicators framework

NOP subsystems	NOP components	Category	Indicators
Nature	Atmosphere	Atmosphere	CO_2 emissions.
	Biosphere	Biodiversity	Impact of human activity on species.
Resources	Financial	Financial	Cost of research and development (technology) for mitigation.
			Investment in environmental sponsorship or advertising activities.
			Benefit for the implementation of recycling, reuse and optimization policies of products, materials and resources.
			Investment in public-private partnerships.
	Materials	Materials and resources	Sustainable materials.
			Variation of volume in transfer of materials.
Human Factor	Other external organizations	Responsibility	Commitment to sustainability.
			Presence of publicly available documents such as promises or collective bargaining agreements on the use of sustainable materials.
	Owners and employees		Management measures to improve feedback mechanisms.
	Clients and community	Technology development	Pertinence of ecotechnologies in the region.
	Competitors and suppliers	Hiring	Local sourcing.
	Owners and employees	Fair salary	Regular payment of workers.
			Salary satisfaction of workers.
	Competitors and suppliers		Punctual payments in time to suppliers and subcontractors.
	Owners and employees	Child labor	Minors who work on construction site.
		Working hours	Overtime worked by employees (at each level of employment).
		Safe and healthy living conditions	Risk management in the use of hazardous materials and substances.
			Injuries attached to the organization
Ideology	Mission, vision, values	Transparency/honesty	Publication of sustainability report.
	Standards, polices and guidelines		Transparency to communicate mechanisms and sources of financing funds for climate change.
	Knowledge	Training and education	Climate change certifications.
			Participation in technical training programs for workers in the use of sustainable materials.
			Participation in training programs in the use of technologies (equipment and machinery).
			Participation in training programs that promote environmental behaviors.
			Environmental education workshops related to sustainability and climate change (suppliers and subcontractors).
			Environmental education workshops and meetings with clients related to sustainability and climate change.
			Inter-institutional agreements disseminated for the execution of environmental education programs and projects.
	Mission, vision, values	Awareness	Integration of ethical, social, environmental and gender equality criteria in purchasing policies for construction materials.
			Association for research and development related to the management of CO_2 emissions.
			Commitment to comply with the principles of the United Nations Global Compact and to present an annual communication on its progress.
			Presence of a feedback mechanism for customers and builders.
			Commitment to training and awareness on social responsibility.
	Standards, polices and guidelines	Commitment	Implementation of standards and/or regulations for the disposal and recycling of construction products or materials.
			Polices implemented for technological development.
			Implementation of the United Nations Code of Conduct.
			Integration of ethical, social, environmental and gender equality criteria in distribution policies and contract signing.

	Worldview	Habits and traditions	Technological innovation in materials and construction processes.
			Customs and habits to invest in a climate change certification system.
			Behaviors and attitudes regarding anticorruption.
			Behaviors and attitudes regarding transparency.
			Attitudes and preferences regarding sustainability (home users and builders).
			Attitudes and preferences regarding sustainability (suppliers and subcontractors).
			Attitudes and preferences regarding sustainability (external organizations).

Environmental *Economic* *Social* *Cultural*

2.2. Design and Application of the Survey

The survey was designed from multiple-choice questions, with five possible responses each accompanied by five performance levels, which range from scale: very good, fair, poor and very poor [19]. They survey was aimed at owners, directors or managers of each of the organizations and aims to know the current situation of the housing building organizations, in this case, in a context of sustainability and climate change.

The population of interest is 76 organizations and with statistical methods [28] a sample of 16 organizations to be surveyed was obtained.

Once the sample size was obtained, the organizations were randomly selected. Once the organizations were identified, contact was established in person which each one of them, in order publicize the objective of the survey and explain how to fill it out. Finally, the surveys were distributed to each of the organizations via email. The survey was designed in a practical way through the forms offered by the Google platform.

2.3. Identification of Critical Climate Change Indicators

Once the survey is applied, the criteria to be used to identify the critical climate change indicators is to classify the indicators according to their results obtained in the survey and according to their level or performance. The indicators that are in the performance levels: poor and very poor are considered critical.

3. Results and Discussions

3.2. Survey

The results for each of the climate change indicators that were considered in this case study are presented below. The results for each indicator are classified in the four dimensions of sustainable development: Environmental, Economic, Social and Cultural.

Figure 3 shows the indicator of the environmental dimension: impact of human activity on species (No. 2), which is classified within the environmental dimension. Regarding this indicator, the 75% of the organizations tend not to implement actions for the protection of biodiversity when building houses.

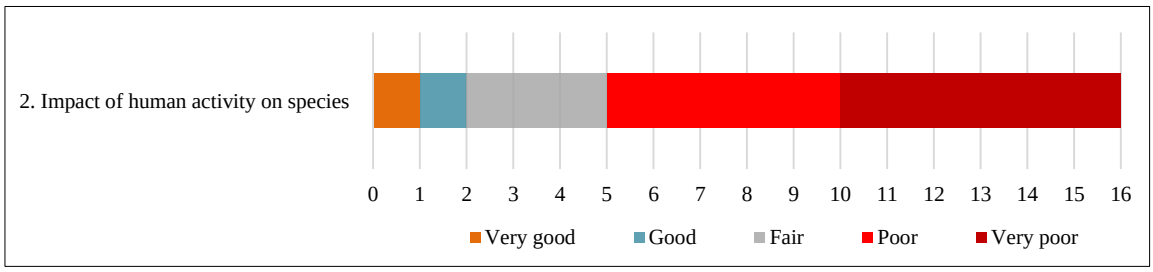

Figure 3. Environmental dimension indicators

Figure 4 shows the results of the six indicators of the economic dimension. In general, it is observed that 63% of the surveyed organizations do not invest in research and development for mitigation (No. 3). The 69% do not invest in environmental sponsorship or advertising activities (No. 4), and the 88% do not invest in public-private partnerships on climate change and sustainable development (No. 6).

The economic benefit that organizations have or expect to have from implementing recycling, reuse and material optimization policies tends to be very poor (No. 5). The 63% of the total organizations surveyed do not consider the use of sustainable materials for building construction (No. 7). The trend in the volume variation in the transfer of materials is good in most organizations (No. 8).

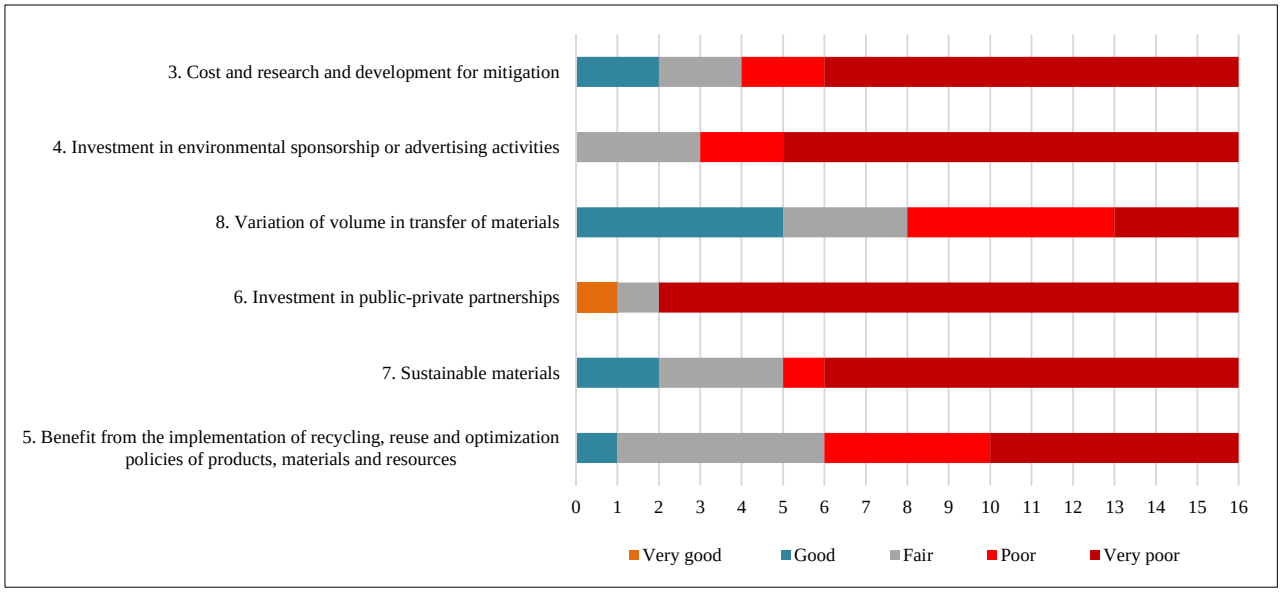

Figure 4. Economic dimension indicators

Figure 5 shows the results of the social dimension indicators, so, there is a responsibility with a negative trend in most organizations. The 75% of the total tend not to establish commitments with sustainability (No. 9), as well as, the 63% of the organizations show a negative tendency to establish collective bargaining agreements on the use of sustainable materials (No. 10). On the other hand, it is observed that there is a good tendency for the hiring of local origin by the organizations surveyed. The management of salaries by the organizations also has a very good trend, as well as the regular payment of workers (No. 14), their salary satisfaction (No. 15) and punctual payment in time to suppliers and subcontractors (No. 16). The presence of minors on the construction site is very low in the vast majority of the organizations (No. 17), it means, the 94% of the total do not hire minors. The encouragement for the reduction of overtime work at the construction site is positive in most organizations (No. 18).

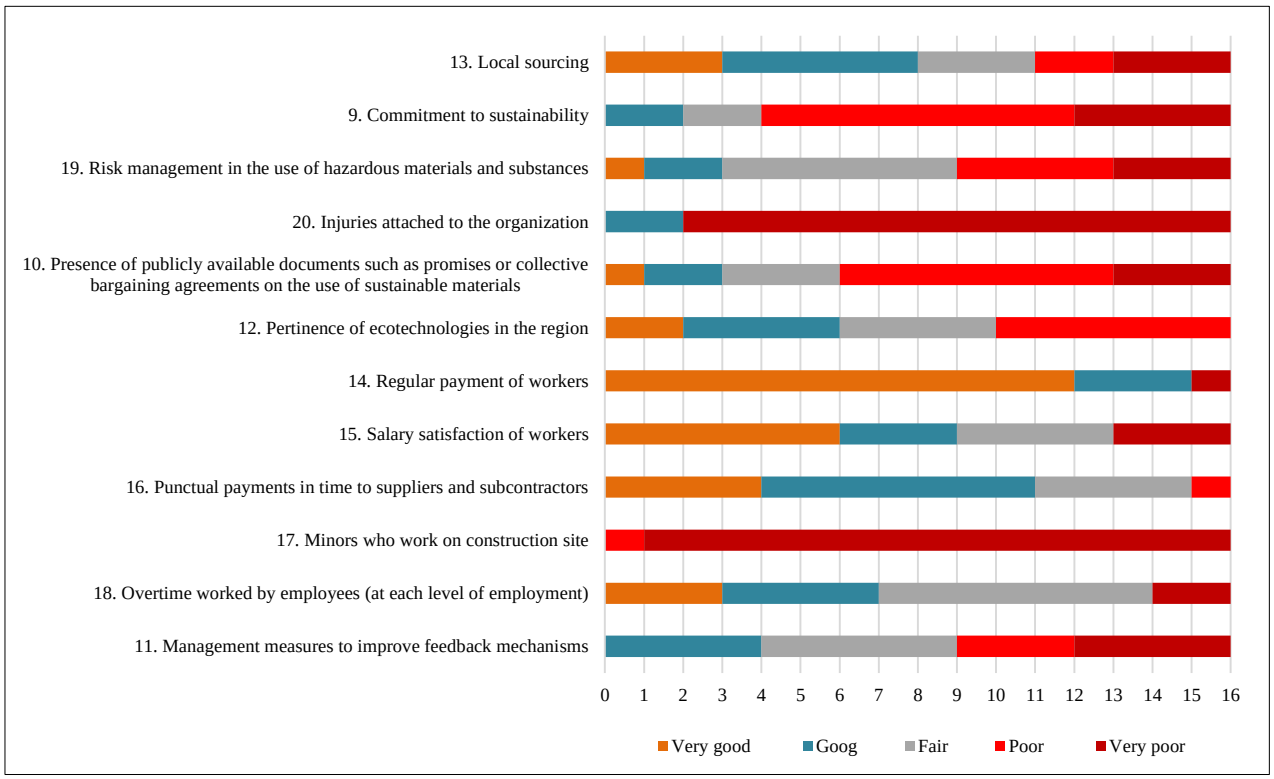

Figure 5. Social dimension indicators

Figure 6 shows the results of the indicators of the cultural dimension, there is a clarity in the lack of training and education, and of environmental commitment and transparency related to climate change and sustainability. The 81% of the organizations do not publish a sustainability report (No. 21), as well as, the 100 of the organizations do not have any certification related to climate change or sustainability (No. 23). There is also a low level of knowledge of the workers of the organizations in the use of sustainable materials (No. 24). The 38% of the total organizations are not trained in any program related to sustainable materials, plus another 38% that hardly train in some kind of related program.

The 69% of the total organizations do not establish partnerships with academic or research institutions in order to manage CO_2 emissions (No. 31). Also, the 44% of the organizations do not commit to comply with the Principles of the Global Compact, much less to communicate their progress (No. 32). There is also a negative tendency for organizations to train and become aware of social responsibility issues (No. 34). The 71% of the organizations follow a negative trend in the lack of implementation of standards related to the disposal and recycling of materials (No. 35), for example, the 69% of the total organizations do not implement any action and another 31% barely manages to implement any standard.

The 63% of the total organizations do not implement technological innovation criteria in materials and construction processes (No. 39), as well as, the 88% does not invest in any type of certification related to climate change (No. 40). On the other hand, a negative trend is also observed by suppliers, subcontractors and external organizations in attitudes and preferences regarding sustainability (No. 44 and No. 45).

3.3. Identification of Climate Change Critical Indicators

The results of the sustainability assessment of the housing building organizations in Nayarit show that 26 out of a total of 44 climate change indicators turned out to be critical (Table 2).

Table 2. Climate change critical indicators

Indicator No.	Indicator
2	• Impact of human activity on species.
3, 4, 5 y 6	• Cost of research and development (technology) for mitigation. • Investment in environmental sponsorship or advertising activities. • Benefit for the implementation of recycling, reuse and optimization policies of products, materials and resources. • Investment in public-private partnerships.
9, 10 y 12	• Commitment to sustainability. • Presence of publicly available documents such as promises or collective bargaining agreements on the use of sustainable materials. • Pertinence of ecotechnologies in the region.
21, 22, 23, 24, 25, 26, 27, 28, 29, 31, 32, 34, 35, 36, 38, 39, 40 y 43	• Publication of sustainability report. • Transparency to communicate mechanisms and sources of financing funds for climate change. • Climate change certifications. • Participation in technical training programs for workers in the use of sustainable materials. • Participation in training programs in the use of technologies (equipment and machinery). • Participation in training programs that promote environmental behaviors. • Environmental education workshops related to sustainability and climate change (suppliers and subcontractors). • Environmental education workshops and meetings with clients related to sustainability and climate change. • Inter-institutional agreements disseminated for the execution of environmental education programs and projects. • Association for research and development related to the management of CO_2 emissions. • Commitment to comply with the principles of the United Nations Global Compact and to present an annual communication on its progress. • Commitment to training and awareness on social responsibility. • Implementation of standards and/or regulations for the disposal and recycling of construction products or materials. • Polices implemented for technological development. • Integration of ethical, social, environmental and gender equality criteria in distribution policies and contract signing. • Technological innovation in materials and construction processes. • Customs and habits to invest in a climate change certification system. • Attitudes and preferences regarding sustainability (home users and builders).

Environmental *Economic* *Social* *Cultural*

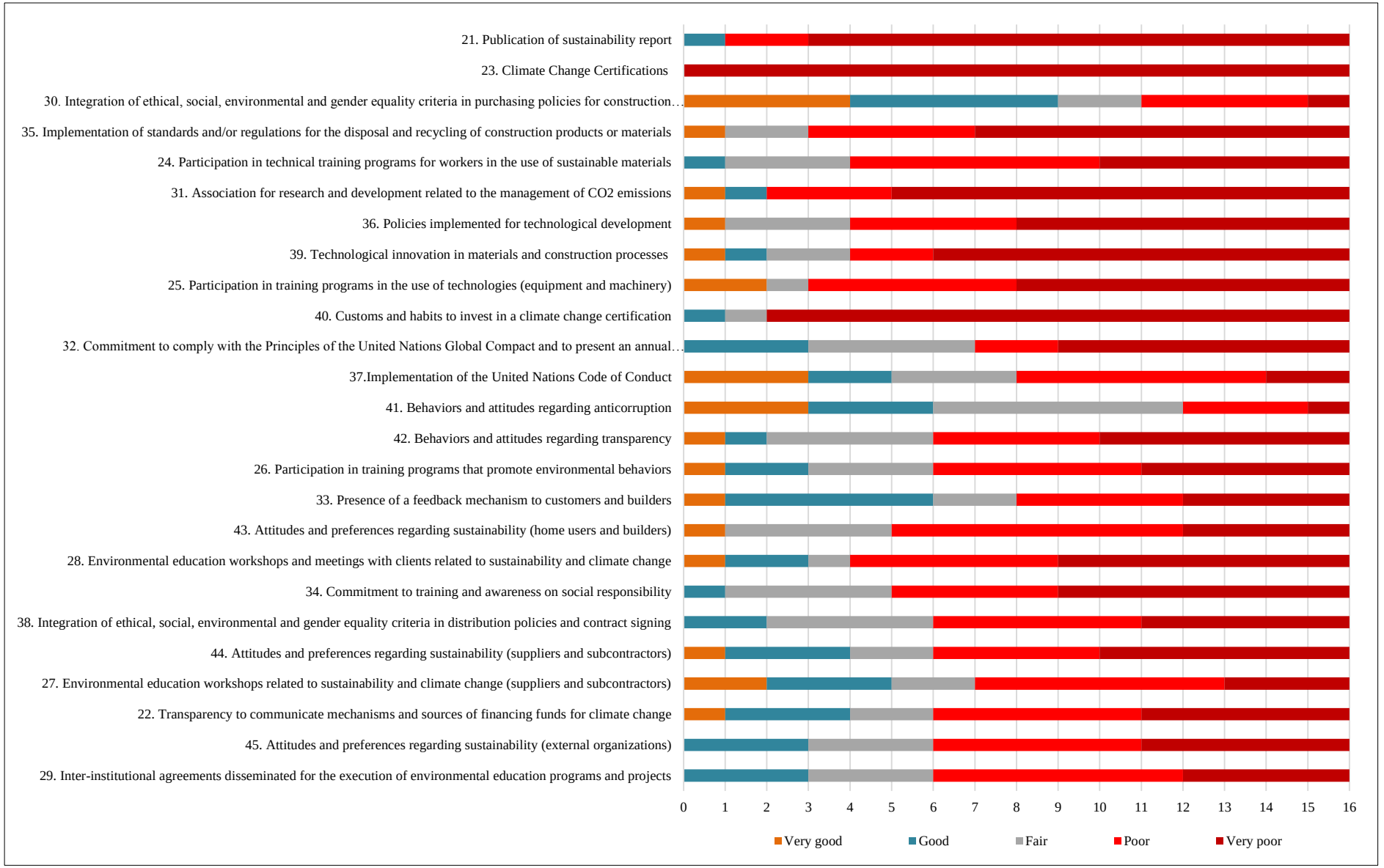

Figure 6. Cultural dimension indicators

3.4. Discussions

The housing building organizations in Nayarit present a significant lack of aspects related to factors that have to do with culture within the context of sustainability and climate change, it means, in relation to a mission, vision, values; standards, policies and guidelines; worldview and knowledge.

In this sense, the results show 26 climate change critical indicators out of a total of 46, which will serve as the basis for the designing strategies against climate change. It also considers important to highlight that most of the critical indicators are in the cultural dimension (Ideology subsystem), it means, 18 out of a total of 26, which represents the 69% of the total. From the economic dimension there were 4 critical indicators which represents the 15% of the total; from the social dimension there were 3 critical indicators which represents the 11% of the total and finally, from the environmental dimension 1 critical indicator resulted which represents the 5% of all the critical indicators.

From the cultural dimension (Ideology subsystem), most of the critical indicators lean towards the Knowledge component, it means, 7 critical indicators out of a total of 18. The rest of the critical indicators resulted as follows: 4 indicators correspond to the Standards, Policies and Guidelines component; 4 indicators to the Mission, Vision and Values component; and 3 indicators to the Worldview (habits and traditions) component. In this sense, it can be inferred that the housing building organizations in Nayarit do not have knowledge about climate change or sustainability due to the lack of training and education on these issues. In addition, these organizations do not have standards, policies and guidelines at the local government level in terms of climate change and sustainability. These organizations do not show interest or commitment to themselves to change their unsustainable habits and traditions in the housing construction processes.

From the economic dimension (Resources subsystem), all critical indicators lean towards the Financial component, it means, 4 critical indicators out of a total of 4. In this sense, it can be inferred that the housing building organizations in Nayarit do not invest financial resources in research for innovation purposes, much less do they invest financial resources to establish partnerships with public-private institutions to find innovate solutions related to climate change mitigation. Furthermore, the majority of these organizations (63%) are completely unaware of the economic benefits that can be achieved by reducing competition for renewable resources and raw materials; it means, reduce their economic dependence which can well be achieved by replacing the linear economy model with a circular economy model, which has to do with recycling, reuse and optimization of products, materials and resources in the housing construction processes.

Therefore, based on the results described above, it is demonstrated that the housing building organizations in Nayarit do not have an adequate culture in terms of sustainability and climate change, it means, there are no strategies or good practices that contribute to increasing knowledge further; the mission, vision and values; awareness and the habits and traditions in these organizations. In addition, at the state and local government level, there are no standards, policies and guidelines that force organizations to change the habits and customs in their unsustainable housing building processes for sustainable housing building processes, trough the implementation of strategies or good practices that help reduce CO_2 emissions and consequently reduce their impact on climate change.

4. Conclusion

At the end of the present study, it can be concluded that the objective of this paper was achieved. It means assessing the sustainability of the design of organizational strategies against climate change, based on a holistic and systemic approach to sustainable development, in order to contribute to the decision-making in housing building organizations in Nayarit, Mexico, to reduce its impact on climate change.

The results of the sustainability assessment of the housing building organizations in Nayarit show a negative outlook in terms of climate change and sustainability. The foregoing is clearly attributed to the cultural aspects that exist in the state of Nayarit, which are: the lack of knowledge about sustainability and climate change by these organizations, as a result of the lack of standards, policies, guidelines, and strategies for housing at the estate and local government level, which means that these organizations hardly get involved and feel a commitment to the environment, much less show interest in investing in training or certification programs that increase their knowledge and awareness of the topic. Therefore, this study calls for the design of new policies and guidelines on climate change and sustainability in the housing building industry at the state and municipal levels, as well as suggests other studies towards other building areas, such as other kinds of housing, commercial buildings, services, and schools, among others, and in construction subsectors, such as civil engineering works or specialized works for construction.

In order to establish future lines of research, it is recommended to expand the scope and system boundaries of this study, using the same DEO-CC methodology and considering the rest of the phases of the life cycle of the house (extraction of raw materials, transportation, construction, usage, demolition) or another phase different from

construction, in order to have multiple results that contribute to the design of strategies that are related to the rest of the housing life cycle.

Finally, it is also recommended to carry out a study focused on systematizing the DEO-CC methodology, based on a software or digital application that simulates the CO_2 emissions generated depending on the strategies applied to housing building projects in Nayarit, so the organizations can know their environmental performance in a faster way.

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6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

7. References

[1] Cambio Climático (IPCC), (2014). Mitigación del cambio climático. Resumen para responsables de políticas. Ginebra, Switzerland. Available online: https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full_es.pdf (accessed on May 2020).

[2] United Nations. (1998). Protocolo de kyoto de la Convención Marco de las Naciones Unidas sobre el Cambio Climático, Available online: http://unfccc.int/resource/docs/convkp/kpspan.pdf (accessed on March 2020).

[3] National Institute of Ecology and Climate Change (INECC). (2018). Inventario Nacional de Emisiones de Gases y Compuestos de Efecto Invernadero. Análisis de resultados, Mexico. Available online: https://www.gob.mx/cms/uploads/attachment/file/312045/INEGYCEI6CN_26_marzo_2018.pdf.

[4] International Energy Agency (IEA). (2017). World energy balances: an overview of global trends. Available online: http://biblioteca.olade.org/opac-tmpl/Documentos/cg00444.pdf. (accessed on May 2020).

[5] SENER. (2016). Balance Nacional de Energía, Mexico. Available online: https://www.gob.mx/cms/uploads/attachment/file/248570/ Balance_Nacional_de_Energ_a_2015__2_.pdf (accessed on March 2020).

[6] Abarca-Guerrero, L., & Leandro-Hernández, A. G. (2017). Situación actual de la gestión de los materiales de construcción en Costa Rica. Revista Tecnología En Marcha, 29(4), 111-122. doi:10.18845/tm.v29i4.3042.

[7] Bamgbade, J. A., Nawi, M. N. M., & Kamaruddeen, A. M. (2017). Construction Firms' Sustainability Compliance Level. Journal of Engineering Science and Technology, 12, 126-36.

[8] SENER. (2017). Conuee, IEA, Casedi, Wri México, Giz, Danish Energy Agency, INEVV, Hoja de Ruta para el Código y Normas de Eficiencia Energética para Edificaciones en México, 38. Available online: https://www.gob.mx/cms/uploads/attachment/file/215225/Hoja_de_Ruta_para_el_C_digo_y_Normas_EE_para_Edificaciones_M_xico_ES_Fin....pdf (accessed on March 2020).

[9] Almeida, C. P., Ramos, A. F., & Silva, J. M. (2018). Sustainability assessment of building rehabilitation actions in old urban centres. Sustainable Cities and Society, 36, 378–385. doi:10.1016/j.scs.2017.10.014.

[10] Arvizu-Piña, V. A., & Cuchí Burgos, A. (2017). Promoting sustainability in Mexico's building sector via environmental product declarations. The International Journal of Life Cycle Assessment, 22(11), 1744-1759. doi:10.1007/s11367-017-1269-z.

[11] Le Quéré, C., Andrew, R. M., Friedlingstein, P., Sitch, S., Hauck, J., Pongratz, J., … Canadell, J. G. (2018). Global Carbon Budget 2018. Earth System Science Data, 10(4), 2141–2194. doi:10.5194/essd-10-2141-2018.

[12] Senaratne, S., Lambrousis, G., Mirza, O., Tam, V. W. Y., & Kang, W.-H. (2017). Recycled Concrete in Structural Applications for Sustainable Construction Practices in Australia. Procedia Engineering, 180, 751–758. doi:10.1016/j.proeng.2017.04.235.

[13] Aydin, E. (2016). Novel coal bottom ash waste composites for sustainable construction. Construction and Building Materials, 124, 582–588. doi:10.1016/j.conbuildmat.2016.07.142.

[14] Joshua, O., Olusola, K. O., Busari, A. A., Omuh, I. O., Ogunde, A. O., Amusan, L. M., & Ezenduka, C. J. (2018). Data on the pozzolanic activity in coconut shell ash (CSA) for use in sustainable construction. Data in Brief, 18, 1142–1145. doi:10.1016/j.dib.2018.03.125.

[15] Daunfeldt, S.-O., Johansson, D., & Halvarsson, D. (2015). Using the eurostat-OECD definition of high-growth firms: a cautionary note. Journal of Entrepreneurship and Public Policy, 4(1), 50–56. doi:10.1108/jepp-05-2013-0020.

[16] Rogelj, J., den Elzen, M., Höhne, N., Fransen, T., Fekete, H., Winkler, H., … Meinshausen, M. (2016). Paris Agreement climate proposals need a boost to keep warming well below 2 °C. Nature, 534(7609), 631–639. doi:10.1038/nature18307.

[17] Ullah, W., Noor, S., & Tariq, A. (2018). The development of a basic framework for the sustainability of residential buildings in Pakistan. Sustainable Cities and Society, 40, 365–371. doi:10.1016/j.scs.2018.04.009.

[18] Rocchi, L., Kadziński, M., Menconi, M. E., Grohmann, D., Miebs, G., Paolotti, L., & Boggia, A. (2018). Sustainability evaluation of retrofitting solutions for rural buildings through life cycle approach and multi-criteria analysis. Energy and Buildings, 173, 281–290. doi:10.1016/j.enbuild.2018.05.032

[19] Haider, H., Hewage, K., Umer, A., Ruparathna, R., Chhipi-Shrestha, G., Culver, K., … Sadiq, R. (2018). Sustainability assessment framework for small-sized urban neighbourhoods: An application of fuzzy synthetic evaluation. Sustainable Cities and Society, 36, 21–32. doi:10.1016/j.scs.2017.09.031.

[20] Gonzalez-Garcia, S., Manteiga, R., Moreira, M. T., & Feijoo, G. (2018). Assessing the sustainability of Spanish cities considering environmental and socio-economic indicators. Journal of Cleaner Production, 178, 599–610. doi:10.1016/j.jclepro.2018.01.056.

[21] Dong, Y. H., & Ng, S. T. (2016). A modeling framework to evaluate sustainability of building construction based on LCSA. The International Journal of Life Cycle Assessment, 21(4), 555–568. doi:10.1007/s11367-016-1044-6.

[22] Liu, G., Zheng, S., Xu, P., & Zhuang, T. (2018). An ANP-SWOT approach for ESCOs industry strategies in Chinese building sectors. Renewable and Sustainable Energy Reviews, 93, 90–99. doi:10.1016/j.rser.2018.03.090.

[23] Hernández, F. J., Ayón, H. H., & Ovalle, A. D. C. V. (2016). Evaluación de la sustentabilidad en organizaciones por medio del Modelo NOP. Revista Iberoamericana de las Ciencias Biológicas y Agropecuarias: CIBA, 5(9), 111.

[24] Mercado, U. (2019). Diseño de estrategias organizacionales frente al cambio climático desde un enfoque de la sustentabilidad, caso: el sector de la edificación de viviendas en Nayarit, Universidad Autónoma de Nayarit, Sinaloa, Mexico. Available online: http://repositorio.ujed.mx/jspui/handle/123456789/99 (accessed on March 2020).

[25] U. Mercado, F. Hernández, (2019). Marco de indicadores para cambio climático para organizaciones del sector de edificación de viviendas desde un enfoque de la sustentabilidad, in: Casos Gestión Y Sustentabilidad En Las Organ., UNAM FCA P, 269–316.

[26] Nußholz, J. L. K., Nygaard Rasmussen, F., & Milios, L. (2019). Circular building materials: Carbon saving potential and the role of business model innovation and public policy. Resources, Conservation and Recycling, 141, 308–316. doi:10.1016/j.resconrec.2018.10.036.

[27] Mercado Burciaga, U., Sáez, P. V., & Javier Hernández Ayón, F. (2019). Strategies to Reduce CO2 Emissions in Housing Building by Means of CDW. Emerging Science Journal, 3(5), 274–284. doi:10.28991/esj-2019-01190.

[28] Hernández Sampieri, R., Fernández Collado, C., & Baptista Lucio, M. D. P. (2014). Metodología de la investigación. Mcgraw-hill. McGraw-Hill, New York, United States.