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Organizational Analysis of Sustainable Building Certifications in Mexico City

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Abstract

In 2008, the Sustainable Building Certificate Program was implemented in order to identify and to foster sustainable buildings. The aim of the work is to analyze, since an organizational perspective, the contribution of the users' "day a day" actions to archive sustainability. The principal variable is the building property actions to obtain the certification and the criteria defined at the Certification Program. The central significance of this work is to define how important is the implementation of strategies to introduce sustainable patterns to the building users in contrast with the facility features. The most interesting finding shows that certification design and punctuation assignation to each criteria influence in sustainable actions. The incorporation of technology devices primes over the sustainable actions by the users of the buildings. This condition represents a practical implication because the sustainable actions pattern presents a challenge to the sustainable vision. People do not assume the sustainability as a change in human actions, but a technological question. So, the central value of this research is to demonstrate the very low importance in the Mexico City certification program and stakeholders in sustainable user's patterns. The principal limitation the research is many sustainable buildings, certificated by international programs were not includes. This consideration implies future studies, to identify a general tendency of sustainable actions related with the users' activity.

Keywords: sustainable building, organizational analysis, sustainable certification, sustainable actions, Mexico City

1. Introduction

Buildings represent the most prevalent form of artificial use of a city's territory, and most of its natural and energy resources are used by human constructions. Therefore, buildings are a major source of environmental impact. Metropolises have been often shown to be responsible for substantial environmental impact; they completely transform the natural ecosystem into an essentially anthropic space. The creation of cities initiates processes that change soil conditions, wildlife environments, and water bodies, contributing to climate change and environmental degradation as a result of the loss of biodiversity and resources [1].

In Mexico, buildings account for 25% of total electricity consumption, 17% of energy consumption, 5% of water consumption, 20% of carbon dioxide emissions, and

20% of waste generation [2]. Most of the pollutants generated by buildings are due to the use of low-quality materials and unsustainable products, which result in constant economic costs related to the restoration and replacement of obsolete materials that degrade or become damaged. On the other hand, insufficient building maintenance results in decreased resilience to environmental problems due to the deterioration of energy and water supply and distribution equipment over time [3].

The role of habitability is essential in building design and construction processes as a leading consideration concerning the different needs of users in terms of sustainability; sustainable buildings are resilient and respond to the current environmental problems affecting habitability [4]. Consequently, many institutions created sustainability certifications in order to decrease the environmental impact of the buildings. These certifications consider a set of criteria linked with the general qualities of the buildings, most of them in terms of technology and design. Nevertheless, there is no studies about the role of the everyday user's activity linked with the sustainability as consequence of the internal organization in the buildings. Therefore, there are some criteria related with the human activity, we believe that these factors are so few in comparison with the technological and design factors. To promote sustainability patterns in user emphasis, the construction of a new consciousness and avoid delegating the sustainability as a technological question.

The purpose of this chapter is to analyze the design of the Mexico City's sustainable building certification program from an organizational perspective and to analyze its implications in actions carried out by building owners to obtain such certification in the period from 2011 to 2018. The Sustainable Buildings Certification Program seeks to promote environmental actions aimed at improving the habitability and sustainable configuration of affordable buildings [5]. The present study is focused on facilities operated by the private sector. We will analyze actions carried out by proprietary companies and users that directly determine the way in which building users organize toward sustainability. This research contributes to understand how the internal organization of users foster sustainable patterns, as a vital factor to create a sustainable consciousness in urban people.

The first analysis unit is the environmental criteria used to evaluate sustainable buildings, which will be analyzed on the basis of scores assigned to each criteria in terms of efficiency and excellence. The second analysis unit is the actions carried out by agents who adapt buildings in search of certification. We used these analysis units were to determine whether everyday sustainable actions are promoted in addition to the installation of sustainable technology. To carry out these analyses, we used generalizable data providing evidence of the list of recurrent actions associated with the sustainable management of buildings. This approach raises the importance of standardizing the organizational process as a fundamental factor of building design to improve the control of sustainability-oriented activities in urban facilities [6].

2. Literature review: organizational vision in sustainable buildings

The Brundtland Report represents the starting point to comprehensively address the global environmental crisis. Among other important aspects, it contains the traditional definition of sustainable development, which emphasizes meeting current needs without compromising the ability of future generations to meet their own needs [7]. Environmental degradation triggered the necessity of a definition of sustainability at the time; however, due to the complexity of its transdisciplinary vision, the concept is in constant reconfiguration. Nevertheless, the role played by nature as a support, condition, and prerequisite of the production process is consistently acknowledged [8].

Although sustainable buildings can represent increased costs—from the design to the construction phase—the investment will return during the life cycle of the facility because sustainability optimizes water and energy consumption in the benefit of building users and society in general. Thus, sustainable construction is considered a holistic process to restore and maintenance the harmony between the natural and human environments by creating spaces that affirm human dignity and promote economic equity. In this context, the challenges posed by environmental problems can be considered as opportunities to adapt, change, and improve currently unsustainable practices and cease to be threats to development.

Different companies in the architectural and construction sectors are seeking to change their role as part of the problem caused by the environmental impacts associated with buildings and seek to become part of the solution [9]. Sustainable buildings certified as such under a given standard favor high value-added services and address their social responsibility with the territory by collaborating in environmental restoration. From a financial and social point of view, a sustainable building certification will bring benefits to the building's owners [10]. One definition of sustainable building involves a construction where the environment is healthy and is based on ecological principles and an efficient use of resources [11].

Organizational interaction is an essential element to achieve a sustainable construction. The organizational structure consists of defined processes that allow for an adequate execution of the activities carried out in buildings. Derived from the organizational vision and mission, sustainability should be part of its planning efforts. To achieve this, the organization must be sustainable and building users should commit to sustainable practices: sustainability is directly associated with short-term actions, planning, and projects via an organizational system that allows for the management of an important stabilizing factor for society [12]. **Table 1** presents the transcendental factors that determine the construction of an organizational system focused on sustainability.

When it comes to internalizing the need for sustainable practices in everyday life, organizational culture is possibly the central attribute, from which the rest derive. However, it can be significantly affected by the historical, political, and social context of complex and dynamic interpersonal relationships. Denison *et al.* [15] has pointed out certain conditions that influence the development of organizational practices.

The first is involvement, which corresponds to the level of acceptance of organizational goals and common values; these are the guidelines to create a balanced

Factor	Attributes
F1. Innovation and design	1.1. Construction 1.2. Environmental conditioning
F2. Organizational structure	2.1. Organizational culture
F3. Materials and resources	3.1. Green purchases
F4. Building maintenance	4.1. Building conditions 4.2. Substitution of materials 4.3. Usage patterns
F5. Cost–benefit relationship	5.1. Cost reduction 5.2. Organizational environmental performance

Source: Adapted by the authors from Liyin *et al.* [13] and for each factor from the following sources: F1 [10], F2 [12, 14], F3 [13], F4 [10], and F5 [13].

Table 1.
 Organizational factors of sustainable facility development.

environment and improve the coexistence of active agents in their environment. It is also a practical structure that contributes to enhance organizational skills among employees. It is based on integrative learning among work teams [15, 16]. The second is adaptability, which refers to the capacity and resources of members of the organization to cope with unscheduled events. It is explained by the ability of its members to respond to unforeseen events [15, 17].

The mission states a strategic intention whose objectives are guided by the intention of shaping a future. To a certain extent, the mission articulates the vision, provides unity to the organization, and represents what is expected to be achieved in a given period [15, 18]. Finally, a climate of organizational confidence is necessary to achieve consistency. This consistency is measured by the degree to which the members of an organization have the necessary conditions for their professional development, which is consequently articulated with the relevant ethical considerations. As a result, human interactions reconcile core values that contribute to the establishment of common objectives, which have an integrating function within the organization [15].

Taking organizational life into account reveals the environment in which organizational life takes place as shown by its administrative units as it strives to increase the efficiency of its construction efforts and optimize its resources. A regulation instrument is required to monitor the users' sustainable habits. Constant monitoring and commitment is required to guarantee a timely response to the organization's internal and external issues, hence the importance of specifying the actions that contribute to sustainable practices [19].

3. Methodology: certification program categories under analysis and actions carried out to obtain certification

The purpose of the certification program created by Mexico City's Environment Secretariat in 2008 was to promote and encourage the reduction of pollutant emissions and the efficient use of natural resources based on sustainability and environmental efficiency criteria for the design and operation of buildings in Mexico City. Economic incentives are given to those who build sustainably and obtain the certification, which is valid for three years [20].

Sustainable buildings derive from the human right to have a healthy environment and the need to provide sustainable spaces for society. This right should be adequately guaranteed in the Mexican Constitution, but this is not the case; therefore, the configuration of this right must be sought in the specific laws that address it [1].

One of the pillars of such configuration is the Sustainable Buildings Certification Program (PCES), which seeks to promote these actions in order to improve habitability as a right to a healthy environment. However, a sustainable approach is not enough due to the small number of certified properties. Regrettably, sustainable buildings are still uncensused, but the program is a benchmark to join efforts in meeting the sustainability criteria established by the Environment Secretariat [21].

In this context, the analysis of this certification seeks to contribute to our knowledge about the design of criteria used to certify sustainable buildings in Mexico City. Our purpose is to examine the importance given to actions aimed at modifying user patterns to achieve sustainability in contrast with the emphasis on actions focused on the design or technological qualities of the facility. Therefore, this approach compares the two different types of factors that guide the construction of sustainable buildings. The elements of the program to be analyzed will be: 1) features of sustainable properties; and 2) criteria closely associated with organizational factors that potentially result in sustainable practices by building users (**Table 2**).

Linking the operationalization of variables based on sustainability criteria is important to enable new alternatives for urban regeneration models that allow for the association of ecological architecture with actions favoring sustainable responsibility carried out by users. Therefore, the organizational process is the driver of change, it originates the specific measures to be carried out by local agents in order to improve the constitution of sustainable buildings in the city's boroughs.

Three levels of certification are possible depending on a numeric score: compliance, between 21 and 50 points; efficiency, between 51 and 80 points, and excellence, between 81 and 100 points. The constitution of a building corresponds to its physical and technological attributes, but the present chapter includes a section on organizational factors, which are used to reveal organizational capacities and social participation toward sustainability.

The program is organized in five categories that group 47 criteria;¹ each of them has a maximum possible score to avoid all actions being concentrated in only one area. The total possible score is 120 points, distributed as follows: Energy: 40 points; Water: 25 points; Solid waste: 10 points; Quality of life and social responsibility: 25 points, Environmental impact and other impacts: 20 points. However, the score of the criteria represents a total of 221.5 points (**Table 2**).

In the present study, we classified each criteria depending on whether it was met based on the design of the facility or on the internal organization of users. This classification was used to determine the transcendence of actions aimed at modifying the users' behavior patterns.

Category	Features of the facility	Points	Organizational factors	Points
Energy	Enclosure efficiency	20	Environmental conditioning	8
	Bioclimatic design	25		
	Energy (renewable)	20		
	Solar heaters	10		
	Efficient lighting	4		
	Engines	2		
	Light control systems	2		
	High-efficiency equipment	10		
	<i>Subtotal</i>	93		8
Water	Rainwater collection and reuse in the facility	5	Use of efficient drinking water technologies/savings-related elements	5
	Rainwater infiltration	5		
	Installation of wastewater treatment and reuse plants	8	Campaigns on the efficient use of water and water culture	10
	Use of wastewater treated by the municipal network	8		
			Leak repair	5
	<i>Subtotal</i>	26		20

¹ **Notes**

SEDEMA [5] states that the number of criteria is 46, but when reviewing each category, we found inconsistencies in the total number of criteria in the categories of "Energy", "Water", and "Environmental impact and other impacts".

Category	Features of the facility	Points	Organizational factors	Points
Solid waste	Infrastructure for temporary storage	3	Separation of recoverable waste	2
	Signposting	0.5	Adequate final arrangement	3
	Furniture for adequate indoors management	1.5	Dissemination and sensitization program on solid waste separation	0.5
			Special waste handling management plan (optional)	2
	<i>Subtotal</i>	5		7.5
Quality of life and social responsibility	Rooftop greening	7	Adequate and timely maintenance	2
	Accessibility	3		
	Ascent and descent bays for transports	1	Provision of transportation facilities to permanent users	2
	Noise level control inside buildings	2	Existence of a participatory culture concerning sustainability	2
	Bicycle parking	3	Green areas intended for comfort and to encourage social interaction	3
	Bicycle stations	2		
	Internal bike lanes	2		
	<i>Subtotal</i>	20		9
Environmental impact and other impacts	Parking accessibility	4	Green purchases	3
	Use of local materials	1	Elimination of refrigerants based on chlorofluorocarbons	2
	Use of materials low in volatile organic compounds (VOCs) for construction and finishing	3		
	Use of recycled construction materials	2	Indoors contamination control	3
	Recycling of existing structures	2		
	Reconversion of soil use and remediation	5	Use of biodegradable materials for the maintenance of green areas and buildings	1
	Respect for existing trees	1		
	Use of certified wood	2		
	Permeable road areas	4		
	<i>Subtotal</i>	24		9
Total		168		53.5

Source: Prepared by the authors based on SEDEMA [5].

Table 2. Classification facility features or organizational factors of the evaluation criteria used by Mexico City's Sustainable Buildings Certification Program.

Thus, the first part of this analysis focused on the criteria associated with the organization and user behavior patterns, including their assigned scores. The second focused on the actions carried out by building owners to obtain certifications,

and it was based on a review of implementation resolutions [22] provided to the building owners by facility evaluators.

The present study describes such evaluation, including the actions carried out by the owners as a result of the initial inspection, which is accompanied by recommendations that must be met in order to obtain the certificate. The analyzed actions were carried out over a seven-year period (2011–2018), and we could identify favorable and unfavorable trends concerning the internal organization of users.

4. Design of Mexico City's sustainable buildings certification program and its results

The program has a number of inconsistencies in terms of total scores and required scores for certification; therefore, obtaining certification is relatively easy: only 21 points, or 17.5% of the total score, are needed for the compliance level. The category of energy alone could be enough grounds for a certification. As a consequence, the holistic nature of the assessment is lost. As has been indicated, beyond organizational actions or user behavior patterns, we focus on the importance of the criteria associated with the features of the facility.

When these criteria were classified based on the two analysis categories created for the present study, only 16 out of 47 were found to be associated with the users' organization and behavior patterns. These criteria represent 34% of the total number of criteria, and they represent only 24.2% of the total points. This difference varies depending on the category.

The most represented category is "Solid waste": 60% of the score can be obtained due to actions associated with organizational and user behavior issues. Concerning the "Energy" category, only 7.9% of the points are obtained via user actions, whereas the rest, or 92.1%, is obtained by designing and incorporating technology into the facility. In fact, in all categories except for Solid Waste, most of the points can be obtained by including technological solutions in the design of the facility (**Table 3**).

An analysis of the certification program reveals a clear preference for the use of technology in the design of a facility as the main mechanism to attain sustainability, disregarding a fundamental aspect of sustainable development, that is, sustainability as a result of the transformation of behavior patterns.

It is important to highlight the implications of such a program: the population can wrongly perceive a facility as a sustainable architectural environment only because it includes efficient technological components, and the need to modify their patterns of consumption or use of resources ecologically is never internalized. Sustainability can be hardly achieved if the population fails to take on the responsibility of using resources rationally.

A comprehensive environmental system becomes more relevant when the intention is to involve a facility's users in the improvement of the quality of their habitats. Sustainability criteria highlight the importance of aligning environmental management with current regulations to achieve substantial changes in the habitability of buildings.

Regrettably, the scope of the analyzed certification has been very limited. Despite the large number of buildings in Mexico City, only 43 of them were certified in seven years. This outcome shows that the program has ample room for improvement to design mechanisms encouraging the development of sustainable facilities. The certification classifies each facility depending on their performance status: excellence or efficiency. Half of the evaluated buildings achieved a level of excellence, which is closely associated with the total score that can be possibly obtained for the certification. The excess of points, described above, reveals one of the deficiencies in the evaluation design, which

Category	Features of the facility		Organizational factors		Total	
	Points	%	Points	%	Points	%
Energy	93	92.1	8	7.9	101	100
Water	26	56.5	20	43.5	46	100
Solid waste	5	40.0	7.5	60.0	12.5	100
Quality of life and social responsibility	20	69.0	9	31.0	29	100
Environmental impact and other impacts	24	72.7	9	27.3	33	100
<i>Total</i>	<i>168</i>	<i>75.8</i>	<i>53.5</i>	<i>24.2</i>	<i>221.5</i>	<i>100</i>

Source: Prepared by the authors based on SEDEMA [5].

Table 3. Synthesis of scores by category, facility features, and organizational factors in Mexico City’s Sustainable Buildings Certification Program.

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019*	2020*
Buildings	3	8	8	17	13	21	11	14	5	3

Source: prepared by the authors based on SEDEMA [22].
 *Certification is granted for a period of three years; therefore, the facilities that obtained it in 2017 and 2018 will have a valid certification until 2019 and 2020, respectively.

Table 4. Mexico City: evolution of properties registered by Mexico City’s Sustainable Buildings Certification Program, 2011–2020.

makes certification easy to comply with. On the other hand, 26% of the evaluated buildings achieved an efficiency level, and 24% remained undefined in certification resolutions, but it can be inferred that they achieved compliance level.

Organizational capacity depends on actions to control and mitigate environmental contamination inside and outside the building. For that reason, the study of different types of buildings shows how specific actions have been selected to favor user dynamics and environmental comfort [23].

Most of the evaluated facilities (62%) are office buildings; this observation can be associated with the economic advantages offered by the program in terms of tax exemptions and the socially responsible image that a company acquires when it shows an interest in the environment. The remaining 29% of the facilities corresponds to condo towers that seek to reduce operational costs and provide a high-value offer to a population segment interested in environmental preservation.

Table 4 shows that the number of buildings included in the certification program increased gradually until a peak in 2016. After that year, the interest in obtaining certification has declined from 20 buildings to only three in 2020. Despite the economic benefits of certified buildings.² This could be possibly associated with the lack of cost–benefit advantages identified by the owners, as reflected by the lack of renewed interest in additional certifications after the initial three-year period.

² The two main benefits of sustainable actions are property and payroll tax breaks, an option available to private companies [5], however, these breaks must be processed independently from certification, which increases bureaucracy costs for building owners.

Document what bases the analysis [2, 5, 13, 15, 20] the documents governmental with a time-periodic publication.

The next section will analyze the actions carried out by building owners to obtain certification. This analysis was carried out based on the classification presented in the previous section and it intends to highlight the different actions aimed at strengthening sustainable organization and user behavior patterns.

5. Evolution of sustainable actions in certified buildings

The underlying design of the certification program is the main antecedent of the decisions made by facility owners to obtain the necessary scores. However, as already noted, the large number of possible points gives owners room to decide on the actions that they can easily enable depending on their specific conditions.

The present section analyzes these actions based on the classification previously presented for the certification program criteria. Again, this analysis will be analyzed by category and on a temporary basis in order to identify trends during the study period. Our aim is to determine whether these actions are linked to users' actions toward sustainability or they are limited to the use of green technologies in the design of these buildings.

As noted in the previous section, the relative weight of the criteria associated with the organizational aspects of building users was 22.3% of the total possible points. This categorically determines the type of action decided by the owners in favor of sustainability in order to obtain the certification and emphasize actions associated with the adequacy of the facility. However, as shown by graphic 2, the total number of actions associated with users' organization is higher than the proportion shown by the program design.

The proportion of actions associated with users' organization is consistently lower than the proportion associated with the features of the facility, which is 28.2% higher than the reference in all years except for 2018, when, only 27% of the registered actions concerned organizational strategies involving the users. This downward trend could be explained by the availability of economic resources that building owners can use to acquire green technologies and incorporate them into their design, which is certainly opposed to organizational measures involving the users, which until recently appeared as a feasible alternative to expensive technological solutions.

The effect of this trend can be appreciated in each of the five categories. Despite such downward trend, the Water category includes more actions focused on users' organization. Particularly, more than half of the actions carried out in 2012 were of this type. This shows the potential of water-related sustainability actions that can be transferred to the rest of the spaces in which the user interacts with the space.

In the case of the solid waste category, the strongest downward trend was observed in 2011, when 60% of the actions were associated with users' organization, but the percentage had reduced to 20% by 2018 (**Figure 1**). It is necessary to highlight this condition, since waste separation must formally be carried out by the user when generating them. Although infrastructure contributes to such activity, there are no automated systems to carry out such work. Therefore, it is essential to promote a culture of waste separation and reduction so that this category meets the objectives adequate solid waste management.

The rest of the categories are in line with the general trend, i.e., a downward trend, which emphasizes the importance of using technology in buildings over the implementation of actions that encourage changes in user behavior toward more sustainable patterns. This tendency weakens the actions in favor of sustainability that people can carry out and reduces accountability because people assume that the introduction of green technology will be enough to achieve sustainable objectives.

As can be observed, each building owner focuses on different actions. It is interesting to observe the territorial differentiation expressed in **Table 5**. Considering all the facilities, a total of 526 actions in favor of sustainability were identified during the period from 2011 to 2018. A third of these actions are associated with users' organization, which is a relatively high percentage in comparison with the score granted by the program's criteria.

The borough where most organization-related actions were registered was Cuajimalpa, with a percentage of 45%, followed by Cuauhtémoc, with 42%. In contrast, only 22% of the actions in certified Tlalpan properties were associated with users' organization, and only 27% in Benito Juárez. A larger number of actions associated with facility features was found in the south part of the city, as opposed to the center-west, where more actions related to users' organization were observed.

Mexico City's boroughs are quite heterogeneous; therefore, there is no simple explanation for this territorial phenomenon. For example, many of them contain

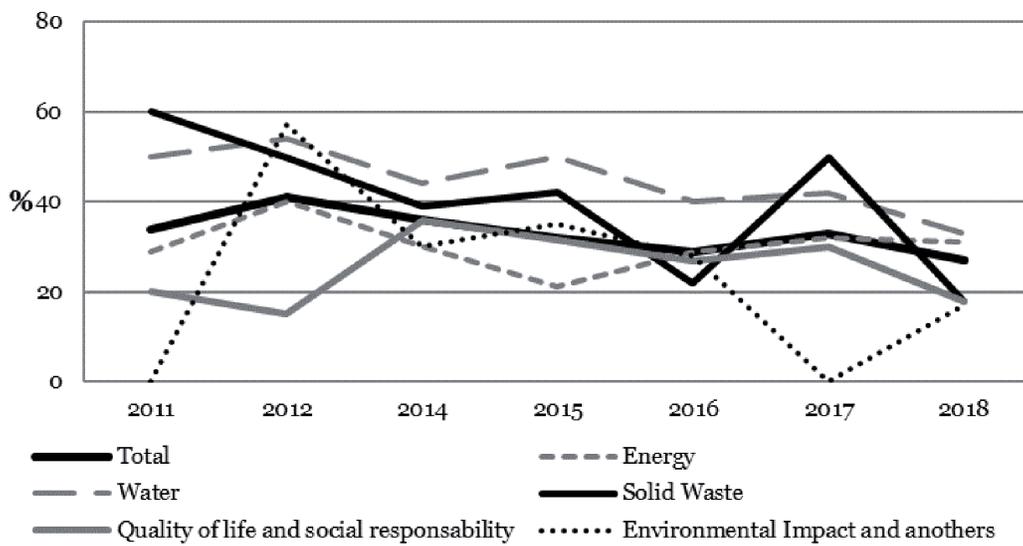


Figure 1. Mexico City: evolution of environmental actions according to facility features and organizational factors (2011–2018). Source: Elaborated by the authors based on SEDEMA [22].

Borough	Total of facilities	Total actions	Facility features	%	Organizational factors	%	Average actions per facility
Miguel Hidalgo	13	211	145	69	66	31	16
Álvaro Obregón	8	134	91	68	43	32	17
Cuauhtémoc	5	77	45	58	32	42	15
Azcapotzalco	3	34	21	62	13	38	11
Benito Juárez	2	30	22	73	8	27	15
Cuajimalpa	2	22	12	55	10	45	11
Tlalpan	1	18	14	78	4	22	18
<i>Total</i>	<i>34</i>	<i>526</i>	<i>350</i>	<i>67</i>	<i>176</i>	<i>33</i>	<i>15</i>

Source: Prepared by the authors based on SEDEMA [22].

Table 5. Mexico City: classification of actions to achieve certification.

areas of high purchasing power as well as marginalized sectors, which would require a more detailed analysis that exceeds the scope of the present chapter.

As could be expected due to the way in which the program was designed, most actions (45.1%) have to do with the energy category. However, the types of actions show a different proportion: 26% of the actions address criteria associated with energy, followed by quality of life and social responsibility, addressed in 24% of cases, which is high considering that the certification program allocates 13.5% of the score in this category to actions related to users' organization. The solid waste category also stands out; it represents only 5.6% of points of the certification, and 18% of the actions are associated with this category (**Table 6**).

Concerning differences by borough, energy-related actions predominate in four of them; however, in all cases, the proportion is lower than the score in this category; the largest proportion was found in Benito Juárez, where these actions account for 43% of the total (**Table 6**). Actions associated with environmental impact predominate in Cuajimalpa; this trend can be associated with the concern about not damaging the protected natural areas present in the borough. Finally, in Álvaro Obregón and Tlalpan, most activities were focused on quality of life and social responsibility.

Interestingly, actions tend to be heterogeneous depending on the territorial conditions of each borough, that is, depending on the most pressing issue at the local level (e.g., water distribution, energy consumption, solid waste management, social responsibility, or environmental impact). This analysis sets the tone for future studies to discuss this behavior in more detail, focusing for instance on building type; in this case, for example, the studied facilities consisted mostly of urban condos and office buildings.

On the other hand, these territory-related decisions reflect a positive attitude among building owners, who align their action plans with local sustainable goals instead of focusing on obtaining a good score and being certified. This attitude is possible because building users are made aware of the environment where they interact and act in solidarity to build their right to a healthy life. We will now broaden the analysis by discussing the five categories in more detail to identify temporal trends and actions specifically related to organizational factors.

5.1 Energy

In terms of score, this category has the highest weight on the score and on the criteria associated with the features of the facility; 92% of the score in this category can be obtained by meeting such criteria, and an average of 70% of the actions in all boroughs are focused on these features. Buildings located in Miguel Hidalgo account for 34% of the actions associated with how users organize, which is the highest percentage of all boroughs (**Table 7**).

Most reported actions concern the use of technological equipment, whereas organizational factors are clearly disregarded. Motion control and automation systems, such as hydro-pneumatic pumping, and in some cases, emergency generators and physical fire protection systems were among the most frequent technological actions. Other initiatives are energy consumption measurement programs, light and refraction control logs, use of natural lighting, solar cells, and adaptations to improve the habitability of common areas are other examples.

5.2 Water

The lack of available water resources is associated with poor consumption habits, excessive social consumption, and a lack of environmental culture. As a consequence, the recharge of aquifers is often compromised because the natural water cycle is

Borough	Energy	%	Water	%	Solid waste	%	Quality of life and social responsibility	%	Environmental impact	%	Total actions	%
Álvaro Obregón	31	23	21	16	30	22	37	28	15	11	134	100
Azcapotzalco	10	29	8	24	5	15	9	26	2	6	34	100
Benito Juárez	13	43	5	17	5	17	4	13	3	10	30	100
Cuajimalpa	0	0	6	27	4	18	4	18	8	36	22	100
Cauhtémoc	21	27	13	17	17	22	18	23	8	10	77	100
Miguel Hidalgo	56	27	44	21	33	16	48	23	30	14	211	100
Tlalpan	4	22	2	11	3	17	6	33	3	17	18	100
<i>Total</i>	<i>135</i>	<i>26</i>	<i>99</i>	<i>19</i>	<i>97</i>	<i>18</i>	<i>126</i>	<i>24</i>	<i>69</i>	<i>13</i>	<i>526</i>	<i>100</i>

Source: Prepared by the authors based on SEDEMA [22].

Table 6.
Mexico City: total actions by environmental category by borough, 2011–2018.

Borough	Total actions	Features of the facility	%	Organizational factors	%
Miguel Hidalgo	56	37	66	19	34
Álvaro Obregón	31	22	71	9	29
Cuauhtémoc	21	16	76	5	24
Benito Juárez	13	9	69	4	31
Azcapotzalco	10	7	70	3	30
Tlalpan	4	3	75	1	25
<i>Total</i>	<i>135</i>	<i>94</i>	<i>70</i>	<i>41</i>	<i>30</i>

Source: Prepared by the authors based on SEDEMA [22].

Table 7.
 Energy-related actions carried out to obtain certification in Mexico City, 2011–2018.

Borough	Total actions	Features of the facility	%	Organizational factors	%
Miguel Hidalgo	44	29	66	15	34
Álvaro Obregón	21	12	57	9	43
Cuauhtémoc	13	6	46	7	54
Azcapotzalco	8	3	38	5	63
Cuajimalpa	6	2	33	4	67
Benito Juárez	5	3	60	2	40
Tlalpan	2	1	50	1	50
<i>Total</i>	<i>99</i>	<i>56</i>	<i>57</i>	<i>43</i>	<i>43</i>

Source: Prepared by the authors based on SEDEMA [22].

Table 8.
 Water-related actions carried out to obtain certification in Mexico City, 2011–2018.

disturbed. In this category, the possible points to be obtained due to organization-related actions represent 43.5% of the total and points related to building features represent 56.5%; therefore, this category was found to be the best balanced.

On average, the actions carried out by building owners to obtain certification are organized in practically the same way in this regard (43–56%). The cases of Azcapotzalco and Cuajimalpa stand out, since the actions carried out by building owners focused on users' organization are 63 and 67%, respectively (**Table 8**).

Integral water management policies have achieved a balance by incorporating the relationship between organizational factors and building features. Among our findings are internal campaigns carried out by companies and efficient water use programs in condos. In some cases, checks for leaks are conducted daily, and some owners have built treatment plants to irrigate green areas for use in common areas or domestic use. In addition, recent proposals have focused on distributive justice, such as rainwater collection and purification or reinstating traditional practices such as preserving natural waterways to allow for the infiltration of clean water into the soil.

5.3 Solid waste

The treatment of solid waste often requires structural changes to respond to the increasing numbers of residents and visitors in urban buildings. For that reason, infrastructure such as transfer stations and sorting, compaction, and recycling plants is currently used for processing 60% of the waste produced in Mexico City.

Borough	Total actions	Features of the facility	%	Organizational factors	%
Miguel Hidalgo	33	25	76	8	24
Álvaro Obregón	30	17	57	13	43
Cuauhtémoc	17	7	41	10	59
Azcapotzalco	5	3	60	2	40
Benito Juárez	5	3	60	2	40
Cuajimalpa	4	2	50	2	50
Tlalpan	3	3	100	0	0
<i>Total</i>	97	60	62	37	38

Source: Prepared by the authors based on SEDEMA [22].

Table 9.
Mexico City: actions associated with solid waste certification, 2011–2018.

As previously mentioned, this category has a score ratio of 60–40 in favor of actions associated with users’ organization, contrary to the previous cases, where the proportion of actions of this type was higher or equal to the score. Actions associated with facility features are clearly predominant (62–38) (**Table 9**).

In Cuauhtémoc 59% of the actions are related with user’s organization. By contrast, in Tlalpan, all actions are associated with facility features, which raises questions about the efficiency of waste management actions in facilities where no actions requiring the users to separate waste have been put in place.

5.4 Quality of life and social responsibility

Social involvement in cross-sectional interventions focused on environmental management will be possible provided that users become aware of the importance of their commitment as agents responsible for the dissemination of sustainable-oriented actions. Therefore, most of these actions would be expected to be associated with user’s organization.

However, the proportion is very close to the score given by the certification program, that is, in which 69% of the actions are related to facility features. In other words, 71% of actions are associated with facility features, whereas only 29% are associated with users’ organization. Cuauhtémoc represents a higher proportion of actions associated with activities carried out by users, accounting for 39% of the total actions (**Table 10**). In contrast, in Cuajimalpa, all actions are related with the design of the facility, which challenges the adequacy of this strategy on social responsibility.

A wide range of actions translates into better chances to improve social interaction; however, the user should find it easy to comply with sustainability-related actions. At the same time, building users should be rewarded with comfortable environments in terms of infrastructure, logistics, and enough space to engage in leisure activities. Therefore, the activities of a building’s users are essential to foster social responsibility, an essential element in the transition to sustainability.

5.5 Environmental impact and other impacts

This section refers to environmental contamination and the impact of the construction itself on the environment, both of which must remain within permissible levels. The proportion of actual registered actions is similar to the score suggested by the program. Therefore, the highest possible score based on criteria associated users’ organization represents only 27.3% of the total, and the remaining 72.7% represents actions associated with the design of the facility.

Accordingly, 29% of the actual actions are related with user activities. The case of Cuajimalpa stands out: half of the actions carried out in this borough involve building users. In contrast, Benito Juárez, Tlalpan, and Azcapotzalco focused their actions entirely on facility features (**Table 11**).

Environmental building safety is a result of environment-related regulations intended to guarantee the reduction of harmful and hazardous contaminants. These regulations allow suppliers to demonstrate that they are operating within current legislation and that their emissions are permissible at the local level [5].

In this regard, program design and actual actions are clearly related. The proportions are very similar in three of the five cases: water, quality of life, social responsibility, environmental impact, and other impacts. Concerning the energy category, the balance is relatively in favor of criteria associated with sustainable activities. However, most of the actions in this category are limited to facility design features. In the case of solid waste, again, most actions have to do with facility features, which demonstrates the preference for technological solutions over changing the population's behavior, an essential element to promote environmental awareness.

Borough	Total actions	Features of the facility	%	Organizational factors	%
Álvaro Obregón	37	27	73	10	27
Azcapotzalco	9	6	67	3	33
Benito Juárez	4	3	75	1	25
Cuajimalpa	4	4	100	0	0
Cuauhtémoc	18	11	61	7	39
Miguel Hidalgo	48	35	73	13	27
Tlalpan	6	4	67	2	33
<i>Total</i>	<i>126</i>	<i>90</i>	<i>71</i>	<i>36</i>	<i>29</i>

Source: Prepared by the authors based on SEDEMA [22].

Table 10.
 Mexico City: actions associated with Quality of life and social responsibility certification, 2011–2018.

City Halls	Total actions	Features of the facility	%	Organizational factors	%
Miguel Hidalgo	30	19	63	11	37
Álvaro Obregón	15	13	87	2	13
Cuajimalpa	8	4	50	4	50
Cuauhtémoc	8	5	63	3	38
Benito Juárez	3	3	100	0	0
Tlalpan	3	3	100	0	0
Azcapotzalco	2	2	100	0	0
<i>Total</i>	<i>69</i>	<i>49</i>	<i>71</i>	<i>20</i>	<i>29</i>

Source: Prepared by the authors based on SEDEMA [22].

Table 11.
 Mexico City: Actions for certification in the area of environmental impact and other impacts, 2011–2018.

6. Conclusions: assimilation of sustainable practices by users

Around 78% of Mexico's population is expected to be located in urban environments by 2050, ranking eighth at the international level [24]. Although agglomeration economies favor the efficient use of resources in cities, the growing demand for natural resources and infrastructure services has an undeniable impact on nature [25], and buildings play a central role in such demand.

Buildings require energy and water to operate and to enable the activities carried out by human beings who use them; therefore, they are sources of pollution [3]. The present study identified a clear trend toward sustainability based on technological solutions included into the design of the facilities. However, a lack of maintenance can reduce the efficiency of the technology or affect its performance. This is an essential factor to involve users in sustainable actions.

The practical impact of this research deal with the organizational factors is the element that adds meaning to sustainability criteria: the introduction of ecotechnology is not enough when the user will fail to use it properly. Therefore, the adoption of sustainability criteria to overhaul buildings is important, but also the incorporation of environmental culture into organizational climate, and consequently, specialized knowledge about sustainability-oriented user patterns is not enough: reasonable goals are needed to achieve habitability as a right to a healthy environment. Certification programs represent a guiding instrument for owners to conduct adequate and decisive actions in favor of sustainability. Even when buildings incorporate the latest technological sustainability features, users must become involved in the sustainable aspect of their physical environment.

The principal finding of the present study evinced the relatively low importance of organizational processes as a factor in the specific actions carried out by local agents to configure sustainable buildings in Mexico City's boroughs, and many of these actions reflect how certification programs are designed, specifically, the low consideration given to social actions.

Infrastructure and technological devices are favored in 76% of the cases, whereas only 24% of the cases favor users' organization. The proportion is very similar in terms of specific actions, and although there is a temporary trend favoring actions associated with facility features, the same proportion is observed in the program's score, since by 2018, 27% of total actions focused on users' organization issues. Improvement processes arise from the particular needs of a building, but any process must always be accompanied by constant monitoring to reproduce the intrinsic motivation of environmental awareness [26]; however, as shown by the decreasing trend in this area, true improvement may not be accomplished.

Users' willingness and abilities are essential for an adequate building management; in the present study, we differentiated the weight of each environmental item by linking them with organizational factors. Control measures are not temporary strategies: sustainable actions must be integrated into the users' activities to consolidate the environmental management program in a given building.

The actions associated with the implementation of energy-saving technologies have an outstanding presence in Mexico City's certification program; however, actual actions differed from this reference. However, the proportion is still uneven: only 30% of total actions were associated with guiding the user toward sustainable behaviors. On the opposite end of this spectrum is the category of solid waste management; in this category, the program allocates greater importance to criteria associated with users' actions (60% of the score), but building owners focused on the same proportion when implementing actions associated with the features of their facilities. The rest of the categories are in line with the score allocated by the

certification program, which proves its transcendence as a guideline for owners to define the most convenient actions to obtain certification.

The value of the findings is linked with the low holistic awareness among building users is a sign of decreased interaction with the natural world, which results in poor organizational skills—users perceive themselves as separated from their environment, and they assume that sustainability will be achieved simply by using technology classified as sustainable.

The key contribution impact of this study is related with the design of Sustainable Building Certification Program. This program in Mexico City has a series of challenges, for instance, its lack of capacity to transcend into the sustainability framework of the city and its need to produce adequate guidelines to help users internalize sustainability as a vision. The first challenge is associated with the decreasing number of buildings seeking certification, which can be associated with a lack of economic incentives for the owners.

The second challenge is connected with this lack of interest; the insufficient environmental awareness among building users and owners limits their goals to economic aspects. In this regard, strengthening criteria associated with users' organization would favor the assimilation of a sustainable vision among the population and encourage the renewal of certifications under a shared goal: creating healthy environments for the population.

Mexico City's certification program is undoubtedly a sign of progress in terms of sustainability as a basic component of the urban environment. Buildings take up an average of 90% of the surface area in cities; therefore, they are the most important space in terms of urban sustainability. However, there are many areas of opportunity and strengthening the criteria to encourage sustainable actions by users is paramount.

This chapter reveals the marginal importance of the sustainable pattern users in the Sustainable Building Certification Program, nevertheless, the limitations of this research refers with the necessity to explore the central reasons of stakeholders to promote sustainable patterns in contrast with technological investment in sustainable devices. There is a clear tendency to introduce new technology as a solution to reduce environmental impact of human activity, even though the financial cost of this technology.

There is no doubt that the sustainable technology will increase and maintain its development. Future studies should analyze the manufacture environmental impact of these technologies in contrast with the investment in sustainable education and promotion of low impact patterns of urban people. We believe that the creation of sustainable consciousness will have a more effective impact in sustainability. Finally, users use these devices and make them efficient.

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