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Review

Reviewing the Role of Key Performance Indicators in Architectural and Urban Design Practices

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Abstract: Energy use and relative CO_2 emissions drive climate change that affects both the environment and human health. Extreme events caused by climate change, such as heat waves, flooding, and droughts are increasingly frequent and dangerous and the quality of life in cities is progressively decreasing. The building sector is among the most energy intensive sectors and mitigation and adaptation strategies are needed to reduce the emissions and impacts of climate change. This article presents a literature review created using the SCOPUS database on 515 articles setup to investigate the role of Key Performance Indicators (KPIs) in architectural and urban design processes and to understand how KPIs can be used to improve sustainability in the design of buildings and cities. Findings from the literature review highlights the potentiality of KPIs as a tool for managing complexity and for measure performances starting from the early design stages up to the lifetime of buildings and, in general, design. In parallel, the analysis of results showed that KPIs are commonly used to evaluate performance at a very different scale, but the building scale is the most considered. The use of KPIs in architecture, focusing on sustainability, should be implemented more in the future to allow for a better control of architectural performances.

Keywords: key performance indicators (KPI); buildings; design process; environmental sustainability

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1. Introduction

According to the International Energy Agency, the contribution of buildings toward the total energy use in 2021 reached 30% in developed countries and 27% of the total emissions of the energy sector [1]; CO_2 emission is not only considered the primary effect of energy production but it is also more widely considered as the result of all anthropogenic activities. The 2022 IPCC Report highlights the main responsibility of human activities in causing climate change, stating that CO_2 emissions are proved to be one of the primary causes of these changes [2,3].

Due to climatic changes, the urban environment is now characterized by extreme events such as heat waves, drought, and floods, which do not only affect environmental balances but also human health [4–6]. Because of these issues, a more performance-oriented approach in the design process would be an improvement in terms of risk reduction; urban areas can be exploited as "laboratories" for adaptation and mitigation to climate change initiatives [7]. Different methods could be taken into account to manage this challenge in the context of urban and building design: conventionally, several design strategies are demonstrated to be useful to reduce energy consumption (e.g., insulation strategies, more efficient cooling and heating plants) [8]. In the context of computational design, one of the most common tools could be the use of software that considers the building's consumption already in the design process [9].

However, in order to effectively manage building performances and to support sustainable design approaches to reduce consumption and relative emissions, one of the most versatile tools are Key Performance Indicators (KPIs), [10]. KPIs are generally used to measure performances and to focus on specific aspects of outputs [11]; furthermore, they are also used as tools to represent project goals and help to measure and manage design progress in relation to those goals [12].

This performance-based approach is strictly related to the sustainability concept, which has been progressively more widely used in design practices in recent decades [13]. It focuses on the three pillars of sustainable development: economic growth, environmental protection, and social equality [14]. The idea that the concept of sustainability without a reference scale is meaningful has increasingly spread; therefore, for each scale, sustainability considers different aspects [15]. At the building scale, for example, one of the most common definitions for sustainable architecture is "smart building", mainly related to energy consumption reduction and control [10]. In this context, current design approaches need also to face with the Sustainable Development Goals (SDGs) defined by the United Nations for the Agenda 2030 [16]. In particular, SDGs 11 and 12, focused on sustainable cities and communities and responsible consumption and production, are the most related to buildings and cities and need to be considered during the design process.

Current design approaches only partially consider the challenges posed by the complexity of the urban environment: during the design process, solutions universally considered 'sustainable' are commonly identified, often without considering the specifics of the site and without predicting the performance of those particular solutions, lacking a systematic approach [17,18]. Because of this lack, a literature review of the current use of KPIs in the design process has been set up. The findings of the research would help in defining a more scientific approach to the design process and in improving the capacity of buildings and districts to be more environmentally sustainable and, in particular, to reduce energy use and relative CO_2 emissions and for climate change adaptation.

The paper is organized as follows: in the introduction, the authors provide an overview of current issues of the urban environment and of the resulting central role of building construction. In the Section 2, research methods and the progressive article selection system are explained. The Section 3 shows the first output of the review and the results' elaboration sets up the discussion in order to answer the research questions. Finally, in the conclusion, the ending remarks highlight the findings.

Aim of the Study

This review is set up in order to evaluate if and how KPIs are used in building and urban design, with a focus on a sustainable design approach. Starting from this general objective, the following more specific research objectives can be drafted:

1. Identify the main research fields related to building and urban design that consider KPIs.
2. Among the fields identified in Point 1, define and discuss the main purposes related to the use of KPIs.
3. Identify the most common methodologies used for KPIs evaluation in building and urban design.
4. Evaluate if and how KPIs are considered in terms of sustainability evaluation and the main aspect of sustainability considered in the literature.

2. Materials and Methods

The literature review is set up in order to define the relationship between architectural and urban design process and KPIs. The review is based on a first in-depth analysis of all the papers found with a first database search (515 articles), followed by the identification of a small group of articles that were considered relevant to the research objective.

The review was created using the SCOPUS database [19], with the following set of keywords: "KPI" OR "Key Performance Indicator*" AND "design" OR "urban planning" OR "architecture" for titles, abstracts, and keywords categories. This first search resulted in 2549 articles: starting from this result, specific filters were applied in order to select articles more coherent with the main aim of the review and accessible. In particular, filters were defined as follows:

For the "Language" filter, only English articles were selected. In relation to "Document type", only articles or book chapters. Excluded fields include: computer science, physics and astronomy, mathematics, business, chemistry, economy, medicine, health, immunology, biochemistry, genetics and molecular biology, and chemical engineering. This specific layer of filtering has been setup in order to identify articles related to the building and urban design field, even though other research fields are naturally related to sustainability studies such as, for example, chemical engineering.

Finally, a selection of "Exact keywords" is defined: "KPI", "Design", "Key Performance Indicators (KPIs)", "Architectural Design", "Key Performance Indicators (KPI)", "Design/methodology/approach", and "Architecture". After the application of this set of filters, the final set of articles extracted from SCOPUS was created using 515 articles written from 2004 to 2022.

Among the 515 articles identified through the application of the filters, the most relevant for the research aims were selected, i.e., the ones related to urban design, building design, and building component design.

Then, a deeper analysis was conducted on the previously selected articles to define:

- Which KPIs were considered.
- If the research was based on simulations or field measurements, or even in the case of a literature review.
- Scale considered (urban, building, building element, the component of building element).
- Aim of the use of KPIs.

Through deeper analysis of the selected articles, a further reduced group of articles directly related to the building design field was analyzed. All articles in the field of manufacturing not focused on products for building construction are not considered in the last part of the analysis, because the final list of KPIs aimed to be mainly related to the architecture and urban design field.

The sample size of the review after the second step of filtering is 76 articles, on which a critical analysis was conducted in order to be able to answer the research question set. For the selected articles, the followings characteristics are identified:

- The aim of the research and the relative role of KPIs.
- The specific field (urban, building, building materials, building component, a component of building component).
- The tools, e.g., simulations or field measurements.

In parallel, an analysis of keywords used in the literature has been set up using VOSViewer software in order to visualize networks and cooccurrences of the keywords, as well as the frequency of keywords. For the analysis of the keywords, "association strength" has been selected as a method for normalization within the VOSViewer settings. This kind of analysis is useful to identify groups of keywords that are commonly used in this specific research field and the main focuses of analyzed papers.

To be able to evaluate the kind of KPIs considered in reviewed papers and their frequency, a clustering of KPIs has been performed. Eight clusters were defined after a review of all KPIs described in the 36 articles (Figure 1).

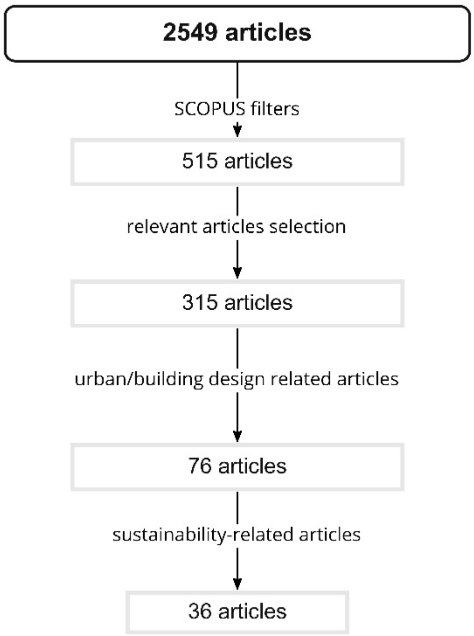

Figure 1. Diagram showing the progressive selection of articles for the review, starting from the first output from SCOPUS to the selection of building/urban sustainability-related articles.

3. Results and Discussion

The articles selected in the first part of the review (2549), i.e., before the application of filters related to main fields of interest, were written between 1987 and 2022.

After the application of filters described in the Section 2, 515 articles were selected. Among them, a first analysis allowed for the identification of the ones relevant for the research (articles referring to the architecture of software, computer science, economy, and social sciences were excluded). Excluding articles that are not relevant helped in identifying 315 articles directly related to building and urban design. In parallel, for each of the 315 selected articles, the relative field of research was identified, i.e.,:

- Manufacturing;
- Building design;
- Engineering and technology of building/infrastructure/materials (so, mainly related also to building construction and urban design);
- Urban design. (Figure 2):

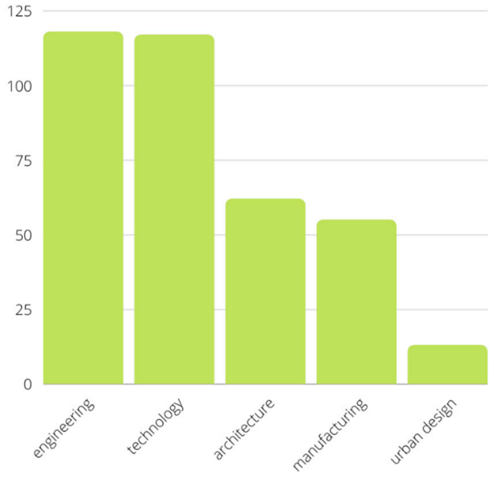

Figure 2. Graph of partition of 315 articles in five fields of interest (building design, (building-related engineering, technology, manufacturing, and urban design).

The other 200 articles were mainly focused on computer science and technology applied to other fields such as the automotive and information industries and logistics and other economic fields.

After the application of filters, the selected papers were published between 2005 and 2022: the review highlights that KPIs as tools for architects and planners to measure the performances of buildings (or their components) are increasingly used over time, with a peak in the number of articles written in 2019. The number of publications highlights the increasing interest in using KPIs as tools to improve design performances. Nevertheless, it is necessary to specify that since the review has been set up in March 2022, data related to the publication of this year are not exhaustive (Figure 3).

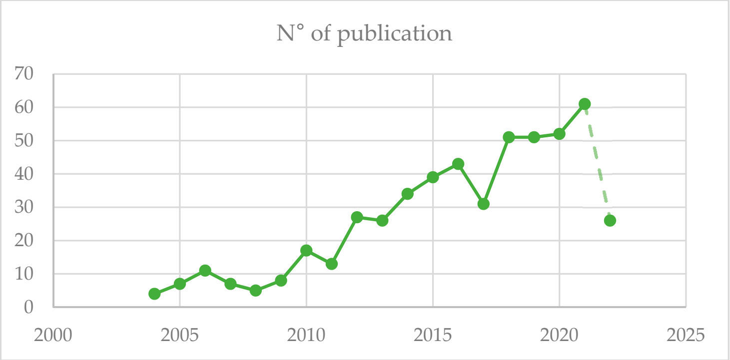

Figure 3. Diagram showing the frequency of articles in the fields of architecture, urban design, and manufacturing starting from 2004 to 2022.

An in-depth analysis of the articles showed that some of them related to the manufacturing field referred to other domains than building construction. After the second step of the filtering, which consisted of considering only the articles related to building construction and urban design, a group of 76 articles was finally selected (Figure 4).

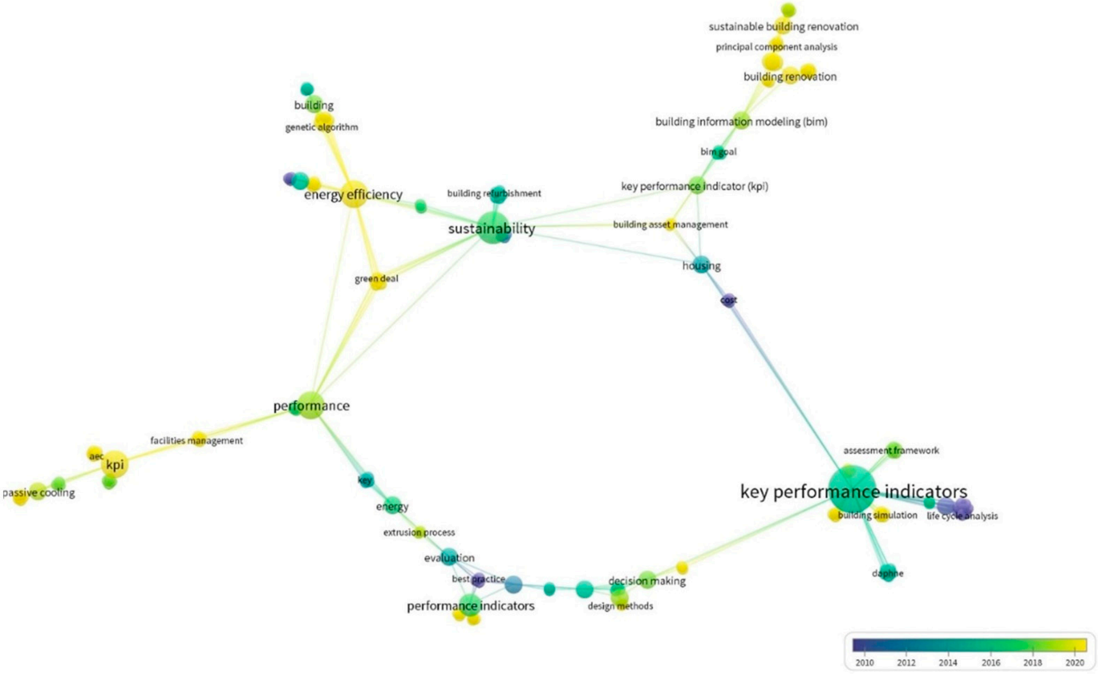

Figure 4. Keywords network (co-occurrences) from the selected 76 articles (edited with VOSViewer software). The diagram highlights the central role of sustainability.

An analysis of the keywords used in the 76 selected articles firstly shows that Key Performance Indicators are very often coupled with benchmarking, which plays a central role in the KPIs approach. Secondly, the output of the analysis, shows a strong relationship with energy use reduction and cooling and heating plants (Figure 5).

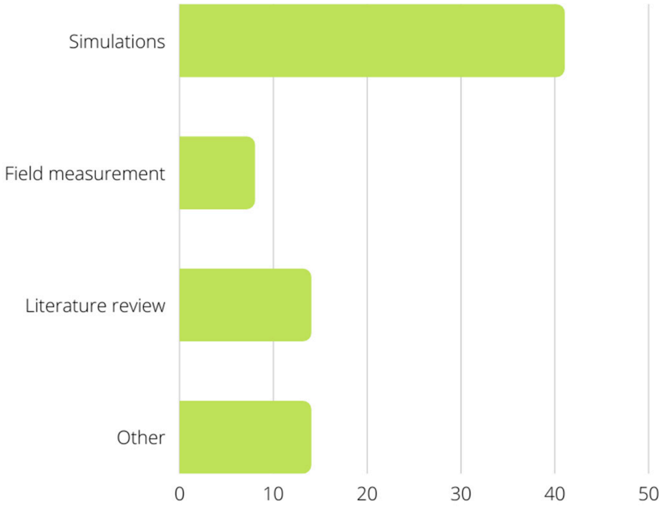

Figure 5. Frequency of different methodological approaches in analyzed literature.

In addition, focusing on the network of keywords related to “architectural design”, Figure 5 shows that there’s a connection with keywords such as “life-cycle” approach and “environmental sustainability”, but, again, this focus highlights the central role of energy utilization and efficiency. As described in Section 2—Materials and Methods—the keyword diagrams highlight the main research fields and highlights in the selected literature.

An in-depth analysis has been conducted in order to be able to define the methodology used, the scale considered, and the aim of the research for each of the 76 selected articles.

The first analysis was oriented to define which methodology is used in the selected literature. Three main categories have been defined: software simulations, field measurement, and others (mainly literature reviews). Table 1 shows the different approaches used:

Table 1. Analysis of the methodology used in reviewed articles.

Methodology	Papers
Simulations	[20–60]
Field measurement	[61–68]
Literature review	[69–82]
Other methodologies	[83–88] survey [89] coding [90–92] analysis [93] comparison

Table 1 shows that simulations and in general informatics tools are widely used to validate research hypotheses. This result highlights the central role of software simulations in the design process and allows designers to have a prediction of the performance of the project before the construction, unlike field measurements that can provide data about the performances of an object only after the construction (Figure 5).

The second analysis was set up to define on which scale analyzed papers are focused. Table 2 shows if the selected publications focus on: urban scale, building scale, building material, building component, or component of building component.

Table 2. Analysis of the reference scale used in reviewed articles.

Scale	Papers
Urban	[21,26,29,44,54,58,64,70,72,78,90,91]
Building	[20,22–25,27,31,32,61–63,69,73–77,83,84,89] [35,37,41–43,45–47,50–53,67,68,79,80,85–87,93] [55–57,59,60,81,82,88,94,95]
Building materials	[33,38,48]
Building component	[30,34,36,40,65,66,71,92]
Component of building component	[28,39,49]

Table 2 shows that the analyzed studies are concentrated at all scales of detail, albeit with different frequencies: starting from the urban scale up to the scale of a single component of an object. However, the analysis of results highlights that the main focus is more related to a building's evaluation in its complexity than to a single component or material. The results coming from it highlight the central role of KPIs in the assessment of specific performances on a building scale (Figure 6).

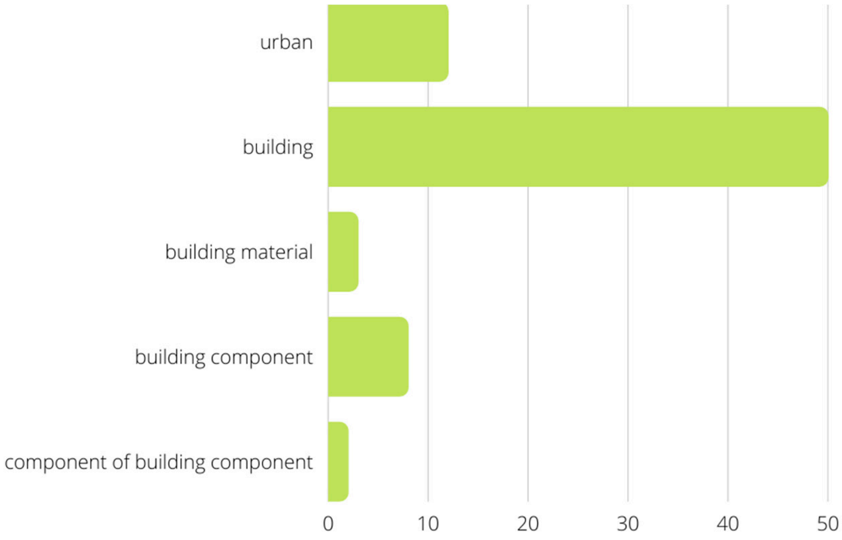

Figure 6. Distribution in percentage (%) of scale considered in papers.

The third part of the analysis is focused on the identification of the main aim of the research of analyzed papers, as shown in Table 3.

As already highlighted in Table 1, analyzed papers focus on very different research aims, since KPIs can be used very widely to evaluate performances. Table 3 shows that four main categories of aims can be drafted: improve manufacturability, improve sustainability, optimization of product or process, and recommendation provision. A wide range of other aims has been listed, demonstrating the adaptability of KPIs as tools and at the same time the level of complexity that characterizes architectural and urban design. Nevertheless, an analysis of the results defines sustainability improvement as the main aim of the selected articles (Figure 7).

Table 3. Analysis of the main aim of the research in reviewed articles.

Main Aim	Papers
Clustering	[32,42,65,78]
Improve/measure sustainability	[22,24–26,34–36,38,40,41,43,45,46,51–53,56–59,61,62,66,70,71,74,75,80,83,87,89–93]
Optimization	[19,21,24,33,38,39,43,46,47,49,54,57,65,66,71,73,87]
Provide recommendation	[20,34,68,76]
Measurement	[64,84,91–94]
Other	[32] (investigate the perception of the importance of KPIs) [35] (validate hypothesis) [36] (pre-design evaluation) [73] (explore role of KPIs in DM) [37] (manage complexity) [48] (define material peculiarities) [85] (management) [54] (define relationships) [95] (evaluate success)

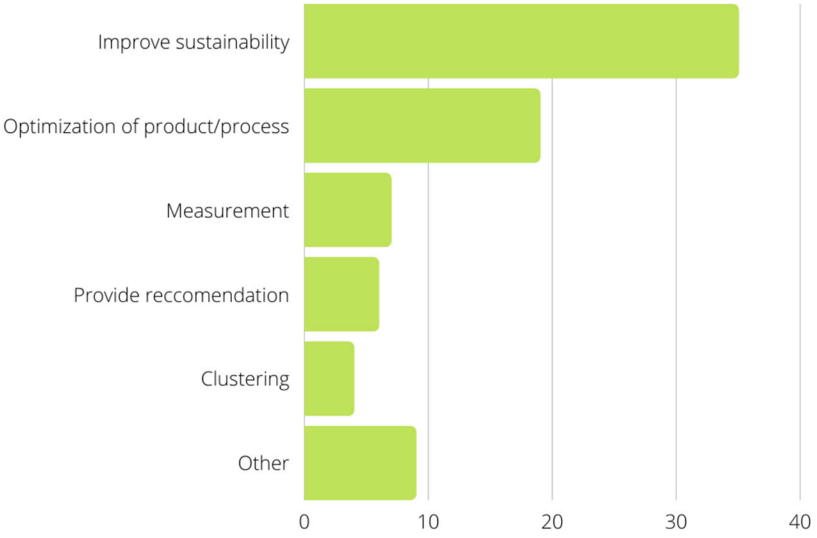

Figure 7. Graph showing the distribution in percentage (%) of the aim of analyzed articles.

Starting from the set of 76 articles relevant for this review, the analysis shows that 36 articles are set up to address a sustainable-based objective, which is different within papers; some of the most common objectives are related to materials' qualities and performances or production process improvements. The first reading key of these 36 articles is related to the defined distribution of the three pillars of sustainability: economic, social, and environmental. An in-depth study of the selected papers imposed a more complex definition of KPIs (as shown in Table 4) (Figure 8).

Table 4. Number of KPIs for each cluster identified; total KPIs identified through the literature review: 325.

Author(s)	**Main Focus**	**KPI 1**	**KPI 2**	**KPI 3**	**KPI 4**	**KPI 5**	**KPI 6**	**KPI 7**	**KPI 8**
[22]	Building restoration	6	1	1	3	-	-	-	-
[61]	Reduce building energy demand	-	2	-	-	-	-	-	-
[24]	Reduce building energy demand	-	4	-	1	-	-	-	-
[25]	Reduce building energy demand	1	1	1	-	-	-	-	-
[26]	Reduce building energy demand	1	2	1	-	-	-	-	-
[70]	Promote sustainable water use	-	-	-	-	-	-	-	-
[71]	Remanufacturing	-	-	-	-	-	-	-	-
[89]	Building restoration	5	2	1	2	-	-	-	-
[83]	Building restoration	5	2	1	2	1	1	1	-
[90]	Urban and mobility sustainability	-	1	2	3	2	-	-	17
[74]	Circular economy	-	1	1	-	-	2	-	2
[62]	Sustainable maintenance and refurbishment	4	1	4	2	-	8	5	9
[75]	Sustainable construction	1	1	4	2	2	1	-	-
[34]	Optimize PV panels performance	-	3	1	-	-	-	-	-
[35]	Measure sustainability	4	2	-	-	1	-	1	3
[36]	Urban energy balance	2	1	-	-	8	-	-	-
[38]	Accelerate the transition toward a sustainable future	-	2	-	-	2	-	-	-
[40]	Reduce energy use	-	7	-	-	-	-	-	-
[41]	Energy saving	3	16	5	1	8	-	-	1
[43]	Improve building's performance in terms of energy use	5	-	-	-	2	2	3	3
[66]	Reduce energy consumption	-	4	1	-	1	-	-	2
[91]	Circular approach in urban design	1	2	-	-	3	2	-	3
[45]	Limit energy use and losses	-	-	-	-	-	-	4	-
[93]	Define common features of IB (intelligent buildings)	-	2	6	6	1	-	4	2
[46]	Sustainability in BIM	-	-	4	-	-	-	-	10
[49]	Improve performances of plants	-	-	-	-	-	-	-	-
[80]	Building refurbishment	-	1	-	1	1	-	-	-
[51]	Multiscale analysis of the building	-	1	-	-	1	-	10	-
[52]	Improve eco-efficiency	-	4	2	-	1	-	-	-
[92]	Optimize processes and reduce waste	-	1	-	-	1	-	-	3
[87]	Optimize NZEB design	2	1	-	-	-	-	-	-
[53]	Sustainable energy use	-	1	-	-	-	-	-	-
[56]	Improve building performance	6	-	1	1	-	1	-	1
[57]	Improve energy efficiency	-	1	-	-	-	-	-	-
[58]	Improve urban and building performance	-	-	-	-	-	-	-	-
[59]	Improve building performance	1	1	2	1	4	3	1	3
	Total amount of KPIs for each section	47	69	38	24	39	20	29	59

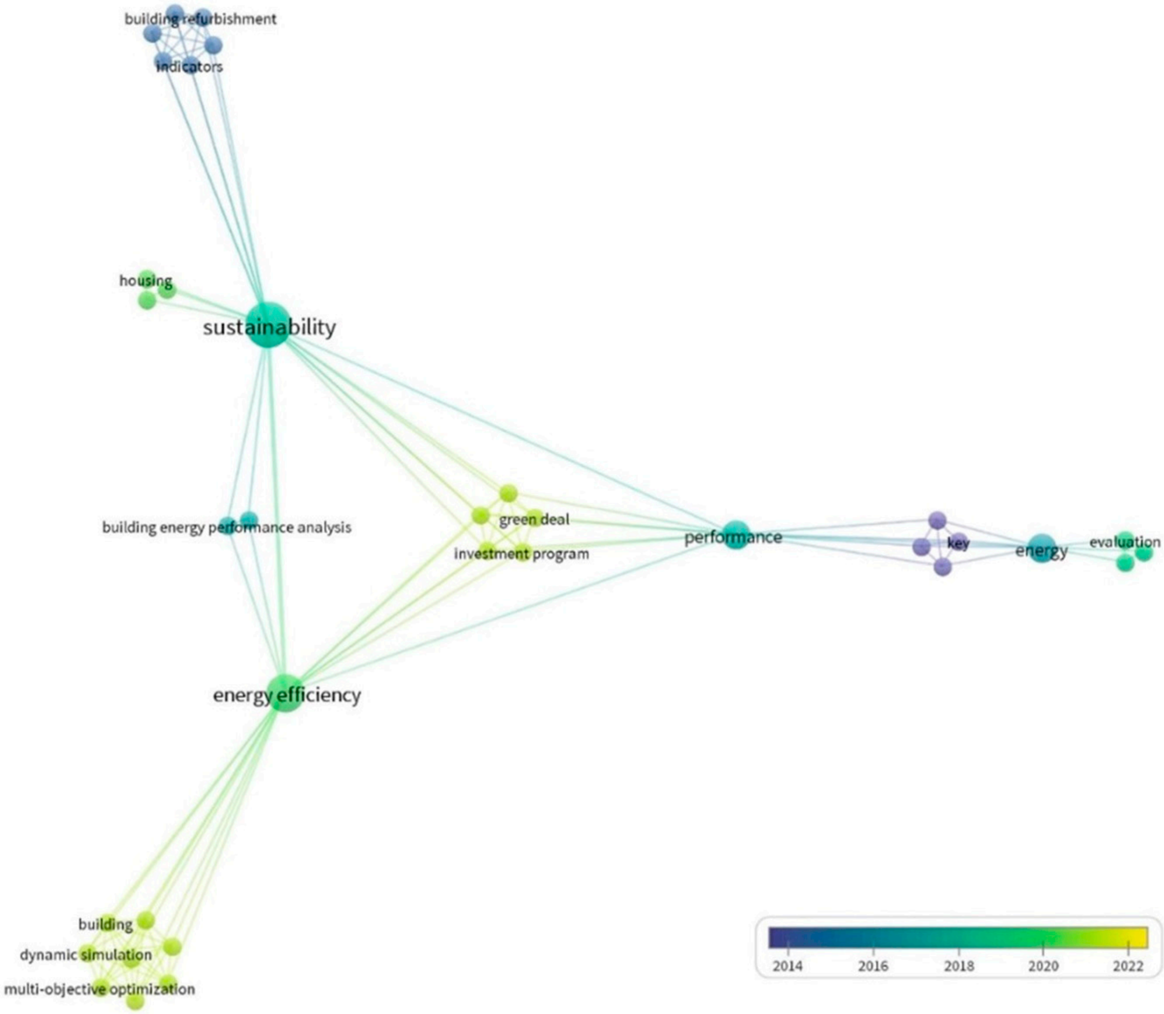

Figure 8. Keywords of the 36 articles directly related to sustainability in urban and building design fields (edited with VOSViewer).

Since the list of KPIs used in the 36 articles is very wide, systematization has been carried out by clustering KPIs in the eight categories listed below, in order to make the table more readable (complete KPIs groups and lists are available as Supplementary Materials).

The eighth cluster encloses all remaining KPIs which were not referable to the previous clusters and which were not characterized by a common scope. These are:

1. **Indoor comfort KPIs:** e.g., indoor thermal comfort/thermal comfort score, indoor air quality, daylight factor.
2. **Energy-related KPIs:** e.g., energy consumption/demand, daily energy use, renewable energy sources.
3. **Economic KPIs:** e.g., initial costs, investment costs, cost in use.
4. **Social KPIs**: e.g., degree of satisfaction, degree of privacy, accessibility.
5. **Environmental KPIs**: e.g., carbon absorption by trees, radiation: sum of shortwave radiation coming into project area; albedo: average albedo of the project area.
6. **Architectural (compositional) KPIs**: e.g., layout, floor area, architectural form.
7. **Building technical KPIs:** e.g., average thermal transmittance, ventilation heat losses, solar heat gains.
8. **Other KPIs:** e.g., security, location, changes to legislation.

Table 4 shows that the most used KPI category is the one related to energy use, followed by the indoor comfort one. The hierarchy of KPIs used is:

- Energy-related;

- Indoor comfort;
- Building technical;
- Environmental;
- Economical;
- Others (very case-specific KPIs mainly related to performances of single components);
- Social—architectural (compositional aspects).

The analysis shows that the indicators belong to the following clusters: indoor comfort, energy-related, economic, environmental and building technical adopt standardized units for measurement (International System of units (SI)), while others are more qualitative/site specific. These belong to, e.g., social and architectural clusters (Table 5).

Table 5. Most frequent KPIs found in the literature starting from Table 4.

Indicator	Frequency
Thermal comfort	10 times
Energy consumption	10 times
CO_2/GHG emission	6 times
Indoor air quality	5 times
Renewable energy sources	4 times
Daylight factor	4 times
Discomfort hours (27–28 °C)	3 times
Daylight requirement	3 times
Investment costs	3 times
Degree of satisfaction	3 times
Wellbeing	3 times
Solid waste	2 times
Solar radiation	2 times
Accessibility	2 times
Initial costs	2 times
Degree of privacy	2 times
Eco-efficiency	2 times

For each cluster, one (or more) particularly relevant KPIs have been selected to describe which kind of parameters are most considered and which kind of relative tools are used to evaluate specific performances. In building construction and urban design areas the most common evaluation of sustainability is mainly related to their environmental impacts, but the concept of sustainability concerns different areas [14]. Therefore, it is interesting to understand if and how these other fields are considered in the sustainability evaluation.

The in-depth analysis conducted in order to define if and how economic and social sustainability are considered in the literature, in addition to environmental sustainability, shows that economical sustainability is only partially considered (as a component directly related to energy consumption), and specific economical KPIs are defined in eight articles [34,41,56,74,83,93]. In particular, these KPIs are mainly related to construction and maintenance costs (mainly related to life-cycle costs), investments, productivity improvement, and management of resources and buildings.

In parallel, KPIs useful to measure social sustainability are rarely considered, in particular, in only five articles [41,56,62,83,93], and are mainly related to well-being, psychological comfort, and satisfaction of people living in the analyzed buildings. Starting from the results showed in the previous paragraph, the study highlights that only 11 of the 36 articles analyzed consider each of the three components of sustainability in their assessment method.

The analysis of KPIs used in the reviewed articles highlights the possible role of them in managing sustainability in building construction. Except for clusters 6, 7, and 8, which are mainly related to architectural/compositional practices and relative characteristics, the other clusters of KPIs identified in this paper highlight the direct connection between the use of KPIs to measure sustainability and different SDGs from the Agenda 2030 of United Nations: in particular goals 3 (good health and wellbeing), 7 (affordable and clean energy), 11 (sustainable cities and communities), 12 (responsible consumption and production), and 13 (climate action) [16]. In parallel, specific KPIs defined in the literature can play a key role in planning adaptation and mitigation strategies to climate change.

For example, considering specifically indoor thermal comfort and energy consumption/demand related KPIs (adaptation KPI and mitigation KPI, respectively), which are the most commonly used KPIs described in the selected literature, the analogies and differences between the different studies can be outlined, not only in terms of methodology, i.e., with the use of simulations and field measurements, but also in terms of parameters, tools, and software considered (Table 6).

Table 6. Different methodologies used to measure KPI 1.1—indoor thermal comfort.

KPI 1.1—Indoor Thermal Indoor					
Author(s)	**Methodology**	**Scale**	**Indicator**	**Tool(s)**	**Notes**
[22]	Simulations	Building	Discomfort hours above 27 and 28 (°C)	-	-
[26]	Simulations	Building	LPD	HAMBase framework	-
[36]	Simulations	Building	Physiological equivalent temperature (PET) (°C)	Envi-met	-
[41]	Simulations	Building	-	-	Thermal comfort is considered as a secondary indicator
[43]	Simulations	Building	Temperature (°C) according to ASHRAE standards	BRESAER (EU Horizon 2020 project) BEMS	The tool is the result of the project
[56]	Simulations	Building	-	-	Simulations are not described in the paper
[62]	Field measurement	Building	Temperature (°C)	-	-
[83]	-	Building	PMV, PPD, Discomfort hours above 27 and 28 (°C)	Not defined	-
[89]	Simulations	Building	PMV, PPD	PARADIS	-
[91]	-	Building	PMV	Not defined	-

As highlighted in Table 6, indoor thermal comfort is mainly calculated through software simulations allowing the prediction of building performance in terms of, for example, thermal insulation and indoor ventilation. In order to evaluate simulation results, different kind of indicators are considered, mainly according to the current regulations of the countries where the analyses are carried out.

Differently, all the paper analyzed with a focus on energy consumption/demand rely on the use of simulations [22,41,89], with an exception made for the articles that consider energy consumption as a KPI that focus on its role in sustainability assessment but not on its evaluation [25,52,80,87,91].

From the previously cited articles, only few of them consider case studies and describe the process directly referring to the tools used to simulate energy consumption. In particular, refs. [25,41] propose the use of EnergyPlus, while ref. [22] describes the use of Revit and ref. [87] uses eQuest.

The detailed analysis of the indicators and methodologies used in the reviewed literature is useful to have as an overview of which variables are currently most considered in sustainability assessment. Furthermore, it provides a useful tool for researchers and designers to predict from the first design steps which standards architectural and urban design, respectively, must fulfill, both in terms of new construction and retrofitting [25,37], and [45] proposes interesting methodological approaches to manage environmental sustainability of design, in particular from a comfort and energy reduction perspective.

4. Conclusions

The review highlights the potentiality and the importance of KPIs in the design field and the growing interest in relation to them in the last 16 years. In relation to the sustainability assessment, the review shows the matters in defining a specific set of KPIs usable for different case studies: this is because evaluating environmental sustainability is a very complex task and it can be seen from different perspectives depending on specific cases and needs. The research shows that KPIs are not widely used to evaluate the overall environmental impact of building design, since the most common use of KPIs found in the literature is related to the reduction in energy consumption and waste.

The following main conclusions can be drafted:

- The review highlights the adaptability of KPIs as tools for managing complexity and measuring specific performances. The main research that considers KPIs as a tool to measure building and urban design performance are engineering and technology, while in the field of architectural and urban design these are used much more rarely (243 articles for engineering and technology, 76 articles for architectural and urban design).
- KPIs are widely used to evaluate the performances of products or elements, sometimes within their life span; therefore, KPIs are used to evaluate performances at different scales, starting from the element scale, up to the urban scale. In particular, the main aim of using KPIs in reviewed papers is to optimize performance (17 papers) or to improve sustainability (36 papers).
- The most common methodology used to validate a research hypothesis is software simulations, while field measurements are rarely used (41 simulations/8 field measurement). Sometimes, these two methodological approaches are used combined in order to validate the results.
- Of the selected articles, 36/76 focus on the role of KPIs for the sustainability improvement of buildings or one of its components (e.g., materials, production process of technical components of a building). Among the 36 sustainability-related articles, 8 are directly related to energy use reduction.
- An in-depth study of the papers related to architectural and urban planning fields show that the focus of the research is mainly placed at the building scale (50/76 articles). KPIs are demonstrated to be a promising tool to manage the increasing complexity of the building construction sector at a time of great change due to climate change issues, which require a greater control over the construction process and the life cycle of buildings and cities, in order to afford satisfactory standards of sustainability.
- Overall, the review of the papers shows that KPIs can be an effective tool for architectural design although they are not fully exploited in this field compared to other related areas of study such as engineering. This study also highlighted the importance of using KPIs to manage and assess the impacts of architectural and urban interventions.
- In parallel, the identification of parameters used for evaluation can be a first step to deepen the methods used to assess performance and, if needed, to propose new and more accurate approaches. Further research should consider methodological approaches and tools used in order to improve the efficiency of the evaluation in relation to specific goals (starting from SDGs for sustainable development). In parallel, results from the review could be validated through the application on a real case study.
- In addition, future research could be oriented toward the definition of composite indicators to propose a more accurate assessment of the environmental sustainability

of a project not only in terms of reducing design impacts but also in terms of adaptation to and mitigation of climate change.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su142114464/s1, Table S1. List of KPIs used in each paper.

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