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An Integrated SWOT-PESTLE-AHP Model Assessing Sustainability in Adaptive Reuse Projects

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Abstract: In the recent past, sustainable development has been considered a major issue for urban and regional studies. Adaptive reuse appears to be a practical solution for sustainable urban development. Beyond and in addition to a conceptual base consistent with circular economy and sustainability principles, how do we know if adaptive reuse is actually sustainable, provided that it constitutes a multidisciplinary and multilevel process? The present study aims at evaluating, in as much as feasible quantitative terms, adaptive reuse practices sustainability. This was attained using a set of indicators, developed combining PESTLE (the Political, Economic, Technical, Social, Legal, and Environmental aspects) and SWOT (the Strengths, Weaknesses, Opportunities, and Threats) approaches, of which the results were subjected to evaluation by experts (pairwise comparisons), following the Analytic Hierarchy Process (AHP). The indicators representing strengths and opportunities of the process were calculated to be of higher value (overall level of final cumulative indicators values; 70.4%) compared with indicators representing weaknesses and threats. Enhancing strengths and opportunities and counteracting weaknesses and threats contribute making the potential of adaptive reuse practices in urban sustainability more evident. Among analysis dimensions, political and economic aspects rank first, followed by environmental, socio-cultural, technological-technical, and legal aspect. The empirical results of this paper serve as a useful reference point for decision-making and policy formulation addressing adaptive reuse practices in sustainable development strategies.

Keywords: adaptive reuse; urban sustainability; SWOT analysis; PESTLE analysis; AHP technique; heritage preservation

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1. Introduction

Sustainability concerns all aspects of the modern way of living, including the build environment [1]. As a result of the cumulative impacts that buildings have on the environment, eco-friendly practices [2,3], metropolitan sustainability [4,5], as well as urban metabolism [6,7], circular cities [8–10], and more specifically the circular economy principles [11–17], e.g., within the framework of the European Green Deal [18,19], currently represent an essential part of design, planning, and building processes [20,21]. In this context, over the past 20 years, a considerable number of studies have provided empirical evidence supporting the relevance of adaptive reuse of building stocks when promoting sustainable urban development [22–26]. Adaptive reuse of industrial buildings of cultural heritage (hereinafter in the interest of brevity "adaptive reuse") in particular, is an

increasingly promising approach also for preserving cultural heritage [27–30]. Indeed, as a consequence of the global monetary crisis [31], and the hit in the construction industry, urban industrial buildings, with large, flexible, and adaptive spaces, are becoming attractive alternatives to greenfield development [32]. Moreover, heritage items, listed or not, are testimonies of the past and are irreplaceable, thus repurposing projects, preserve future generations legacy [33].

Although adaptive reuse may challenge designers and urban planners in their attempts to introduce new uses [34], the present study questioned if economic, social, and environmental benefits are apparent, latent, or absent.

Framed within the following definition of adaptive reuse, the objective of the current research is to assess the importance of adaptive reuse as a suitable response to the urban sustainability agenda. This response reflects an industrial building transformation process for changing use, maintaining the original construction as much as possible while improving the performance to existing standards [35].

2. Literature Review

A significant number of adaptive reuse examples exist as several scholars have pointed out, outlining urban sustainability, with reference to the protection of the environment, economic impacts, participation in the life of the community, as well as energy conservation [36–48]. The contribution of adaptive reuse to urban sustainable development and the importance of emblematic infrastructure, seem more direct and clear than ever [49,50]. Thereby, the more the adaptive reuse tends to increase, the more likely it is that sustainable development in environmental, economic, social, and cultural dimensions can be positively affected [51–53]. Adaptive reuse projects are a fundamental principle in the field of local sustainable development [54], but widespread rhetoric about the benefits involved [55] prevent a comprehensive understanding of the intimate factors of change. How communities can benefit from this transformative regeneration is also under intense debate [56].

Different conceptual, exploratory, qualitative and quantitative studies, from different perspectives and disciplines have been performed in the ever-increasing scholarly literature to report on adaptive reuse [57,58]. In their analysis, Wang and Jian [59] discussed the significance of the adaptive reuse of historic industrial buildings. Through a survey, Bullen [60] found that building owners support adaptive reuse as a practice oriented toward the key concepts of sustainability. Langston [61] conducted an investigation on how the construction industry can reposition itself to increase its focus on adaptive reuse. In an attempt to shed light on how regeneration strategies contribute to sustainability, Bullen and Love [62] carried out research examining policies and legislation adopted to encourage adaptive reuse. Later, Bullen and Love [63] developed a model to assist practitioners with their decision-making when considering reuse of an existing built asset, while Wilkinson et al. [64] focused on how adaptive reuse potentials can be modeled, designing an integrated decision making practice. In the context of testing adaptive reuse processes, Langston et al. [65] used a potential model and established the most effective time to undertake adaptive reuse projects. Song et al. [66] found that the integrated design process and sustainability can be attributed to the execution of successful designs in adaptive reuse, and Ross el al. [67] identified design-based adaptive reuse strategies. Yung et al. [68] explored community-initiated urban regeneration through adaptive reuse. In addition, Conejos et al. [69,70] developed a tool assessing the adaptive reuse potential of future buildings. A meta-study revealed that different legal, financial, technical, functional, and architectural problems define the possibilities and risks of building transformations [71]. Furthermore, Langston et al. [65] examined the extent to which obsolescence, heritage value, and redevelopment pressures can affect adaptive reuse. Chan et al. [72] examined the adaptive reuse projects impacts on society, and Adiwibowo et al. [73] argued that adaptive reuse projects while maintaining the intrinsic architectural characteristic of buildings may have a positive impact on the public intention to visit. Additionally, Misirlisoy and Günçe [74] through the evaluation of socio-cultural, economic, and physical aspects of the

adaptive reuse projects questioned the suitability of the new functions, and provided a list of factors affecting adaptive reuse decision-making in order to develop a model for adaptive reuse [75]. Several attempts have been also made towards the selection of the most suitable reuse alternatives [76–78]. For instance, Dell'Ovo et al. [79], in order to identify the best alternative solutions, used NAIADE, an innovative tool combining different decision methodologies based on the opinion of conflicting stakeholders. Eshrati et al. [80] investigate the authenticity [81] in adaptive reuse projects. Interestingly, Pendlebury et al. [82] opened up a discussion over the processes of forgetting and remembering that occur in the adaptive reuse, concluding to propose the 'uncomfortable heritage' category. More recently, Bottero et al. [83] presented a novel methodology for ranking adaptive reuse strategies of cultural heritage, Günçe and Misirlisoy [84] assessed adaptive reuse practices success through user experiences, while Sing et al. [85] developed a model for examining links among the building sector, the number of existing buildings available for reuse, and adaptive reuse policies. Farjami and Türker [86] explored the environmental rating systems towards identifying mutual aspects with adaptive reuse models. Della Spina [87], pointed up a multilevel process able to support optimizing investment choices for the efficient allocation of public resources with reference to adaptive reuse of unused historical public buildings. Palma et al. [88], using a 3D modeling interface and visual programming language scripting approach, presented an optimized remediation and reuse plan able to support the discussion on possible site regeneration options. Efforts have also been undertaken to further add inputs to the wider discussion on adaptive reuse using fuzzy sets theory [89–91].

Although adaptive reuse is essential for sustainable urban development [92], literature reviews document how sustainability of the adaptive reuse sector has scarcely been studied, thus allowing the scope for the current research.

3. Methodology

3.1. Theoretical and Operational Framework

The present study, in order to produce measurable outcomes, synthesizes a quali-quantitative analysis combined with a decision-making system. This was attained by adopting a hybrid analysis method, recently suggested by scholars, meeting a satisfactory rate of acceptance by researchers and academics (in terms of impact and reputation of the journal published, as well as the citations received), in order to evaluate the sustainability of a broader range of disciplines and sectors [93–95]. In particular, this research proposes a method combining a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis with a PESTLE (Political, Economic, Technical, Social, Legal, Environmental) framework, powered by an extensive literature review, in order to define appropriate indicators, in turn evaluated using Analytic Hierarchy Processing (AHP). Multi-criteria decision-making techniques were largely used to delineate sustainable adaptive reuse practices and assess possible inhibitory factors or conflicting consequences [96].

A review of the literature was provided on the basis of the analysis of published works, providing insight into the field of adaptive reuse. The objective of the literature review was not to critically analyze the information gathered, in terms of shading light on theories and points of view, or reviewing areas of controversy towards formulating areas for further research—since this is considered it would divert the study scope set—but rather document the state-of-the-art with respect to adaptive reuse the urban sustainability components involved, towards establishing the credibility of the current research fitting into and adding to an existing body of agreed knowledge (see Section 4.1). Table 1 lists the most frequent keywords sampled in the literature review.

Table 1. Keywords used in literature review.

Keywords-Level A	Keywords-Level B
Adaptive Reuse Industrial Building Preservation Heritage Conservation Urban Regeneration Built Environment	Assessment Indicators Decision-making Sustainability Planning Design Strategies Management

PESTLE analysis is considered a common research tool to analyze and classify political (P), economic (E), social (S), technological (T), legal (L) and environmental (E) issues [97,98]. The wider context and the specific influence factors were identified through a comprehensive description of the system under investigation. SWOT analysis is a cognitive process studying the interrelations between internal and external environments of an organization, territory or sector, based on a mixed (subjective–objective) evaluation of strengths, weaknesses, opportunities, and threats [99,100]. Combining these analysis strategies will serve to provide an exhaustively and updated picture and a detailed assessment of the situation being examined (Figure 1).

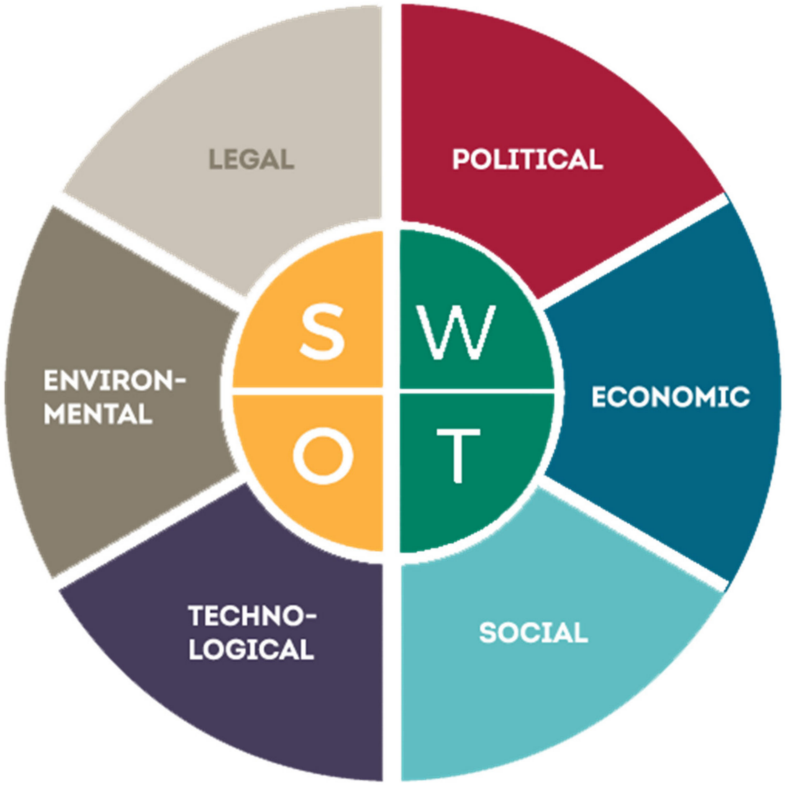

Figure 1. Combining PESTLE framework with SWOT analysis.

The SWOT-PESTLE integration will consider internal and external dimensions, which are designated as sustainability indicators of the adaptive reuse practices in Greece.

To assess adaptive reuse practices intended as a response to urban sustainability, Saaty's [101] assumptions on how to establish measures of intangibles were used. When problems are complicated and more than one aspect should be assessed, commonly known multi-criteria decision-making tools have been proven effective [102]. By assessing multiple variables, these tools were able to define and solve real life problems. Decision makers often use these tools when choosing among different alternatives, as these tools help to

select the most promising solution taking into account a series of indicators [103,104]. The Analytic Hierarchy Process (AHP) is indeed particularly useful in (group) decision making and for handling large-scale multi-criteria decision issues [105–107]. Thus, the present study, based on the AHP method, was structured in a hierarchical model (Figure 2).

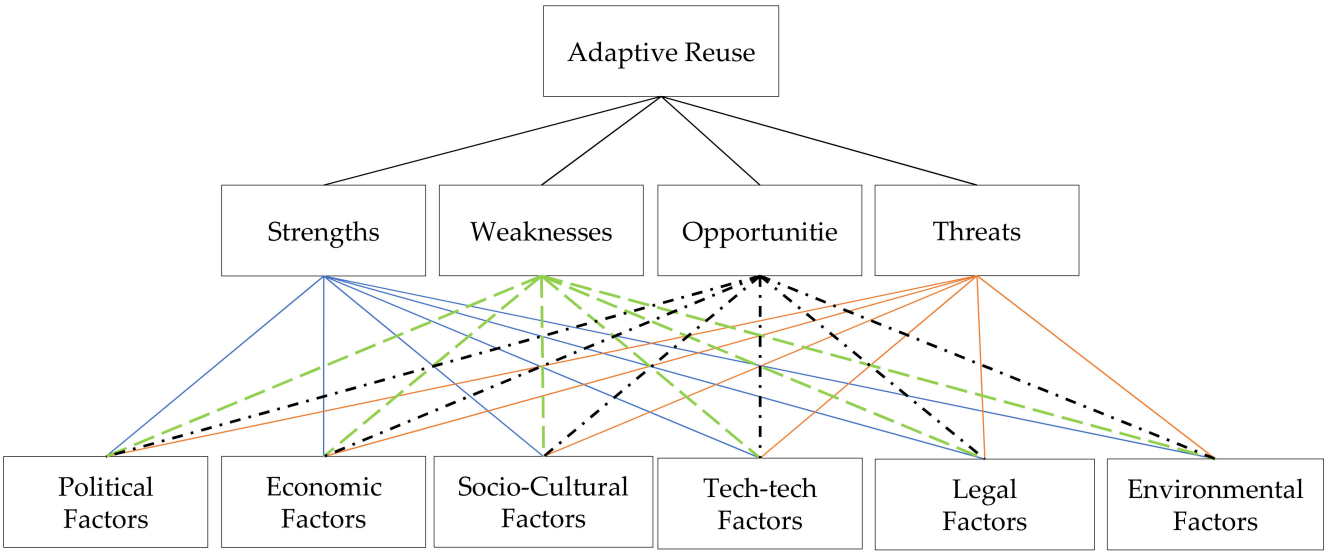

Figure 2. Adaptive reuse assessment hierarchical model.

The next step of Saaty's AHP process involves definition of the relative weight of each element of the decision tree. In order to achieve a quantitative evaluation of sustainability indicators (formed in the preceding step), a set of pairwise comparisons was carried out. Pairwise comparisons were performed—and later quantified—using an integer scale, employing the free web-based AHP Calculator, AHP Online System-Business Performance Management Singapore (www.bpmsg.com (accessed on 29 July 2021)). Experts were invited to perform pairwise comparison. In particular, in the initial phase, experts were requested to perform 15 pairwise comparisons with respect to the PESTLE framework aspects, while in the second stage they were invited to complete 36 pairwise comparisons with respect to the SWOT components of each PESTLE aspect (Table 2), on a scale from 1 to 9 (Table 3) [108]. Of course, after completion of each step, the experts were instructed to check consistency, and proceed with adjustments if necessary [109]. The methodological conceptual flow diagram is presented in Figure 3.

Table 2. Pairwise Comparisons List.

	Phase A		**NPC**
Political	vs.	Economic	1
Political	vs.	SocioCultural	2
Political	vs.	TechnologicalTechnical	3
Political	vs.	Environmental	4
Political	vs.	Legal	5
Economic	vs.	SocioCultural	6
Economic	vs.	TechnologicalTechnical	7
Economic	vs.	Environmental	8
Economic	vs.	Legal	9
SocioCultural	vs.	TechnologicalTechnical	10

Table 2. *Cont.*

		Phase A		NPC
SocioCultural		vs.	Environmental	11
SocioCultural		vs.	Legal	12
TechnologicalTechnical		vs.	Environmental	13
TechnologicalTechnical		vs.	Legal	14
Environmental		vs.	Legal	15
		Phase B		
Political	Blocking Neglect Policy	vs.	Political Support Level	16
	Blocking Neglect Policy	vs.	Urban Redevelopment Strategies-Incentives	17
	Blocking Neglect Policy	vs.	Political Inertia	18
	Political Support Level	vs.	Urban Redevelopment Strategies-Incentives	19
	Political Support Level	vs.	Political Inertia	20
	Urban Redevelopment Strategies-Incentives	vs.	Political Inertia	21
Economic	Economic Growth Boost	vs.	Inability to Estimate Economic Viability	22
	Economic Growth Boost	vs.	Capitalization of Cultural Value	23
	Economic Growth Boost	vs.	Investment Returns	24
	Inability to Estimate Economic Viability	vs.	Capitalization of Cultural Value	25
	Inability to Estimate Economic Viability	vs.	Investment Returns	26
	Capitalization of Cultural Value	vs.	Investment Returns	27
SocioCultural	Cultural Values Preservation	vs.	Facadism	28
	Cultural Values Preservation	vs.	Quality of Life Improvement	29
	Cultural Values Preservation	vs.	Gentrification	30
	Facadism	vs.	Quality of Life Improvement	31
	Facadism	vs.	Gentrification	32
	Quality of Life Improvement	vs.	Gentrification	33
TechnologicalTechnical	Technological Innovation	vs.	Asset Condition	34
	Technological Innovation	vs.	Scientific Fields Cooperation	35
	Technological Innovation	vs.	Technical Difficulties	36
	Asset Condition	vs.	Scientific Fields Cooperation	37
	Asset Condition	vs.	Technical Difficulties	38
	Scientific Fields Cooperation	vs.	Technical Difficulties	39
Environmental	Reduced Environmental Footprint	vs.	Achieving Net-Zero Energy Goals	40
	Reduced Environmental Footprint	vs.	Eco-Building	41
	Reduced Environmental Footprint	vs.	Indoor Environmental Quality	42
	Achieving Net-Zero Energy Goals	vs.	Eco-Building	43
	Achieving Net-Zero Energy Goals	vs.	Indoor Environmental Quality	44
	Eco-Building	vs.	Indoor Environmental Quality	45
Legal	Legislative Context	vs.	Building Standards	46
	Legislative Context	vs.	Land Use Plan and Zoning	47
	Legislative Context	vs.	Ownership Status	48
	Building Standards	vs.	Land Use Plan and Zoning	49
	Building Standards	vs.	Ownership Status	50
	Land Use Plan and Zoning	vs.	Ownership Status	51

Table 3. AHP scale.

1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2 4 6 8	Values in-between

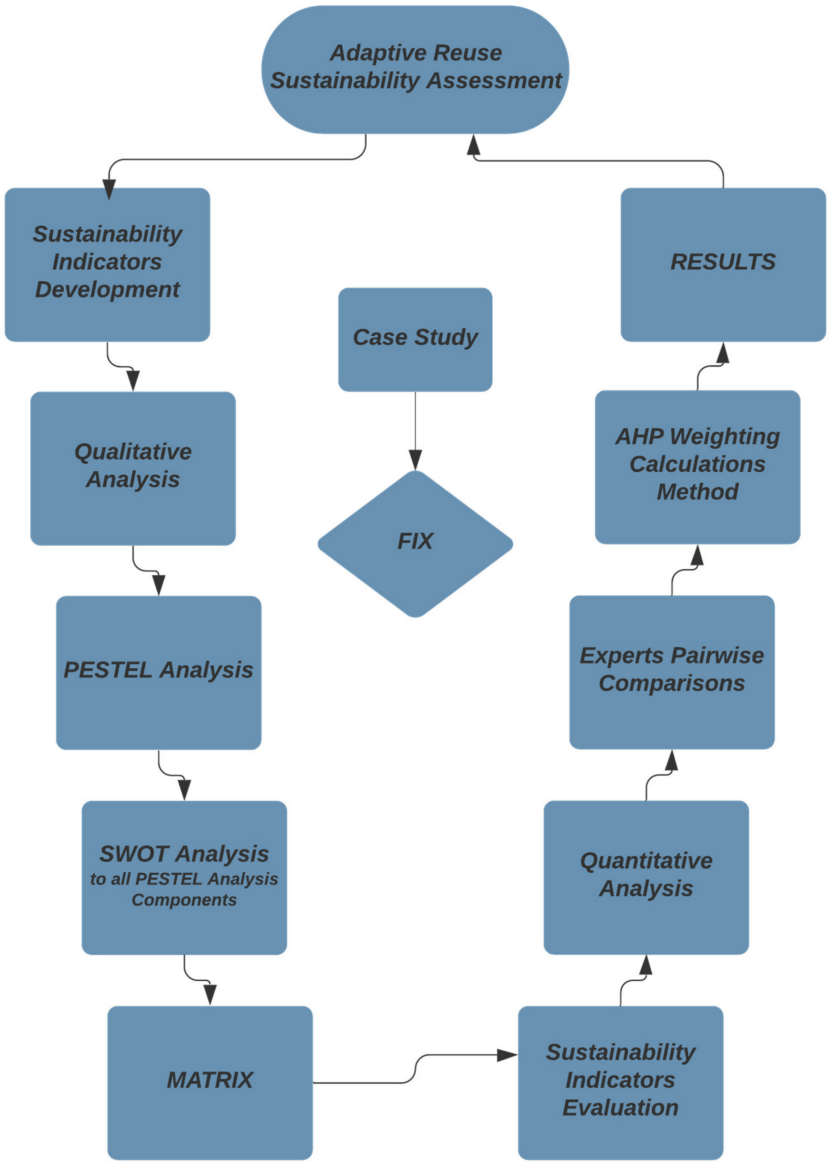

Figure 3. Methodology conceptual flow diagram.

Specifically, all pairwise comparisons (pwc) are typically of the form; (a) $pwc = (a_1, a_2, \ldots, a_{npc}), (x_1, x_2, \ldots, x_{npc})$, whereas integers are $a_i \in [0,1]$, $x_i \in [1, M]$, $M = 9$ (Table 2) and $i = 1 \ldots npc$, which stands for the number of pairwise comparisons; $npc = \frac{n^2-n}{2}$. Thus, for n criteria the $n \times n$ decision matrix is then filled from pwc. For each $a_i = 0$, x_i is considered, while for $a_i = 1$ the reciprocal of x_i is calculated. To consolidate expert judgments, the geometric mean and standard deviation were cal-

culated. Sum of the three (3) experts was calculated based on the following formula (b) $pwcx = \sum_{k=1}^{K} ln(pwc_k)$, while the square sum according to (c) $pwcx^2 = \sum_{k-1}^{K}[ln(pwc_k)]^2$. The geometric mean was calculated based on (d) $pwc_{CONS} = exp(\frac{pwcx}{K})$. Standard deviation, based on the following formula, estimates weight variations based on experts' judgments variations (e) $pwc_{SD} = exp\left(\sqrt{\frac{pwcx^2 - \frac{1}{K}pwcx * pwcx}{K-1}}\right)$. Finally, using the data from the *pwc* the final decision matrix was formed (f) $a_{ij}^{cons} = \left(\prod_{k=1}^{K} a_{ij}\right)^{\frac{1}{K}}$. Shannon entropy and its partitioning into two independent components (alpha and beta diversity) were used to derive the AHP consensus indicator [110]. For consistency ratio calculation the linear fit proposed by Alonso and Lamata [111] is used, (g) $CR = \frac{\lambda - n}{2.7699 * n - 4.3513 - n}$.

Consequently, the sustainability indicators (i.e., the expert evaluations for each pair) were calculated according to the AHP weighting method. In particular, strengths, which are included in the internal aspect of the system, are positive, weaknesses, although of internal origin in the system, are negative, opportunities have a positive interaction and are evidently of external aspect, and, lastly, threats are an external origin attribute of the system, and represent the negative effects.

The sampling process of the group of experts (while the experts provided invaluable perspective and advice to this research, they may hold totally different views on one subject under study; they were not invited to individually or collectively endorse this study methods nor findings), regarded as experts by their experience and expertise, followed the purposive sampling technique [112]. The experts accordingly represent the three pillars of sustainability, namely economy, society and the environment. These were an economy expert, working for the Hellenic Centre for Renewable Energy Sources, a political scientist, who works for the Hellenic Ministry of Interior Affairs, and an environmental expert serving at the Department of Environmental Inspectorate of the Hellenic Ministry of Environment. Different expertise serves different perspectives, which can be expected to lead to diverse comparisons, resulting in reliable outcomes. For the purposes of the current research, the experts were asked make pairwise comparisons, considering all sustainability dimensions, the PESTEL aspects importance in the adaptive reuse perspective, reflecting their personal experiences, perceptions and beliefs. The group member's evaluations were considered of equal importance. Certain characteristics of the experts' profile are presented in Table 4.

Table 4. Experts' characteristics.

Experts	Age Distrb	Yrs Exp	Education	Job Title
Economy expert	35–45	>12	Doctorate in Economics and Sustainable Development	Senior Researcher in Socioeconomics at the Hellenic Centre for Renewable Energy Sources
Society expert	35–45	>10	Doctorate in Sustainable Economics and Political Sciences	Political Scientist at the Hellenic Ministry of Interior Affairs
Environmental Expert	35–45	>15	Environmental Biologist Agronomist, MSc in Environmental Management	Environmental Scientist at the Department of Environmental Inspectorate of the Hellenic Ministry of Environment

3.2. Case Study

Within this context, this research focuses on a recent urban transformation of the old FIX Brewery to house the Hellenic National Museum of Contemporary Art in Athens [113]. As argued by Yin [114], a single case was appropriate to study a contemporary event, as well as to derive theory from phenomena within a real environment, while it is necessary for the subsequent empirical analysis, helping to conduct research on real facts [115]. The FIX building, designed by the architects Takis Zenetos and Margaritis Apostolidis, embraced

the principles of the modern movement in architecture in the 1960s, and was destined to be a historic landmark of both modern architecture and the city of Athens [116]. Nevertheless, the building was abandoned in 1971, since the FIX Brewery production moved away from downtown Athens [117]. While the building was standing in poor condition, the longest northern part of the initial design was demolished in the mid 1990s for subway construction work purposes. This event, radically altered the building character, and thus was, and still is sharply criticized by architects, heritage preservatives, urban planner, scholars, and residents of the surrounding neighborhoods [118]. In 2000, preceded by a significant number of public consultations, a decision has been taken to adaptively reuse the old FIX brewery premises to house the newly established Hellenic National Museum of Contemporary Art (www.emst.gr/en (accessed on 29 July 2021)). The work was carried out by the Mouzakis and Associate Architects and 3SK Architects collaborating design studios, and was completed in late 2014.

The FIX building landmark is unquestionably worth studying; the ever-evolving architecture, the economic and social transformations of the Athenian urban fabric, the industrial heritage, the new use, are cumulative components likely challenging the principles of sustainability. Thus, ensuring the sustainable future of such assets should be at the core of urban sustainability policy making. However, sustainability is established only if economic competitiveness, environmental protection and promotion of social and cultural values are ensured.

4. Results

4.1. Qualitative Analysis

The long lasting economic difficulties in Greece led to a recession in the building sector [31]. Together with these economic circumstances, the growing environmental awareness [119–121] created conditions that directly and indirectly influence the practice of adaptive reuse [122–124]. Since, however, adaptive reuse practices in Greece are currently under development, qualitative analysis was performed on a growing body of scholarly literature, in addition to reports, notes, benchmarks, from governmental bodies, and international agencies.

4.1.1. Political Aspect

The political factor is essential towards unleashing the potential of adaptive reuse. On the one hand, political apathy or rigidity could hinder adaptive reuse projects [125], or endanger the successful completion of such endeavors, or even put the sustainability of the planned projects at risk. On the other hand, elected representatives can seize the political initiative and maximize the level of political support for the ideas of sustainable development and adaptive reuse [126], and block neglect policy, which, as [127] note, interpreting the Marxist approach theory, the powerful lobbies follow, until such time as they become aware that the resulting urban degradation could yield tremendous profits. One way to make suitable properties attractive to developers as sustainable adaptive reuse projects, besides setting the urban re-development strategy, is to secure financial incentives, for example in the form of tax concessions, or similarly to introduce a generous and up-to-date legislation framework regarding building codes.

4.1.2. Economic Aspect

Repurposing dilapidated buildings is expected to positively contribute to the urban economic agenda [128]. Reusing existing building stock to meet the demands of an increasingly postindustrial economy bolsters the development of a number of trades or industries which can generate an economic momentum in addition to employment opportunities [129]. Creating space for economic, social and cultural activities makes different parts of the cities more attractive to visitors [130,131]. These three activities combined, boost the property market, which will enable initial capital investment returns in terms of increase in rent or commercial value [132,133]. Hence the value of the redeveloped building—in addition to

the surrounding buildings—will increase, lengthening the buildings economic sustainability while reducing maintenance costs [134,135]. However, empirical evidence argued that the inability to estimate the long-term fiscal viability and thus to ensure, from a planning standpoint, the sustainability of economic growth is considered to be a hindrance [136,137].

4.1.3. Socio-Cultural Aspect

A solid sustainable urban development and regeneration involves preserving, and when possible, properly utilizing intrinsic heritage and cultural values [138,139]. By giving new life to historic, iconic, or well-loved buildings, or even landmarks of a distinctive identity, the character of the particular part of the city is strengthened, imparting a sense of familiarity [140,141]. This sense of familiarity, the memory between spatial settings and material consistency [142], and authenticity [143], through conservation of certain historical aspects [144], contribute to the socio-cultural tenet, with benefits in this context felt by a wider region, such as community well-being and involvement, visual amenity, attractiveness, increased safety, and social sustainability at large [145–147]. New uses seeking community benefits are associated with local populations and district history, identity, and quality of life, and thereafter address the broader concept of sustainable development that includes equity and well-being [148,149]. In the context of urban development and regeneration, the well-known controversial topic of gentrification arises [150,151]. A sharp improvement of all aspects of neighborhood quality could potentially lead to a widespread alteration of the racial/ethnic composition due to lower-income residents' forced displacement [152]. Planning-wise, such a process should be taken under serious consideration, but not used as an argument towards hindering the discussion of genuinely progressive urban re-development strategies [153,154]. On the other hand, not well-considered adaptive reuse projects could shift, albeit subtly, towards facadism. It is, however blurring the line and a totally different technique, or, better yet, a compromise—an easily revealed illusion, a mask [155], which will not produce the expected results.

4.1.4. Technological-Technical Aspect

Since adaptive reuse is a construction work, in the broadest sense, it inevitably involves applicable building codes. Thus, urban re-development strategies, in line with the topic of adaptive reuse, should also consider technological and technical matters, and encourage research and development of innovative durable techniques, systems, and components, in order to achieve the desired outcome of an improved built environment [156]. In many cases, buildings under consideration, despite the obsolescence to which they most probably have been subjected to, continues to operate in a satisfactory manner. Sometimes, constructions remain in a reasonably fair state, but the embodied technology is outdated. Such an upgrade, precisely because each building case is different, perhaps holding traditional construction techniques or materials, should be seen as an opportunity for innovatively improving building components, technical installations, services and systems, flexibly seeking custom-made solutions within a challenging multi-step process for wide range of scientific fields [157]. Even so, technical difficulties that might be generated, could lead to the permissiveness of intervention, decisively influencing the successful completion of the adaptive reuse project [158].

4.1.5. Legal Aspect

Adaptive reuse success and sustainability is significantly dependent on regulatory frameworks and related policy instruments, that support, through multi-level enablers at varying local or wider contexts, such practices [159].

The existing legislative framework, since the adoption of the 1975 Hellenic Constitution (Hellenic Constitution (1975)—Hellenic Government Gazette Issue A No 111/09.06.1975-[online]-https://goo.gl/VuCkYE (accessed on 29 July 2021)), ensured the protection of the natural and cultural environment by attributing this responsibility to the state. The state, in accordance with the Hellenic Constitution, must undertake preventive measures

within sustainability principles. The Hellenic Constitution refers to both tangible and intangible monuments (Within the meaning of remembrance of historic times and cultural heritage.), but it also refers to unclassified traditional elements and trends of the past. Notably, the Hellenic Constitution defines restrictions of ownership in such cases, evidently acknowledging the issues arising around ownership.

At the same time, the Hellenic Building Code (Hellenic Government Gazette Issue A No 79/09.04.2012-[online]-https://goo.gl/xhjVH6 (accessed on 29 July 2021)) along with the Buildings Energy Performance Hellenic Code (Hellenic Government Gazette Issue B No 2367/12.07.20174-[online]-https://goo.gl/7fMEyT (accessed on 29 July 2021)) successfully incorporate the most recent EU considerations and directives on technical and environmental construction matters.

4.1.6. Environmental Aspect

Adaptive reuse has been debated over the last few decades due to deepening concerns around environmental protection [160], given that the built environment is the largest energy consumer and greenhouse gas emitter [161]. Thus, seeking new uses for disused constructions undoubtedly promotes minimization of the associated environmental burden [162], helping to achieve sustainability [163]. From the environmental standpoint, adaptive reuse is likely to involve a life cycle extension of resources and materials, resource consumption reduction in terms of material, transportation and energy [164,165], recycling, waste reduction [166–169], water use reduction, minimization of carbon production, eco-friendly building technologies [170,171], and urban and suburban sprawl prevention [172,173]. However, if a building preserved for a new purpose is not fully compliant with the conservation construction regulations, it may cause occupant dissatisfaction in terms of the indoor environmental conditions [174–176].

The PESTEL analysis set out above, feeds the SWOT components of adaptive reuse in Greece, which were regarded as sustainability indicators, as listed in Table 5.

Table 5. Adaptive reuse SWOT-PESTLE matrix.

Sustainability Indicators	Strengths	Weaknesses	Opportunities	Threats
Political	P1.Blocking Neglect Policy	P2.Political Support Level	P3.Urban Re-Development Strategies/Incentives	P4.Political Inertia
Economic	E1.Economic Growth Boost	E2.Inability to Estimate economic Viability	E3.Capitalization of Cultural Value	E4.Investment Returns
Socio-Cultural	SC1.Cultural Values Preservation	SC2.Facadism	SC3.Quality of Life Improvement	SC4.Gentrification
Technological-Technical	TT1.Technological Innovation	TT2.Asset Condition	TT3.Cooperation in a wide range of scientific fields	TT4.Technical Difficulties
Environmental	EN1.Reduced Environmental Footprint	EN2.Achieving Net-Zero Energy Goals	EN3.Eco-Building	EN4.Indoor Environmental Quality
Legal	L1.Current Legislative Context	L2.Current Building Standards	L3.Land use plan and zoning	L4.Ownership Status

4.2. Quantitative Analysis

The twenty-four (24) indicators (Table 5) were input as criteria, resulting in fifty-one (51) pairwise comparisons. The indicator rank results for each expert's evaluation are presented in Table 6, and the final collective decision (geometric mean) is listed in Table 7. The indicators listed in this matrix as strengths and opportunities were positive, while the indicators identified as weaknesses and threats were negative (Table 7), and are illustrated in Figures 4 and 5 so as to graphically present the total negative versus the total positive indicators area.

Table 6. Indicators evaluation and rank by expert.

Expert:	Economy		Society		Environment	
Indicators	**Priority (%)**	**Rank**	**Priority (%)**	**Rank**	**Priority (%)**	**Rank**
P1.Blocking Neglect Policy	4.1	8	3.0	8	0.6	16
P2.Political Support Level	6.8	3	9.8	4	1.4	13
P3.Urban Re-Development Strategies/Incentives	6.8	3	28.1	1	2.7	11
P4.Political Inertia	1.9	13	1.4	16	0.6	16
E1.Economic Growth Boost	11.9	1	14.3	3	1.1	14
E2.Inability to Estimate Economic Viability	2.9	11	6.0	6	0.6	16
E3.Capitalization of Cultural Value	6.8	3	2.1	11	3.5	9
E4.Investment Returns	2.9	11	0.9	13	3.5	9
SC1.Cultural Values Preservation	1.5	15	10.9	2	6.4	6
SC2.Facadism	1.5	15	3.9	7	1.1	4
SC3.Quality of Life Improvement	1.5	15	2.5	9	9.3	2
SC4.Gentrification	0.5	16	0.8	14	6.8	5
TT1.Technological Innovation	5.5	4	6.7	5	2.8	10
TT2.Asset Condition	2.5	12	2.3	10	1.0	15
TT3.Cooperation in a wide range of scientific fields	5.5	4	0.9	13	5.5	7
TT4.Technical Difficulties	4.3	7	0.4	17	0.6	16
EN1.Reduced Environmental Footprint	3.7	10	1.9	12	4.2	8
EN2.Achieving Net-Zero Energy Goals	2.9	11	0.9	13	7.9	4
EN3.Eco-Building	5.0	6	0.4	17	27.7	1
EN4.Indoor Environmental Quality	3.7	10	0.1	19	8.0	3
L1.Legislative Context	4.0	9	1.6	12	0.3	17
L2.Building Standards	7.1	2	0.7	15	0.7	
L3.Land Use Plan and Zoning	5.1	5	0.3	18	2.4	12
L4.Ownership Status	1.7	14	0.1	19	1.1	14

Table 7. Indicator of final values.

	Indicators Rank	**Geometric Mean (%)**	**+/−**	**Value (%)**
1	P3.Urban Re-Development Strategies/Incentives	12.9	+	12.9
2	E1.Economic Growth Boost	10.0	+	10.0
3	TT1.Technological Innovation	8.5	+	8.5
4	SC1.Cultural Values Preservation	6.8	+	6.8
5	P2.Political Support Level	6.3	−	6.3
6	EN3.Eco-Building	6.2	+	6.2
7	E3.Capitalization of Cultural Value	5.7	+	5.7
8	SC3.Quality of Life Improvement	5.0	+	5.0
9	EN1.Reduced Environmental Footprint	4.7	+	4.7
10	TT3.Scientific Fields Cooperation	4.6	+	4.6
11	EN2.Achieving Net-Zero Energy Goals	4.2	−	4.2
12	E4. Investment Returns	3.2	−	3.2
13	E2.Inability to Estimate economic Viability	2.8	−	2.8
14	EN4. Indoor Environmental Quality	2.5	−	2.5
15	L3.Land Use Plan and Zoning	2.5	+	2.5
16	SC2.Facadism	2.3	−	2.3
17	TT2.Asset Condition	2.1	−	2.1
18	L2.Building Standards	2.1	−	2.1
19	L1.Legislative Context	1.8	+	1.8
20	P1.Blocking Neglect Policy	1.7	+	1.7
21	SC4.Gentrification	1.7	−	1.7
22	TT4.Technical Difficulties	0.9	−	0.9
23	P4.Political Inertia	0.8	−	0.8
24	L4.Ownership Status	0.8	−	0.8

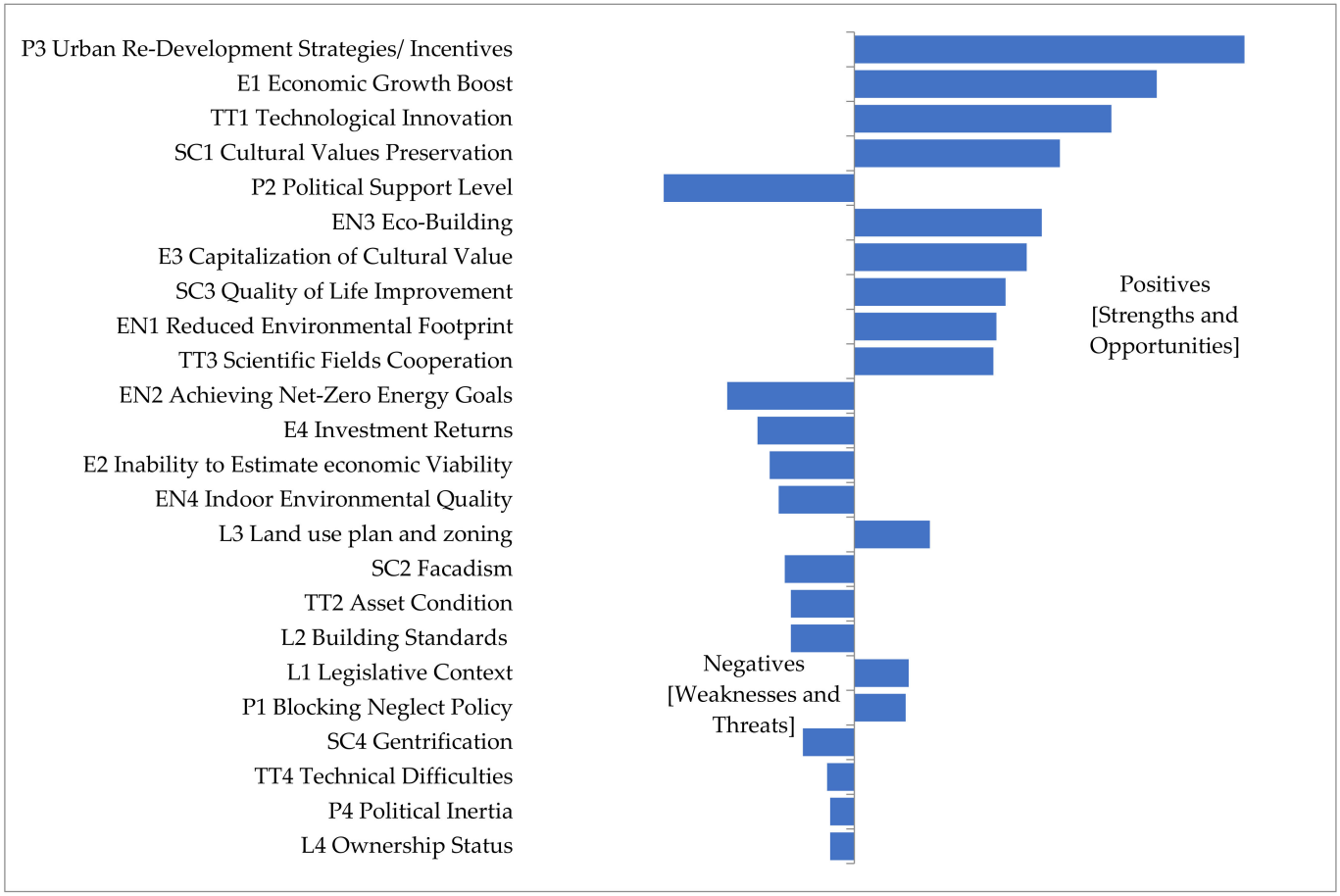

Figure 4. Indicator values, graphically.

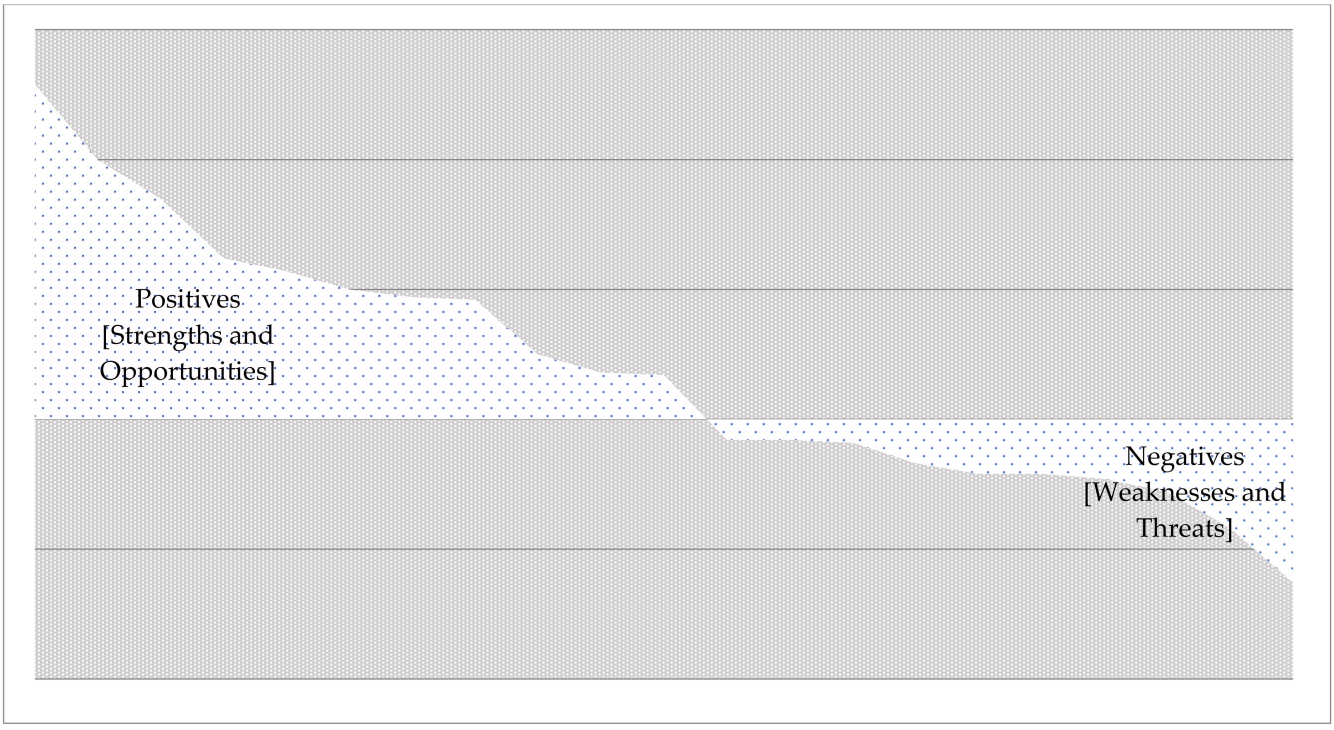

Figure 5. Positive versus negative indicators in a graphic area.

5. Discussion

Adaptive reuse in Greece reflects a complicated micro-environment, a unique macro-environment, and a large number of public and private actors. However, according with the empirical results of the quantitative analysis, the positive area overpasses the negative area, supporting the argument that adaptive reuse could be a sustainable urban development practice. Overall, the above analysis shows that political and economic aspects rank first, followed by environmental, socio-cultural, technological-technical, and legal aspects.

The expert evaluations provide an interesting range of views, stressing the fact that adaptive reuse practices in Greece are not a subject of common perception among the various parties concerned.

Looking deeper, the P3.Urban Re-Development Strategies/Incentives indicator, although is not of great significance for the excerpt on the environment, ranks first, being a matrix element that could be exploited to advantage the system, i.e., an opportunity. The P2.Political Support Level weakness indicator ranked fifth. Hence, these two indicators almost distribute their value and significance in the matrix between the positive and the negative areas, showing that the political aspect exerted an ambivalent effect on the system. Almost the same mutual exclusion applies to the P1.Blocking Neglect Policy indicator and the P4.Political Inertia indicator, expressing strength and threat in the political aspect, respectively. Although the two latter factors are evaluated to be of low significance in the system, they still add to the total cumulative result, thus it must be ensured that they will not defer sustainable development of adaptive reuse practices. Consequently, the above results prove that it is vital to raise the political profile, in both regional and local levels of governance, in order to highlight its strategic role and foster the benefits of adaptive reuse practices in urban sustainable development schemes.

The E1.Economic Growth Boost indicator, representing the economic aspect as a strength element, ranked second. Additionally, from the economic aspect, the E3.Capitalization of Cultural Value indicator also ranked high, and positive, because it was evaluated as an opportunity to future challenges. Furthermore, weaknesses and threats, i.e., the E2.Inability to Estimate Economic Viability indicator and the E4.Investment Returns indicator, respectively, although both negative, ranked in the middle, although their input does not significantly affect the E1.Economic Growth Boost and E3.Capitalization of Cultural Value indicators' collective input. Therefore, adaptive reuse's economic aspect is considered to be of high importance and it positively affects the contribution of adaptive reuse to sustainable urban development.

According to Table 7, the TT1.Technological Innovation indicator and the TT3.Scientific Fields Cooperation indicator, a strength in the third rank and an opportunity in the tenth rank, respectively, are both positive. Thus, their input was significant. Moreover, it must be noted that although the cross-counting indicators of the Technological-Technical aspect, i.e., the TT2.Asset Condition indicator and TT4.Technical Difficulties indicator, negatively affect the adaptive reuse development, they have particularly low values. Thus, their contribution to the negative area was not significant, adding to the value of the two strong positive indicators of the Technological-Technical aspect. In addition, expert evaluations regarding indicators of the Technological-Technical aspect were considered proportional, resulting in a consistent view with the probable severity of impacts in terms of risk factors analysis [177].

Moreover, indicators of the environmental aspect, as expected, positively affect the system. The EN3.Eco-Building indicator amounts to opportunities and the EN1.Reduced Environmental Footprint indicator, which is regarded as strength, rank sixth and ninth, respectively, owning positive values. However, results indicate that the indicators positive and negative values tend to balance out, pointing out that the stake on the side of the weaknesses and threats is also essential, and can damage the sustainability of the system. Thus, the EN2.Achieving Net-Zero Energy Goals indicator, as well as the EN4.Indoor Environmental Quality indicator, which address environmental aspects of policies, should be developed more to encourage sustainable outcomes of adaptive reuse projects.

Both the SC1.Cultural Values Preservation indicator and the SC3.Quality of Life Improvement indicator were listed in the top ten positive valued indicators, suggesting that the old industrial buildings preservation can help towards maintaining their intrinsic heritage and cultural values and contributing to the intrinsic culture of a society. The SC2.Facadism indicator and the SC4.Gentrification indicator raise issues that are not of particular significance according to the experts' evaluation, and their negative values provide a negligible contribution overall.

The legal aspect stands last. Except for the L3.Land use plan and zoning indicator, which ranks in the middle, all the other three indicators, namely the L2.Building Standards indicator, the L1.Legislative Context indicator and the L4.Ownership Status indicator were placed at the end of the list. The latter, in particular, was the last in the rank. For the adaptive reuse of industrial buildings, the land use plan and zoning is the early stage in the planning and conceptualization. All other associated matters are generally of lesser importance, however, cumulatively, they provided a significant contribution to the negative area posing a strong burden to adaptive reuse practices sustainability; flexibility of the relevant building regulations and land use are necessary to achieve the requested levels of sustainability and effectiveness.

In summary, from the twenty-four indicators discussed above, indeed, some indicators positively and others negatively influence the whole system in terms of overall performance in terms of sustainability. Thus, it may be commonly understood that urban sustainable development is realized mainly through adaptive reuse projects, yet not to be overlooked is certain indicators, certain factors vital to the sustainability "equilibrium" of the system, as identified within the scope of current research [178–180]. Following the FIX Brewery adaptive reuse example, completed in order to become the permanent home for the Hellenic National Museum of Contemporary Art-EMST in Athens, potential stakeholders may attach great importance to balance these indicators in their prospective adaptive reuse projects, adjusting to the latest level of scholarly understanding.

Nevertheless, limitations were set for the scope of the current paper and future research should further expand the above-mentioned methodology and results. For instance, the number and variety, in terms of educational background and professional experience, of experts could increase. In addition, and following the latter, a set of variables for the importance (i.e., weight) of expert judgment could be determined. Future research may replicate the methodology using different adaptive reuse examples, sharing common characteristics and features, in order to either highlight additional notable aspects or to further validate the findings of the present study. In addition, future research could focus on peculiarities among geographical areas [181–183], providing a broader and richer picture of adaptive reuse in practice.

6. Conclusions

Sustainable development has been a major issue in urban planning and management during the past decade. One important element for sustainable urban development is undoubtedly the adaptive reuse of existing building stock. Adaptive reuse aims at creating a (new) city landmark, a cultural and social meeting, a city portal through which the physiognomy of the city is further enhanced or developed, enabling citizens to be connected in a dynamic manner. At the same time, adaptive reuse can achieve low carbon urban development. Adaptive reuse is a complex process requiring a holistic consideration on the political, economic, social, cultural, technical, legal, and environmental aspects.

The current research employed the combination of three tools for sustainability assessment. Results of the PESTLE analysis were used to feed a SWOT analysis, results of which were subsequently subject of evaluation using the Analytic Hierarchy Process. The approach implemented presents an effective way of drawing measurable results through analysis of the surrounding aspects and examining the overall and individual views of experts.

To conclude, this paper argues that in order to underline the strategic role and promote the advantages of adaptive reuse practices in urban sustainable development plans, it is crucial to raise the political profile at both regional and local levels of governance. The economic aspects of adaptive reuse are far from negligible and should be closely considered in order to achieve an overall positive impact of adaptive reuse on sustainable urban development. In order to attain the ultimate outcome of an enhanced and sustainable built environment, technological and technical matters involve striking a fine balance toward promoting research and the development of novel resilient techniques, systems, and components. Although environmental indicators are expected to have a positive impact on the sustainability of adaptive reuse projects, results indicate risks, which can harm system sustainability unless issues related to environmental policy aspects are not further developed. From a cultural standpoint, choosing to adaptive reuse old urban industrial buildings may help towards preserving their intrinsic heritage and cultural values, and consequently the intrinsic culture of the society, thereby promoting specific aspects of sustainability. Finally, yet importantly, from a legislative point of view, the flexibility of the relevant building regulations and land use, is necessary to ensure the requested levels of sustainability and effectiveness.

The results could serve as a reference point for all interested parties to better decide on adaptive reuse practices in Greece, and other countries sharing common characteristics and combined criteria. Consistent with the wider literature, findings of the current study include strengths and opportunities, to be further enhanced or developed and the adverse weaknesses and threats to be counteracted and reduced. In this context, the following decision-making and policy formulation recommendations have been drawn to develop adaptive reuse practices in Greece on a sustainable basis;

- Adaptive reuse is the only sustainable alternative for underutilized former industrial urban buildings.
- Current policies should be reviewed in order to develop attractive financial incentives to promote the adaptive reuse of industrial buildings, in order to generate economic growth and employment.
- In addition to developing the appropriate codes of practice and standards for adaptive reuse, new innovative and green technologies can and should be used.
- The adaptive reuse of neighboring industrial or unutilized buildings and consolidated projects that can better use the current public facilities should be supported in order to achieve holistic urban regeneration.
- Public interest, support, and participation are important to promote adaptive reuse and to reach a consensus within the community in order to optimize building use after transformation.
- For the adaptive reuse practices, sustainable development, further relaxation and flexibility of relevant building land use and zoning regulations should be considered.

Interested parties in adaptive reuse ought to benefit from relevant governmental consulting services concerning viable use options in order to respond to current market needs and optimize the use of urban space. This paper consists of holistic and multilevel research based on theoretical and empirical analyses, and serves as an essential guide for any future adapted reuse project or broader strategic urban reconstruction master plan.

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