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Assessing the Sustainability of Retail Buildings: The Portuguese Method LiderA

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Abstract: Retail stores are among the building typologies with the highest consumption of natural resources. However, studies regarding the development of Building Sustainability Assessment methods for retail buildings are missing, despite their environmental, economic, and social importance. This study intends to address this gap in knowledge by (i) developing the Portuguese method LiderA for retail buildings, (ii) comparing LiderA to other BSA methods, and (iii) assessing results in two case studies. The development of LiderA for retail buildings took under consideration the indicators, weights, and specific guidelines of different BSA methods for retail buildings (namely LEED, BREEAM, and DGNB) and trends in the retail sector expressed in retailers' sustainability reports and retailers' associations. The most innovative aspects of the development of LiderA for retail buildings include the definition of benchmarks to assess sustainability performance in terms of Energy Intensity (EI), Carbon Intensity (CI), and Water Intensity (WI). Additionally, sustainable business operation practices were introduced in selected indicators as an alternative way to foster the roots of sustainability further down into the value chain, namely regarding ethical and sustainable product purchases, the protection of human rights, a code of conduct for suppliers, fair trade, product traceability, healthy food, sustainable agriculture, and local and organic products. The LiderA method, developed for retail buildings, can support designers, managers, and users in designing and managing more sustainable stores by providing benchmarks and best-practice thresholds for EI, CI, and WI. Given that global retailers operate hundreds of stores, the results show a key potential to increase the environmental performance of retail stores, supporting decision-making towards maximum energy efficiency and carbon neutrality.

Keywords: LiderA; retail buildings; building sustainability assessment (BSA) methods; sustainable management

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1. Introduction

Building Sustainability Assessment (BSA) methods can be helpful to raise awareness and promote sustainable building practices in the built environment, minimise environmental impacts and natural resources consumption, optimise operational costs, and assist in providing greater health and well-being to users. They are also valuable methods in the decision-making process of designing buildings, both for design teams and stakeholders. In the European context, buildings account for about 50% of all extracted materials, 50% of the total energy consumption, 30% of the total water consumption, and 30% of waste generation [1]. Retail buildings, in particular, have one of the highest Energy Intensities (EI), particularly food retailers [2]. Similarly, retailers' Carbon Intensity (CI) is considerable for direct and indirect greenhouse gas (GHG) emissions [3]. In addition, the frequent refurbishment of retail stores, motivated mostly by market factors, leads to increased life cycle environmental impacts in retail buildings [4]. Hence, using BSA methods to assist in design choices for retail buildings is of the utmost importance. Nonetheless, few existent BSA methods address retail buildings in their portfolio. There is also little information in the literature regarding how BSA methods can be customised for retail buildings or adapted to regional contexts.

In the context of Portugal, the retail typology is responsible for 7% of total energy consumption in the Portuguese built environment, making it the second-largest energy-consumer sector [5]. The Portuguese construction industry is also responsible for up to 12.3% of total CO_2eq emissions, the third most polluting sector [6]. Hence, the importance of Portuguese retail buildings in terms of environmental impact is important, like that of European retail buildings. The need for commercial buildings to become 70–80% more energy-efficient has been determined by the European Union (EU) in the Energy Performance of Buildings Directive (EPBD) [7]. Sustainable buildings are essential for achieving the goals conveyed by the EU's Circular Economy Action Plan [8], which is also in line with the United Nation's Sustainable Development Goals (SDGs) [9] and the Paris Agreement [10]. Concerted global political and social action under sustainable development has also pushed retailers to "go green" [11] and take responsibility for their environmental, social, and economic impact. The business paradigm shift to the triple bottom line concept [12] has also caused international retailers to gradually develop and implement high-performance building solutions in new or refurbished retail stores, recurring strategically to BSA methods to increase building sustainability performance. Following this international trend, Portuguese branches of international retailers, such as Leroy Merlin, Makro, and Decathlon [13–15], and large Portuguese international retailers, such as Jerónimo Martins [16], are increasingly seeking out sustainability certifications granted by BSA methods as a way of addressing Corporate Social Responsibility (CSR). This situation created a market need in Portugal that justifies developing the Portuguese voluntary certification method LiderA for retail buildings, which this study will explore. The development of BSA methods adapted to regional contexts is justified due to the specific priorities in terms of sustainability of each country, as a solution to bypass the need to comply with foreign regulation implied by international BSA methods, the need to translate documents into a foreign language or to adapt the project's measurement units, which can lead to increased costs and workload [17]. Learning from international experience is, nevertheless, critical. Existing international BSA methods that address non-domestic building types, which include retail buildings, are Leadership in Energy and Environmental Design (LEED) [18], Building Research Establishment Environmental Assessment Methodology (BREEAM) [19], HKBEAM [20], SBTool [21], Green Star [22], NABERS [23], Haute Qualité Environmental (HQE) [24], German Sustainable Building Council (DGNB) [25], and Swiss Sustainable Construction Standards (SNBS) [26]. However, studies comparing BSA methods for retail buildings, or the development of BSA methods for retail buildings, are missing, despite their environmental, economic, and social importance, as pointed out by Gimeno–Frontera et al. [27].

This study intends to address this gap in knowledge by reviewing the shortcomings of the most popular BSA methods for retail buildings and developing LiderA for this purpose. This research will also point out the current contribution of indicators' weighting differences in the most popular BSA methods for retail buildings and differences in their usage-specific guidelines. By comparing LiderA with other methods, as well as the macro-objectives defined in Level(s), a common European voluntary reporting framework [17], it is possible to establish the contribution of LiderA to the existing body of knowledge and how the assessment of retail buildings can inform sustainable management. In this sense, benchmark metrics in terms of energy (EI), carbon (CI), and water intensity (WI) in the retail sector were created specifically for this new development of LiderA and tested in two case studies, in turn offering retailers, designers, managers, and decision-makers innovative environmental performance comparison metrics that can be of service to assist and guide in the operational stage of buildings. Hence, the findings of this research can be used by stakeholders to attain sustainable retail buildings with higher environmental performance at all stages of the life cycle of the building, achieve optimised operational costs, and increase users' well-being.

Henceforth, in Section 2, a description of the methodology of the research is carried out, whereas, in Section 3, a review of the existing literature on the area of the present research is conducted, followed by a comparison of the proposed LiderA method for retail buildings to LEED, BREEAM, and Level(s) and by the presentation in detail of LiderA as a sustainability assessment method for retail buildings, validated by the case studies. Section 4 includes the main findings of the research, including implications and limitations, whereas, in Section 5, the main contributions and future research suggestions are presented.

2. Materials and Methods

To develop LiderA for retail buildings, a study of qualitative nature was carried out based on the literature review and on the analysis of the following data: (i) list of indicators, weights, and implementation manual of different BSA methods for retail buildings-namely LEED, BREEAM, and DGBN; (ii) trends for future developments in the retail sector, expressed either in retailer's sustainability reports or in retailer's associations and coalitions—namely RILA or the European Commission' Retail Forum for Sustainability; (iii) Level(s), an EU voluntary framework designed for buildings sustainability assessment; (iv) local regulations and CEN and ISO standards. As a primary step in developing LiderA for retail buildings, it was decided not to adjust the weights of existing indicators but rather to adjust performance metrics and usage-specific guidelines in existing indicators, as according to previous research, indicators' weighting differences in BSA methods for retail buildings have reduced the impact in the overall classification. Hence, the same methodology was applied in developing LiderA for retail buildings. Nevertheless, a stakeholder inquiry was carried out mostly to retail professionals and project teams (n = 64) to assess which sustainability areas were considered most important in building certification. The inquiry's results did not alter the current weight structure in the original LiderA method (nor in the current development of the LiderA method for retail buildings). Still, they offered perspective on emerging stakeholder trends concerning the importance of sustainability criteria in BSA methods [28], namely on a more equal distribution of weights amongst criteria. Hence, four main steps were considered in this study.

In step 1, the development of the LiderA tool for retail buildings, a critical review of the indicators that needed adaptation for retail buildings was performed. Table 1 portrays this analysis, in which adapted indicators are marked in bold (about half of the total). In addition, the sum of weights given to indicators in the environmental, economic, social, and technical dimensions of sustainability was estimated to evaluate the distribution and impact of each dimension in the LiderA method. Later, the indicators of LEED, BREEAM, and DGBN were compared to assess the strengths and limitations of each BSA method regarding its applicability to retail buildings. LEED and BREEAM were chosen for being the oldest, most popular methods [17], and DGNB was selected for being a second-generation method [29], with emphasis on the Life Cycle Assessment (LCA) approach. The manuals of LEED, BREEAM, and DGBN for this study were collected online [18,19,25], e.g., "LEED v4.1 Building Design and Construction, dated April 2021", "Technical Manual SD5078 BREEAM UK New Construction 2018 3.0 for Non-domestic Buildings", and "DGNB New Buildings Criteria Set Version 2020 International". They were compiled in a data repository to ensure permanent access to these manuals [30]. To further detail and compare the differences between LiderA, LEED, BREEAM, and DGNB for retail buildings, Table 2 was created, in which weighting differences for retail buildings and usage-specific guidelines were disclosed. Since the analysed BSA methods have different structures, categories, and indicators, categories were grouped for comparison according to the core indicators defined by ISO 21929-1: 2011 [31], using the same methodology as other studies, such as Castro et al. [32]. Hence, the categories considered for comparison purposes were (1) management; (2) indoor environmental quality/well-being; (3) service quality; (4) energy; (5) transport; (6) water; (7) materials; (8) waste; (9) sustainable sites; and (10) pollution. Individual indicators were aggregated into these categories, where weights and descriptions of usage-specific guidelines for retail buildings were compiled. Grouping the indicators of LEED, BREEAM, and DGNB under these ten categories was subject to the authors' interpretation, according to the methodology of Cordero et al. [17]. For nomenclature purposes, indicators are defined as straightforward, measurable elements that need completion to achieve the score [17]. The research on existing BSA tools applicable to retail buildings identified the need to develop specific performance metrics for retail buildings, namely in terms of energy and water consumption and carbon dioxide equivalent emissions. Hence, EI, CI, and WI benchmarks were created for retail stores [3] (Supplementary Material).

Table 1. Structure of the proposed LiderA method.

Dimension	Category	Category Weight	Sustainability Indicator	Indicator Weight
Local integration (Habitat)	Soil	4%	P1—Territorial Organization	2%
			P2—Enhance Soil Functions	2%
	Natural Ecosystems	4%	P3—Ecological valuation	2%
			P4—Ecosystem services	2%
	Landscape and built heritage	4%	P5—Enhancement of the landscape	2%
			P6—Valuation of built heritage	2%
Resources (Flows)	Energy	15%	P7—Passive performance *	5%
			P8—Energy systems *	5%
			P9—Carbon management *	5%
	Water	7%	P10—Moderate water use *	5%
			P11—Local water management *	2%
	Materials	7%	P12—Products and materials of responsible origin *	6%
			P13—Durability of built environments	1%
	Food production	1%	P14—Contribution to local food production *	1%
Management of Secondary Loads and Resources	Wastewater	2%	P15—Wastewater management *	2%
	Waste	3%	P16—Waste management *	3%
	Other loads	5%	P17—Noise management *	3%
			P18—Atmospheric emissions management *	1%
			P19—Other environmental loads management	1%
Quality of service and resilience	Quality of service	9%	P20—Environmental quality *	7%
			P21—Safety and risk control (human)	2%
	Structural adaptation	6%	P22—Climate adaptation and other natural hazards	3%
			P23—Resilience and adaptive evolution *	3%
Socio-Economic Experiences	Accessibility	4%	P24—Active mobility *	3%
			P25—Efficient transport systems	1%
	Inclusive areas	4%	P26—Inclusive built areas	3%
			P27—Inclusive spaces—Accessible and safe streets and public spaces	1%
	Social vitality	4%	P28—Flexibility and complementarity of uses *	2%
			P29- Contribution to community well-being (e.g., Health) *	1%
			P30—Social responsibility (and vitality) *	1%
	Amenities and culture	3%	P31—Friendly Amenities	2%
			P32—Contribution to culture and identity *	1%
	Green and sustainable economy	7%	P33—Low life cycle costs *	5%
			P34- Contribution to circular economy *	1%
			P35—Contribution to environmental jobs *	1%
	Connectivity	3%	P36—Connectivity and interaction (Digital Systems)	3%
Sustainable use	Sustainable management	5%	P37—Information management for sustainable performance	3%
			P38—Maintenance and sustainability management	1%
			P39—Monitoring and governance *	1%
	Marketing and innovation	3%	P40—Marketing and innovation *	3%

* Indicators that have been specifically adapted to retail buildings.

Table 2. Main scoring differences and criteria specifications for retail buildings in LiderA, LEED, BREEAM, and DGNB.

		LiderA		LEED		BREEAM		DGNB	
Category	**Indicator**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**
Management	Life cycle cost							Life cycle costs and energy demand reference values	
	Flexibility and adaptability	Sales operation resilience and modular structural mesh flexibility						Structural and building services flexibility	
	Commercial viability							Quality of public transportation	
	Information management for sustainable performance	User manual for building systems							
	Marketing and innovation	Innovation toward sustainable performance							
	Contribution to the circular economy	Circular economy practices							
	Contribution to environmental jobs	Work flexibility and inclusion							
Indoor and Environmental Quality/Well-Being	Visual comfort	Daylight factor of 2% for 35% of the sales area				Daylight factors of 2% or more in 35% of sales areas and 80% of other occupied areas.	2 credits ↑ (range 1–2) **	Daylight factors of 1% (from windows) to 2% (from skylights) Illuminance levels reference values	
	Indoor air quality							Low-emission construction products	4.5% ↓ (range 4.5–5.4%) ***
	Quality of indoor and outdoor spaces								2.3% ↑ (range 1.8–5.4%) ***
	Inclusive design							Barrier-free toilets and staff entrances	4.5% ↑ (range 0–4.5%) ***

Table 2. *Cont.*

		LiderA		**LEED**		**BREEAM**		**DGNB**	
Category	**Indicator**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**
Service Quality	Fire safety								2.9% ↑ (range 2.5–2.9%) ***
	Sound insulation								0% ↓ (range 0–1.9%) ***
	Quality of the building envelope								2.1% ↓ (range 2.1–2.7%) ***
	Use and integration of building technology								2.1% ↑ (range 1.9–2.1%) ***
	Ease of cleaning building components								1.4% ↑ (range 1.3–1.4%) ***
	Ease of recovery and recycling								2.9% ↑ (range 2.5–2.9%) ***
	Immissions control								1.4% ↑ (range 0.6–1.4%) ***
	Mobility infrastructure								1.9% ↓ (range 1.9–2.1%) ***
Energy	Refrigerant management	CO_2eq benchmarks		Non-ozone-depleting refrigerants, annual refrigerant emissions < 15% and leak testing		No refrigerant use, refrigerants with GWP < 10 and leek testing			
	Optimised energy performance				18 credits ≈ (range 16–20) *				
	Thermal comfort			Thermal comfort for >50% of office spaces					4.5% ↑ (range 3.6–4.5%) ***
	User control							Ventilation and temperature control	2.3% ↑ (range 0–2.3%) ***

Table 2. *Cont.*

		LiderA		LEED		BREEAM		DGNB	
Category	**Indicator**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**
Energy	Energy monitoring	Audits, systems retro-commissioning, energy and water consumption monitoring, media data reporting, transparency in the value chain, and cyber security and data privacy				Energy monitoring			
	Energy-efficient cold storage					Code of Conduct for Carbon Reduction			
	Passive Performance	South orientation of spaces, efficient windows, minimisation of air drafts and form factor of 0,52							
Transport	Bicycle facilities			$\geq$2 bicycle storage/465 m^2, $\geq$2 per building or for >5% of building occupants, and no less than +2 per building Bicycle programs for employees and customers		1 bicycle storage per 10 staff, 1 per 20 public car parking spaces			
	Sustainable transport	Green and efficient logistics							
Water	Indoor water use reduction				7 credits ↑ (range 4–7) *			Potable water demand and wastewater volume calculated by users	2.4% ↑ (range 2.3–2.4%) ***

Table 2. *Cont.*

		LiderA		LEED		BREEAM		DGNB	
Category	**Indicator**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**	**Usage-Specific Guidelines for Retail Buildings**	**Differences in Weight**
Materials	Products and materials of responsible origin	Ethical purchase, code of conduct for suppliers, fair trade, animal welfare, traceability, sustainable farming, organic produce, local produce and healthy eating							
Waste	Operational waste management	Partnerships to reduce waste				Dedicated space for recyclable waste volumes			
Sustainable Sites	Neighbourhood Development location				16 credits ↑ (range 9–20) *				
	Contribution to local food production	Meals for employees based on local produce							
Pollution	Local water management	Parking lots with pollutant control							

* score variations in LEED concern the following building types: schools, retail, data centres, warehouses and distribution centres, hospitality, and healthcare. ** score variations in BREEAM concern building types: office, industrial, retail, education, healthcare, prison, law court, residential institution (long and short stay), non-residential institution, and assembly and leisure. *** score variations in DGNB concern building types: office, educational, residential, hotel, consumer market, shopping centres, department stores, logistics and production. ↑ more importance is given to retail buildings than to other building typologies. ↓ less importance is given to retail buildings than to other building typologies. ≈ average importance is given to retail buildings regarding other building typologies.

In step 2, retail desk research, trends of the retail sector were scrutinised based on data retrieved from RILA [33] and the European Commission's Retail Forum for Sustainability [34,35]. The main findings of desk research were considered in adapting LiderA for retail buildings. They assisted in the fine-tuning of usage-specific guidelines in the following indicators: "P9—Carbon management"; "P10—Moderate water use"; "P11—Local water management"; "P12—Products and materials of responsible origin"; "P14—Contribution to local food production"; "P16—Waste management"; "P20—Environmental quality"; "P23—Resilience and adaptive evolution"; "P24—Active mobility"; "P28—Flexibility and complementarity of uses"; "P30—Social responsibility (and vitality)"; "P33—Low life cycle costs"; "P34—Contribution to a circular economy"; "P35—Contribution to environmental jobs"; "P39—Monitoring and governance"; "P40—Marketing and innovation".

In step 3, LiderA, LEED, BREEAM, and DGNB were compared to Level(s), considering six major areas: greenhouse gas emissions, resource efficiency, water use, health and comfort, resilience and adaptation, and cost and value (Table 3). The link between sustainability assessment and sustainability management in the operation stage is also discussed in Section 4.4.

Table 3. Correspondence between the LiderA, LEED, BREEAM, DGNB, and Level(s) macro-objectives.

Level(s) Macro-Objectives	Level(s) Indicators	LiderA	LEED	BREEAM	DGNB
1. Greenhouse gas emissions along a buildings life cycle	1.1 Use stage energy performance (kWh/m^2/yr)	yes	yes	yes	yes
	1.2 Life cycle Global Warming Potential (CO_2 eq./m^2/yr)	yes	yes	yes	yes
2. Resource-efficient and circular material life cycles	2.1 Bill of quantities, materials, and lifespans	yes	yes	yes	yes
	2.2 Construction and Demolition waste	yes	yes	yes	yes
	2.3 Design for adaptability and renovation	yes	yes	yes	yes
	2.4 Design for deconstruction	no	no	yes	yes
3. Efficient moderate water use resources	3.1 Use stage water consumption (m^3/occupant/yr)	yes	yes	yes	yes
4. Healthy and comfortable spaces	4.1 Indoor air quality	yes	yes	yes	yes
	4.2 Time out of thermal comfort range	no	no	yes	yes
	4.3 Lighting	yes	yes	yes	yes
	4.4 Acoustics	yes	yes	yes	yes
5. Adaption and resilience to climate change	5.1 Life cycle tools: scenarios for projected future climatic conditions	yes	no	yes	yes
	5.2 Increased risk of extreme weather	yes	no	yes	yes
	5.3 Increased risk of flooding	yes	no	yes	yes
6. Optimised life cycle cost and value	6.1 Life cycle costs (€/m^2/yr)	yes	no	yes	yes
	6.2 Value creation and risk factors	yes	yes	yes	yes

In step 4, case study assessment, the sustainability assessment of the two case studies was performed to verify whether the proposed method LiderA for retail buildings could assist in rectifying class attribution with regards to the environmental performance of retail buildings by comparing the score obtained in the proposed LiderA method for retail buildings to the original LiderA method. For each case study, visits were made to the store accompanied by a retail company's technical manager and a store manager. During these visits, data were gathered that included energy and water bills for the previous 12 months, operation waste production for the previous year, energy certificate, store architectural projects, bill of quantities for the tender procedure, contractor's winning bid, and pictures of the store. After the store visits, a preliminary sustainability assessment was performed in the existing LiderA method (LiderA V3), where each building obtained a score. Following the development of LiderA for retail buildings, a second sustainability assessment was performed, which confirmed that criteria customised for retail buildings enabled class upgrades in some indicators and improved the overall sustainability assessment classification of the analysed stores (Table 4).

Table 4. Score differences of the assessment of two case studies regarding the original LiderA method and the developed LiderA method for retail buildings.

	Case Study 1		**Case Study 2**	
Sustainability Indicator	**Original LiderA Method**	**LiderA for Retail Buildings**	**Original LiderA Method**	**LiderA for Retail Buildings**
P7—Passive performance	B	A	A	A+
P9—Carbon management	C	A	A	A++
P10—Moderate water use		A	B	A
P12—Products and materials of responsible origin	E	B	E	C
P24—Active mobility	E	D	D	C
P28—Flexibility and complementarity of uses	A+	A++		A++
P31—Friendly amenities	B	A		E
P39—Monitoring and governance	A	A++		A++

3. Results

3.1. Background—Sustainability Assessment in Retail

The past two decades have seen the rise of many BSA tools [36,37] and several studies have compared them to assess their similarities and differences [38–41].

Many studies have focused on the most famous BSA methods used internationally [39,40,42], while other studies referred to the development of BSA methods for specific regions [29,41–44]. The development of regional BSA methods that have benefited from the analysis of internationally recognised ones is supported by several authors [41–43], mainly due to specific cultural and weather differences that imply tailored design practices. The comparison between LEED and BREEAM as the most famous BSA methods is recurrent in terms of criteria, weights, and ranking methods [11,40,43,45,46]. Other studies compared BSA methods regarding specific approaches, such as energy simulation [47–52], or their combination with Building Information Models [53,54].

On a more conceptual level, Srivastava and Raniva [55] developed a methodological framework based on a triple-bottom-line life cycle approach to sustainability assessment in the social, economic, well-being, and environmental realms that can be used for different building stages and building typologies. Assefa et al. [56] evaluated the sustainability performance of BSA methods. They proposed an integrated model of multi-certification for optimal sustainability, which can, in turn, support future updates of BSA tools. Seminara et al. [57] suggested a sequence of building performance methods and identified passive and active measures for the efficiency of buildings, highlighting the importance of post-occupancy analysis.

The development of BSA methods according to particular building types, such as schools [58,59], healthcare buildings [60], or urban design [61–63] is present in the literature but not in retail buildings. Research related to the sustainability assessment of retail buildings is typically case study-based [64] or referred to in commercial building studies in a general manner [65,66]. Furthermore, no study compared different BSA methods to retail buildings. Only one comparative study referred to how BSA methods already developed for retail buildings, like LEED, BREEAM, and DGNB, align to Level(s) in terms of macro-objectives. Nevertheless, retail buildings pose unique environmental challenges regarding the intensity of natural resources they use (namely in energy, water, and carbon emissions), enhanced by their frequent refurbishment cycles, which presents additional impacts on building materials and waste. The proposed LiderA for retail buildings intends to learn from the weaknesses of the most famous BSA methods applicable to retail buildings, namely their lack of benchmarks to assess building performance according to these indicators in the operation stage. In addition, selected economic and social indicators introduced sustainable business operation practices to assist in the path toward sustainable management in the retail sector.

The Proposed LiderA Method, LEED, BREEAM, DGNB, and Level(s)

LiderA is a Portuguese sustainability assessment method for the built environment that is presently being adjusted for retail buildings according to the categories and indicators marked in Table 1.

For the development of LiderA to retail buildings, a comparative analysis of other BSA methods that include retail buildings was performed, as shown in Table 2. This table compiles the main scoring differences and usage-specific guidelines for retail buildings of LiderA, LEED, BREEAM, and DGNB.

In Table 3, the comparison of LiderA to LEED, BREEAM, DGNB, and Level(s) is performed.

Later, in Table 4, the assessment of the two case studies in the developed method LiderA for retail buildings is compared to the one obtained in the original LiderA method.

3.2. Development of LiderA as a Sustainability Assessment Method for Retail Buildings

LiderA is a voluntary Portuguese BSA method launched in 2005 and is currently divided into six dimensions subdivided into 20 categories, each with one or more indicators. LiderA's six dimensions of sustainability are "Local integration", "Natural resources", "Management of secondary loads and resources", "Quality of service and resilience", "Socio-economic integration", and "Sustainable use". The number and nature of categories and indicators vary to cover the most important sustainability issues in the Portuguese context.

LiderA is based on national regulations for buildings and ISO and CEN standards in specific indicators. In LiderA, sustainability's environmental, social, and economic dimensions are addressed using sustainability parameters. Additionally, there is a "technical" dimension regarding the use stage.

LiderA's building certification ranges from class A++ (the best) to class G (the worst), in which class E is considered current practice and is 1 on a scale from 0 to 10. The numerical values of each class are as follows: A++ (10.00); A+ (4.00); A (2.00); B (1.60); C (1.33); D (1.14); E (1.00); F (0.89); G (0.80), which implies that class A++ has an overall sustainability performance of 10-fold current practice.

The weights of individual indicators in the LiderA method were originally obtained by inquiries made to different stakeholders in the construction, environmental, and real estate sectors and analysed according to the Saaty multi-objective [67], using the M-MACBETH software. The Saaty multi-objective method is also denominated Analytic Hierarchy Process (AHP) method. Several authors have used the expert panel method employed in LiderA to analyse data for similar purposes [68,69]. Using the square matrix structure, the relative weight of each indicator and category was established [70]. A sensitivity analysis was also performed to test the results' robustness.

As a primary step in developing LiderA for retail buildings, it was decided not to adjust the weights of existing indicators but rather to adjust performance metrics and usage-specific guidelines in existing indicators. According to previous research, weighting differences have a reduced impact on the overall sustainability score in BSA methods developed for retail buildings, such as LEED, BREEAM, or DGNB. Furthermore, indicators remained the same across the different building typologies assessed in these methods, and differences between building types were addressed as usage-specific guidelines. Hence, the same methodology was applied in developing LiderA for retail buildings. Nevertheless, a stakeholder inquiry was carried out [28] to consider future method developments.

Using a similar approach to LEED and BREEAM, LiderA currently gives more weight to environmental criteria (49%) than to social (21%) or economic (20%) ones [71]. In contrast, DGNB addresses the environmental, social, and economic dimensions. LiderA, similar to LEED and BREEAM, is an older BSA method in which building certification was primarily addressed according to environmental performance [72]. DGNB, being a younger method, could learn from the limitations of previous BSA methods and was structured around six quality areas "Process Quality", "Site Quality", "Environmental Quality", "Economic Quality", "Sociocultural and Functional Quality", and "Technical Quality.

In LiderA, the focus is on the environmental and social dimensions since the categories with higher weight are "Energy" (15%), "Quality of service" (9%), "Water", and "Materials" (7% each). "Energy" is the most relevant category in LiderA, as in LEED and BREEAM, which is corroborated as a trend in existent BSA methods [72].

In terms of indicators, the single indicator with greater relative weight in LiderA is "P20—Environmental quality" (9%), which relates to health and well-being, followed by indicators of environmental nature, such as "P12—Products and materials responsible origin" (7%), "P7—Passive performance", "P8—Energy systems", and "P9—Carbon management" (5% each). Apart from "P33—Low life cycle costs" (5%), indicators within the economic dimension weigh less in LiderA, such as "P13—Durability of built environments" (1%), "P28—Flexibility and complementarity of uses" (2%), or "P35—Contribution to environmental jobs" (1%).

LiderA is a BSA method that allows for prescriptive and performance sustainability assessment according to stakeholder choice to grant more significant application and ease of use. Hence, the innovation in developing LiderA for retail buildings involved finding performance benchmarks and high-performance building solutions applicable to retail buildings that could assist in the design and refurbishment of retail stores. Therefore, in this process, 23 out of 40 indicators were adjusted.

Some of these indicators were slightly adapted. Minor adaptations involved the adjustment of legal threshold values for retail buildings (in "P17—Noise management"), the adjustment of measurement units for retail establishments (in "P16—Waste management"), the adjustment of room designations in retail buildings (in "P30—Social responsibility"), and examples of best practice in retail buildings (in "P34—Contribution to a circular economy" and "P40—Marketing and innovation").

Contrarily, the indicators that weigh the most in the LiderA were significantly adapted to accommodate fully usage-specific guidelines and performance benchmarks for retail buildings, namely "P8—Energy systems", "P9—Carbon management", "P10—Moderate water use", and "P20—Environmental quality".

For the indicators "P8—Energy systems", "P9—Carbon management", and "P10—Moderate water use", benchmarks regarding retailers' energy consumption, carbon emissions, and water use were created as an alternative way to assess sustainability performance. For these benchmarks, two major typologies of retail were considered: food retail (i.e., cash & carry stores, convenience stores, supermarkets, and hypermarkets) and non-food retail (i.e., home improvement stores, pharmacies and drug stores, decoration stores, department stores, office supplies stores, household appliances stores, auto-shops, and other speciality stores). This is necessary since food retailers tend to have higher intensities in these areas, primarily due to food refrigeration systems and food hygiene requirements.

For the indicator "P20—Environmental quality", usage-specific guidelines for retail buildings were created regarding daylight criteria for retail stores.

The following subsections will describe the indicators with the most relevant and innovative adjustments for retail buildings. In addition, the complete LiderA method for retail buildings is presented as a Supplementary File (Table S1), where adjustments made to indicators for retail buildings are signalled in bold.

3.2.1. Energy Systems (P8)

In the original LiderA method, class attribution in this indicator is made via the class obtained in the building's energy certificate. Alternatively, for retail buildings, a class can be attributed to an EI benchmark created for this typology of buildings [3]. This benchmark is based on energy consumption and expressed in kWh/m^2/year (Figure 1).

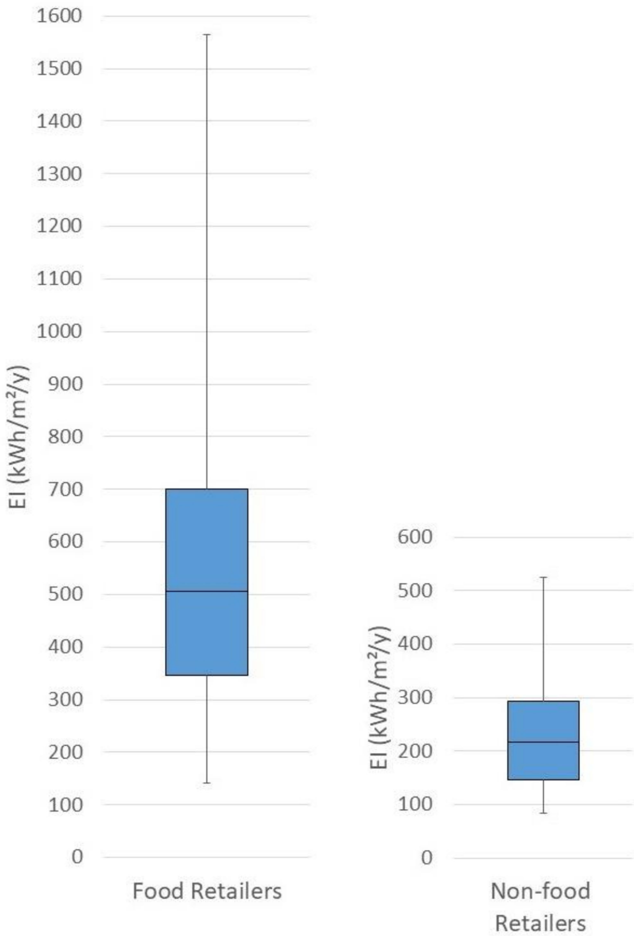

Figure 1. Boxplot of Energy Intensity (EI) benchmark for food and non-food retailers [73].

EI data was collected from the world's 250 highest revenue retailers, using Deloitte's Global Retail Powers rank [74]. EI benchmarks for food and non-food retailers were created according to quartiles, in which "best practice" (class A++) corresponds to the boundary of the 25% lowest values (i.e., 346 kWh/m^2/y for food retailers and 146 kWh/m^2/y for non-food retailers) and "worst practice" (class G) corresponds to the boundary of the 75% highest values (i.e., 705 kWh/m^2/y for food retailers and 291 kWh/m^2/y for non-food retailers). Classes between these two thresholds were calculated according to the numerical values of each class mentioned in Section 4.1. These benchmarks' best performance EI values are contrary to energy demand reference values for retail buildings provided in DGNB, ranging from 70 to 130 kWh/gross floor area/y. Nonetheless, energy demand values in DGNB may be regarding new buildings according to the EPBD [7], which indicates the need for all new buildings to be nearly Zero Energy Buildings (nZEB) through the use of renewable energy sources.

3.2.2. Carbon Management (P9)

Class attribution in this indicator can be obtained via the class obtained by the energy efficiency index (EEI) of most electrical and electronic equipment installed in the building or by the percentage of energy consumption produced from renewable sources. In addition, in LiderA for retail buildings, a class can also be attributed according to a CI benchmark [75] and to credits awarded according to prescriptive measures to lower CO_2eq emissions directly (via the use of lower GWP gases) or indirectly (via the reduction of energy consumption and increase of energy efficiency).

CI benchmarks were based on the store footprint of carbon equivalent emissions and expressed in $CO_2eq/m^2/year$ (Figure 2). Data to define food and non-food retailers' benchmarks was collected from the world's 250 highest-revenue retailers [74]. CI benchmarks were created according to the methodology previously defined for EI benchmarks. Class A++ for retail buildings corresponds to values under 115 kg $CO_2eq/m^2/y$ for food retailers and under 70 kg $CO_2eq/m^2/y$ for non-food retailers. In contrast, class G values are under 420 kg $CO_2eq/m^2/y$ for food retailers and 177 kg $CO_2eq/m^2/y$ for non-food retailers.

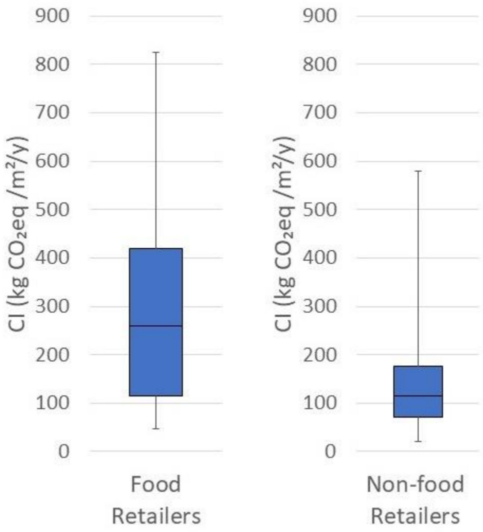

Figure 2. Boxplot of Carbon Intensity (CI) benchmark for food and non-food retailers [73].

Figure 2 measures considered for retail buildings include gases with lower ozone depletion potential in refrigeration systems (i.e., ammonia, CO_2, carbon hydride, propane, glycol, and water) and gas leaks detection programs, such as LEED, BREEAM, and DGNB. Prescriptive measures to reduce energy consumption, such as energy monitoring, are referred to in LiderA for retail buildings, similarly to BREEAM. Other measures to reduce energy consumption (and therefore carbon emissions) can be found in this indicator's sheet in the Supplementary File (Table S1).

3.2.3. Moderate Water Use (P10)

This indicator is assessed through the reduction potential of water consumption and the completion of credits related to water reduction strategies. Alternatively, a WI benchmark was created for retail buildings [75], according to the variables Water Intensity per store Area (WIA), Water Intensity per Store (WIS), Water Intensity per Worker (WIW), and Water Intensity per Revenue (WIR) (Figure 3). The WIA benchmark is a reference benchmark to assess water consumption in retail buildings, is expressed in $L/m^2/year$ and was defined according to the minimum, mean, and maximum water consumption values of the world's 250 highest revenue retailers [74]. Hence, in class A++, excellent water use can be found at WIA levels under 95 $L/m^2/y$, whereas in class G, it can be found at WIA levels above 4320 $L/m^2/y$. Additionally, mean water intensity values (class D–E) can be found at 1123 $L/m^2/y$. In-between classes were adjusted according to the numerical values described in Section 4.1.

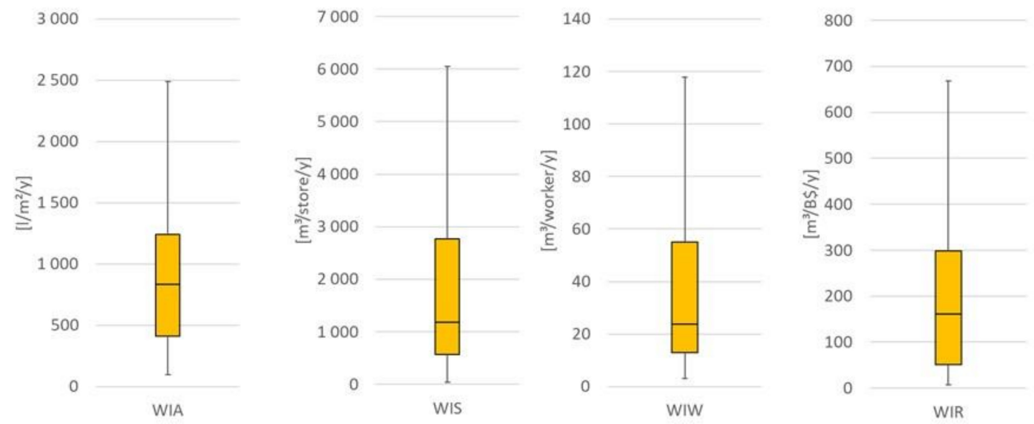

Figure 3. Boxplot of Water Intensity per store Area (WIA), Water Intensity per Store (WIS), Water Intensity per Worker (WIW), and Water Intensity per Revenue (WIR) [76].

LEED and BREEAM do not adjust water use to retail buildings. In contrast, DGNB requires water demand and wastewater volume to be calculated according to the number of employees and customers, which implies that water requirements in this typology of buildings are different and need adjustment.

3.2.4. Products and Materials of Responsible Origin (P12)

The use of low-impact building materials, materials with Environmental Product Declarations (EPD), and materials locally produced are encouraged by LiderA. In this indicator, a class is awarded according to the use percentage of these materials. Using the Level(s)' Bill of Quantities excel file is also encouraged. It facilitates estimating the weight of materials used in new construction or refurbishing projects, which informs LCA calculations.

In LiderA for retail buildings, there is also an option to award credits according to business operation, namely according to products bought for resale, in terms of ethical and sustainable trade, the protection of human rights, a code of conduct for suppliers, fair trade, product traceability, sustainable farming, and organic or local produce. Healthy food with salt and sugar reduction (in own brands' products) is also awarded. Despite not being directly related to building sustainability assessment, these practices promote sustainability on a larger scale, which is the general goal of BSA methods. They also allow for an alternative sustainability assessment in existing stores that may have difficulties quantifying the origin of their building materials.

Regarding adjusting this indicator in other BSA methods, DGNB is the only method that has adjusted materials' specifications for retail buildings by advocating using low-emission construction products in shopping centres.

3.2.5. Waste Management (P16)

In this indicator, class is awarded according to the percentage of recycled waste and the completion of prescriptive credits. In LiderA for retail buildings, credits can also be awarded according to partnerships to reduce waste, such as food donations or end-of-line material donations, the existence of recyclable containers for customer use, reusable pallets, the reduction of graphic paper consumption and the minimisation of plastic packaging, namely in own brands, by its substitution for glass or packaging paper. These measures for retail buildings go beyond those mentioned in BREEAM, which only requires dedicated space for recyclable waste volumes in shopping centres. Neither LEED nor BREEAM addresses waste management for retail buildings.

3.2.6. Environmental Quality (P20)

Under this indicator, several well-being attributes are assessed, such as natural ventilation and indoor air quality, thermal comfort, lighting, and acoustic comfort. In developing LiderA for retail buildings, a natural daylight factor of 2% in at least 35% of the sales area was considered. Here, class attribution improves according to the percentage of natural daylight in sales areas, offices, and receiving areas. BREEAM also supports a daylight factor greater than 2% in 35% of the sales area and at least 200 lux point daylight illuminance for 2650 h/y. In contrast, DGNB recommends daylight factors of 1–2% and visual contact to the exterior in up to 50% of the sales area. Regarding artificial lighting, DGNB allows for very high illuminance levels in some retail subtypes (i.e., 1500 lux (39 w/m^2) for luxury item stores). In contrast, in LiderA, the Passive House Standard for lighting is credited, ranging from 15–18 W/m^2 in existing retail stores and 10 W/m^2 in new stores [77]. The completion of credits related to passive design measures to enhance natural lighting is also acknowledged in LiderA.

Concerning thermal comfort, the possibility of user control for ventilation systems and room temperature is accounted for in LEED and DGNB, just as in LiderA.

3.2.7. Resilience and Adaptive Evolution (P23)

In adjusting this indicator for retail buildings, LiderA considered attributes enabling the continuity of sales operations during a crisis. In addition to water supply, energy supply, seismic resilience, and adaptation to extreme weather that was already covered in the original LiderA method, operational resilience in terms of assurance of stock, presence of employees, and continuity of information systems was considered, which is innovative compared to LEED, BREEAM, and DGNB.

3.2.8. Active Mobility (P24)

This indicator promotes low-impact mobility by supporting pedestrian and bike pathways, car-sharing and transfer services, hybrid or ecological fuel vehicles, exclusive parking for ecological vehicles and bicycles, and electric vehicle charging stations. In developing LiderA for retail buildings, three additional items were considered for credit allocation, namely the transport of goods in electric vehicles or vehicles with ecological fuels, efficient logistics (optimised routes and reverse logistics), and online shopping with ecological delivery systems. Bicycle storage is quantified in LEED and BREEAM for retail buildings but not in LiderA. Portuguese national regulation states that bicycle storage must be provided according to demand, conferring design freedom to quantify demand and choose storage design options according to each project's needs.

3.2.9. Flexibility and Complementarity of Uses (P28)

This indicator fosters the flexibility of spaces, namely through modular areas, adaptable to different uses. In the development of LiderA for retail buildings, three additional points were considered for credit allocation, namely a modular structural mesh with a minimum of 8 m between axles, additional energy connection points in more than 50% of the building, and the availability of buffer areas, such as storefronts, entrances, or tenant areas, that can be converted into other uses. Similarly, in DGNB, the possibility of increasing the building's bearing load and reserve capacity in building services is referred to.

3.3. Case Studies

Case studies' sustainability assessment allowed verification of the effectiveness of the proposed method LiderA for retail buildings.

Case study 1 is a food store, a 21,317 m^2 store in Lisbon, Portugal, part of the top global Cash & Carry Metro Group (Figure 4). The store has two main entrances, one in the food department and another in the non-food department. In the latter are located the reception, information desk, and restrooms. The mezzanine on the first floor is currently used as an independent gym.

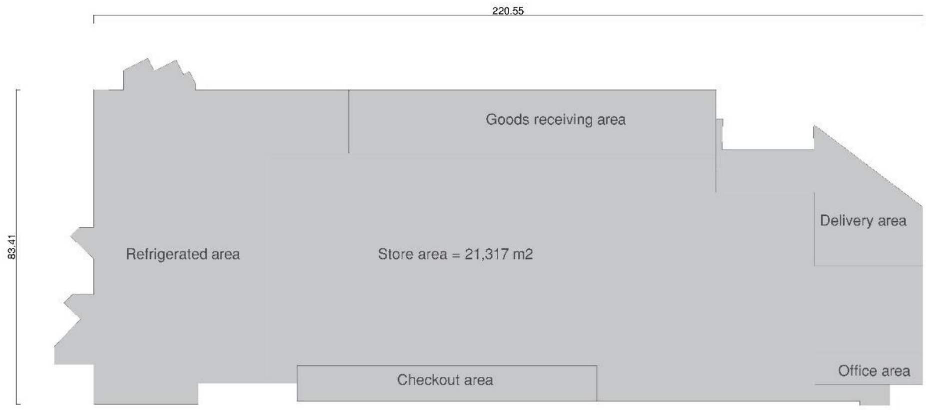

Figure 4. Sales typology plan of the retail food unit in Lisbon (case study 1).

Case study 2 is a 16,473 m^2 non-food store in Algarve, Portugal, part of the top global Do-it-yourself retail group Adeo (Figure 5). The store entrance is through each of the two levels of underground parking. The sales floor comprises cashiers, reception, cafeteria, restrooms, an information desk, and a cafeteria client sanitary facilities. Above the storefront is a mezzanine with offices and staff rooms.

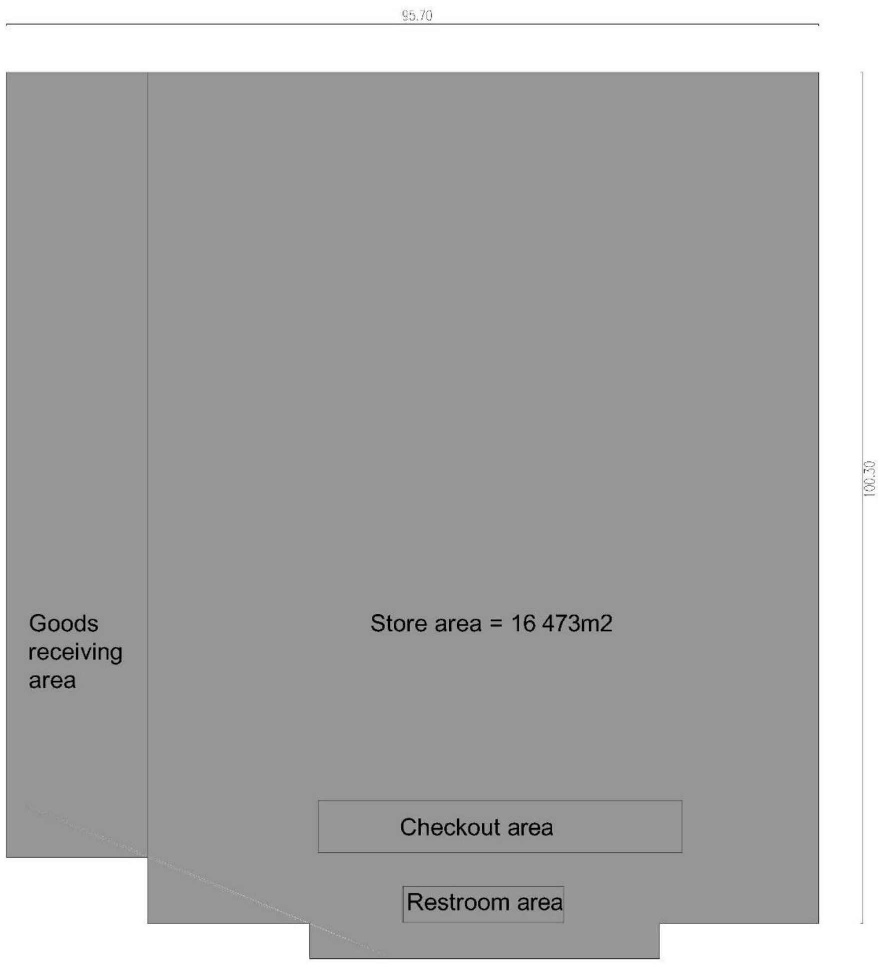

Figure 5. Sales typology level plan of the retail non-food unit in Algarve (case study 2).

Case studies 1 and 2 are typically large, big-box stores in their correspondent food and non-food categories for international food retailers. They are relevant and representative as case studies due to their branding attractiveness, urban location, store size, store layout, and the choice of building solutions and building materials.

Case study 1 scored class A in the assessment made with LiderA for retail buildings, meaning that the store has an environmental performance of about 50% higher than current practice. In contrast, case study 2 scored class A+, meaning that the store has an environmental performance 75% higher than current practice. In both stores, the proposed method LiderA for retail buildings enabled class upgrades in several indicators.

4. Discussion

4.1. Comparison of LiderA and LEED, BREEAM, and DGNB for Retail Buildings

A key point to be discussed is the findings of the validation study and determining to what extent the developed method is effective and which features should be removed, added, or adjusted. Compared to LEED, BREEAM, and DGNB for retail buildings, LiderA conforms to most usage-specific adaptations considered in these methods and includes more adaptations to other indicators, making LiderA overall a more adjusted BSA method for retail buildings. Indeed, only three indicators have user-specific guidelines for retail buildings in LEED, namely “Bicycle Facilities” (set storage spaces per building), “Refrigerant Management” (exclusive use of non-ozone-depleting refrigerants and test leaking), and “Thermal Comfort” (individual thermal comfort controls). As for BREEAM, usage-specific guidelines for retail buildings are found in six indicators: “Visual Comfort” (35% of the sales area to have a daylight factor greater than 2% and at least 200 lux point daylight illuminance for 2650 h/y); “Energy Monitoring” (in sales area, storage, offices and tenant units); “Energy Efficient Cold Storage” and “Impact of Refrigerants” (preference to no refrigerant use and gas leak detection systems); “Operational Waste” (dedicated space for recyclable waste volumes); and “Sustainable Transport Measures” (set bicycle storage spaces per building). Regarding DGNB, usage-specific guidelines differences are found in eight indicators: “ENV2.2 Potable Water Demand and Wastewater Volume” (water demand and wastewater volume calculated by employees and customers); “ECO1.1 Life-Cycle Cost” (building life-cycle cost calculation in €/m^2/y); “ECO2.1 Flexibility and Adaptability” (increase the building’s bearing load and reserve in capacity in building services); “ECO2.2 Commercial Viability” (linked to the quality of public transportation); “SOC1.2 Indoor Air Quality” (low-emission construction products); “SOC1.4 Visual Comfort” (daylight factors of 1% to 2% and visual contact to the exterior in up to 50% of the sales area); ”SOC 1.5 User Control” (individual room temperature control); and “SOC2.1 Design for All” (barrier-free toilets and staff entrances).

In this comparison with DGNB, the authors discuss the significance of life cycle aspects and their evaluation. However, the proposed method seems to lack a good life cycle approach that is proven to be so crucial in retail environments.

When compared to DGNB, this method is more robust in the indicators “ENV 1.1 Building Life Cycle Assessment (LCA)” and “ECO1.1 Life-Cycle Cost” than LiderA is. These are also the indicators that weigh the most in DGNB (about 10% each). LCA evaluation in DGNB is extensive and based on three possibilities: (i) LCA in planning, in which potential environmental impacts of building components and energy use are compared, both for the construction and operation stages; (ii) LCA optimisation, in which alternative solutions are compared for better decision making; and (iii) DGNB LCA calculation, made according to DIN EN 15978. Contrarily, in LiderA, environmentally certified building materials are promoted, but impacts from energy or building materials do not need to be calculated. Nevertheless, extensive LCA calculations, like those advocated by DGBN, may cause hindrances to the certification process and deter stakeholders from using it [39].

Regarding Life Cycle Costs (LCC) in DGNB, tables with life-cycle cost calculations are provided for energy, cleaning, or maintenance across the different life cycle stages of retail buildings (in EUR/gross floor area/year). In contrast, in LiderA, life cycle costs are addressed in the indicator “P33—Low life cycle costs”. Here, the goal is to promote lower-cost solutions for building materials and services under a life cycle perspective, which are then expressed in EUR/m^2/y or the percentage of cost reduction compared to existing or standard solutions. Nevertheless, in DGNB, life cycle costs are addressed in detail, and data on average operational and maintenance costs can benefit stakeholders. Even though cost knowledge does not promote increased environmental performance, it does support decision-making processes. Therefore, the presentation of similar cost metrics for Portuguese retail stores could be considered in future developments of the LiderA method.

Likewise, in future developments, LiderA could incorporate more indicators related to the economic dimension addressing value creation in marketability, service life, and community service [72]. In addition, in LiderA, just as in LEED, BREEAM, and DGNB, demolition and disposal strategies remain largely unaddressed, which could be important due to the frequent refurbishment cycles that retail stores undergo. Hence, integrating demolition and disposal strategies in future developments of LiderA presents an opportunity to foster a closed-loop building life cycle perspective concerning construction waste [72].

However, the development of LiderA for the retail buildings is innovative in terms of the benchmark performance metrics developed for this building typology regarding EI, CI, and WI and concerning the introduction of sustainable business operation elements as an alternative way to assess sustainability. These operational practices awarded in LiderA are expressed in retailers' sustainability reports and associations (such as RILA or the Retail Forum for Sustainability) as relevant sustainability issues. They include, for example, the consideration of ethical and sustainable product purchases, the protection of human rights, a code of conduct for suppliers, fair trade, product traceability, healthy food, sustainable agriculture, and local and organic products. Despite not being directly related to the building, these practices promote sustainability on a larger scale, rooting sustainability further down into the value chain. Healthy food, for instance, promotes psychological well-being, a dimension often overlooked in BSA methods as recognised in the literature [78]. These practices are also in line with the Portuguese roadmap for carbon neutrality [79], namely shared mobility services, reverse logistics and fleet autonomy (P24—Active mobility), reduction of energy consumption (P9—Carbon management), sustainable farming, reduction of cement use and increase of tinder use for superstructure elements (P12—Products and materials of responsible origin), reduction in the use of graphic paper, of food waste, and plastic and increased use of recycled materials and compost (P16—Waste management). Other examples of sustainable business operation practices can be found in indicators "P14—Contribution to local food production", "P34—Contribution to a circular economy", "P35—Contribution to environmental jobs", and "P39—Monitoring and governance", which are compiled in the Supplementary File (Table S1).

4.2. Correspondence to Level(s) Framework

BSA methods in Europe and throughout the world are market-oriented and national policy-driven, and there is a lack of an international standardised approach to measuring the sustainability of buildings [80]. This context is precisely what has driven the European Commission (EC) to launch Level(s) as a sustainability reporting framework aiming at improving buildings' sustainability [1,17], with a set of indicators and metrics that consider the full life cycle of the building. Rather than defining prerequisites, Level(s) is based on progressive steps of sustainable performance, from beginners to experts. Thus, at level 1, a "common performance assessment" is proposed, in which measurement units and reference calculation methods are defined. At level 2, a "comparative performance assessment" is suggested, in which projects can be benchmarked. Finally, at level 3, an "optimised performance assessment" is suggested, in which building performance improvements are simulated through building modelling [81]. Level(s) can also be used directly or indirectly through another BSA similar to the G17 Alliance.

Level(s) is structured around six macro-objectives to achieve EU common policy goals on climate change and sustainable development. These are (i) Greenhouse gas emissions along a buildings life cycle, (ii) Resource-efficient and circular material life cycles, (iii)

Efficient use of water resources, (iv) Healthy and comfortable spaces, (v) Adaptation and resilience to climate change, and (vi) Optimised life cycle cost and value.

When comparing LEED, BREEAM, and DGNB to Level(s), DGNB and BREEAM address all six macro-objectives and all its indicators, whereas LEED does not address several indicators in five of the six macro-objectives, namely “2.4 Design for deconstruction”, “3.1 Use stage water consumption (m^3/occupant/y)”, “4.1 Indoor air quality”, “4.2 Time out of thermal comfort range”, “4.3 Lighting”, “4.4 Acoustics”, “5.1 Life cycle tools: scenarios for projected future climatic conditions”, “5.2 Increased risks of extreme weather”, “5.3 Increased flooding risk”, “6.1 Life cycle costs (EUR/m^2/y)”. This is possibly due to LEED being the oldest and most internationally implanted BSA method, in which the focus on the environmental dimension of sustainability is more apparent [17]. As for LiderA, it is aligned with all six macro-objectives defined by Level(s) but does not fully address indicators “2.4 Design for deconstruction” and “4.2 Time out of thermal comfort range”. In addition, life cycle costs in LiderA are considered from a comparative perspective, whereas DGNB is extensively detailed. BSA methods, including LiderA, are therefore challenged to evolve in the future to bridge the areas where they are less aligned to Level(s).

4.3. Case Study Assessment

The second sustainability assessment made with the proposed method LiderA for retail buildings confirmed that criteria customised for retail buildings enabled the improvement of classification in several indicators for both case studies when compared to the original assessment performed under the general version of the LiderA method (LiderA V3), namely in P7—Passive performance, P9—Carbon management, P12—Products and materials of responsible origin, and P24—Active mobility.

In indicator P7—Passive performance, the class upgrade was mostly due to introducing an extra parameter valuing daylight strategy in more than 80% of the building area. In indicator P9—Carbon management, the class upgrade was possible using the created CI benchmarks for retail buildings, which segmented carbon profiling in global retail. This innovation is of the utmost importance because CI levels in retail stores are influenced not only by the energy consumed but also, quite importantly, by GHG emissions from refrigeration and HVAC systems [82]. In addition, the EI of the retail sector is very high, leading to higher CI levels [83]. Previous class attribution in this indicator was referenced mainly according to the percentage of energy consumption from renewable sources, which disregarded, for example, annual fugitive HFC emissions from refrigeration systems.

As for indicator P12—Products and materials of responsible origin, the class upgrade was possible due to introducing extra parameters regarding ethical and sustainable purchases in business operations. In effect, another innovative aspect of the development of LiderA for retail buildings is its contribution to bridging the current dichotomy between retail building sustainability assessment and operation sustainability assessment, which is extensible to retail’s value chain. In this sense, as indirect GHG emissions from the retail sector are considerably higher than direct emissions—a factor of 7 for its supply chain and a factor of 3 for its products’ end life [84]—and because of the influence of retail in suppliers and consumers, it is important to foster sustainability more deeply into the value chain and in consumer choice, namely by advocating the protection of human rights, a code of conduct for suppliers, fair trade, product traceability, healthy food, sustainable agriculture, or local and organic products. Generally, these practices align with the United Nations’ Sustainable Development Goals [9]. They are also in alignment with other regulatory instruments, such as the European Union’s roadmap for a competitive low-carbon economy in 2050 [85] and the Portuguese roadmap for carbon neutrality for 2050 [86]. Likewise, parameters that include transporting goods in vehicles with ecological or electric fuels, efficient logistics (including optimised routes and reverse logistics), and online shopping with eco-friendly home delivery were added to the indicator P24—Active mobility, which allowed for class improvement in both case studies.

In case study 1, the development of LiderA for retail buildings also allowed class upgrades in the indicators P28—Flexibility and complementarity of uses, P31—Friendly Amenities, and P39—Monitoring and governance. Whereas in the indicator P28—Flexibility and complementarity of uses, additional credits were granted due to the existence of additional criteria valuing large spans in modular structural meshes, in the indicator P31—Friendly Amenities, additional credits were granted due to the radius of influence of amenities being enlarged to 1000 km. In the indicator P39—Monitoring and governance, the introduction of parameters related to sustainable business operation, such as transparency in the value chain, cyber security, and data privacy, allowed too for a class upgrade.

In case study 2, the class upgrade was possible in indicator P10—Moderate water due to the introduction of extra parameters regarding sensors or timers on taps, flowmeters in flushers, and water-saving ultra-rinse guns for floor cleaning.

The results of the two case studies confirmed that criteria customised for retail buildings improved the overall sustainability assessment classification of the analysed stores, reinforcing the validity of adjusting BSA methods to retail buildings.

4.4. From Sustainable Assessment to Sustainable Management

Building sustainable performance depends not only on design but also on building use and management [87]. Therefore, in the path towards higher environmental performance, tools are needed to assess and quantify the sustainable performance of retail stores to support users and managers, particularly in the usage stage. In this sense, the developed method LiderA for retail buildings can contribute to achieving a higher sustainable performance even for buildings in use. It can also be a method used to improve the organisation of information related to sustainability in the building and inform and influence users and stakeholders. Through its benchmarks and best-practice thresholds for EI, CI, and WI, as well as its extensive inventory of high-performance, sustainable solutions that can lead to superior environmental performance, LiderA can highly position the energy, carbon, and water performance of retail buildings, giving users and management insight regarding tangible margins for further improvement. In this sense, the proposed method, LiderA, for retail buildings represents a significant contribution to the existing body of knowledge in the assessment of this typology of buildings. Therefore, it has successfully detected significant features that other analysed methods did not identify, leading to more sustainable design solutions in the retail sector. When applied in the construction and operational stage, LiderA can promote the efficient liaison of building data between the project team, contractors, final users, and managers. Sustainability assessment through LiderA can be used as a bird's-eye view framework, identifying new sustainability aspects to consider in retail buildings and providing performance improvement goals in the short, medium, and long term that can lead, for instance, to net zero or positive energy buildings. The building assessment through LiderA can serve as a base to implement a full sustainability strategy in retail environments, linking sustainability assessment to sustainable management [88] with implications for energy, carbon, and water.

The results of the two case studies confirmed that criteria customised for retail buildings enabled class upgrades in adjusted indicators and improved the sustainability assessment classification of the analysed stores, reinforcing the validity of adjusting BSA methods to retail buildings.

4.5. Implications

BSA methods (and in this specific case, the developed LiderA method for retail buildings) can effectively and efficiently assess the environmental performance of buildings and identify improvement opportunities to building performance; this was evident in the sustainability assessment of the two case studies, which resulted in the possibility of increasing both stores' sustainability performance by over 50%, in turn translating into economic, social, and environmental gains. Building certification can therefore act as a key performance indicator of environmental management in retail, validating BSA methods as useful tools for sustainable business management and further encouraging its use.

The EI, CI, and WI benchmarks developed for LiderA for retail buildings have been demonstrated to be valuable, accurate tools for the definition of "best practice" and "good practice" threshold levels for energy consumption, carbon emissions, and water use in retail buildings, enabling a more efficient natural resources management in the retail sector and providing knowledge regarding allowable limits for resources' use.

Given that each studied retailer operates hundreds of stores, EI and CI results show a key potential to boost EI and CI in the retail sector, in either new stores or refurbishing processes. The variability found in this research shows that according to "best practice", it is feasible to reduce EI in retail stores by a factor of 3 and CI by a factor of 6, which would impact decisively and positively the environmental performance of retail. The same is true for water management, as the variability of results in WIA shows a potential to reduce water consumption by a factor of 3, which would positively influence the direct water footprint of the retail sector.

By bridging the dichotomy between building sustainability assessment and operation sustainability assessment, the promotion of sustainability at a larger scale is achieved, which is the end goal of BSA methods. This was the second contribution of the development of LiderA for retail buildings, extending sustainability assessment to business operations, intending to push sustainability further into retail's value chain.

4.6. Limitations

Comparing BSA methods is subjective since each method follows different weighting structures that are not directly harmonised. The parameters' selection for LiderA for retail buildings and their weights were subject to the authors' interpretation, according to the rationale described in Section 2. Finally, only three BSA methods applicable to retail buildings were compared, and findings could be broadened if more methods were analysed.

5. Conclusions

Compared to other BSA methods developed for retail buildings, such as LEED, BREEAM, and DGNB, LiderA for retail buildings is in line with the adjustments suggested by these methods, namely in refrigerant management, lighting, thermal comfort, and soft mobility principles. In addition, the proposed method includes adaptations covering a more comprehensive list of indicators, making it a more adjusted BSA method for retail buildings, supporting an integral view of sustainability principles applied in the retail sector.

The results of the two case studies confirmed that criteria customised for retail buildings enabled class upgrades in adjusted indicators and improved the sustainability assessment classification of the analysed stores, reinforcing the validity of adjusting BSA methods to retail buildings.

The most innovative aspect of LiderA for retail buildings is the development of benchmarks to assess sustainability performance in EI, CI, and WI. Additionally, sustainable business operation practices were introduced in selected indicators, namely the consideration of ethical and sustainable product purchases, the protection of human rights, a code of conduct for suppliers, fair trade, product traceability, healthy food, sustainable agriculture, and local and organic products, to promote sustainability in a larger scale, deepening the roots of sustainability further down into the value chain.

The LiderA method, developed for retail buildings, can support designers, managers, and users in achieving higher environmental performance by providing benchmarks and best-practice thresholds for EI, CI, and WI, which provide insight into tangible margins for improvement in energy, carbon, and water performance. Given that global retailers operate hundreds of stores, the results show a key potential to increase the environmental performance of retail stores in either new or refurbished stores, supporting decision-making towards maximum energy efficiency and carbon neutrality.

Future research should include the introduction of LCC and LCA studies in BSA tools, given the increasing development of these tools to support decision-making processes. Circular Economy goals should also be considered, namely by promoting modular construction or prefabrication, demolition, and disposal strategies, thereby fostering the opportunity to integrate a closed-loop building life cycle perspective into the BSA method. Additionally, indicators of community service and psychological well-being should be progressively incorporated into BSA methods to further increase sustainability assessment in immaterial dimensions.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su142315577/s1, Table S1: LiderA Thresholds.

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