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Building passport for the sustainable conservation of built heritage

BPSC of built heritage

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Abstract

Purpose – This research presents the development of a Building Passport for Sustainable Conservation (BPSC) as a questionnaire with a set of 23 core indicators, for a baseline assessment of heritage buildings. The aim of this tool is to identify priorities for future interventions, by recognising the contributions of heritage buildings to sustainability that should be preserved and the fragilities that need to be improved.

Design/methodology/approach – The BPSC uses a selection of core indicators for sustainability observable on heritage buildings. It was applied to four different case studies of modern heritage in the Netherlands, to verify its applicability and limitations.

Findings – The results suggest that this tool has the potential to contribute to an expedite assessment, reaching consensual evaluations of priorities for sustainable conservation, while reducing the time and cost of the process, contributing to support informed redesign decisions.

Originality/value – Recently, existing building sustainability assessment (BSA) tools have been adapted and new BSA tools developed for heritage buildings. Some tools target existing buildings, but seldom cover cultural significance and heritage values. Others target the after-redesign situations – aiming at assessing how sustainable the redesign is. Often BSA tools are complex and time-consuming, with extensive indicators and

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data requirements. The BPSC developed in this research covers the main aspects of sustainability and related heritage values, in a simpler tool for a baseline assessment.

Keywords Built environment, Heritage, Sustainability, Conservation, Building passport, Sustainability assessment

Paper type Research paper

1. Introduction

Two decades ago, sustainability and heritage conservation were often considered as opposite or contradictory (Dornelles *et al.*, 2020; Lidelöw *et al.*, 2019). Today, the contribution of the conservation of built heritage to sustainability is seldom under question, and further steps have been taken on their further integration by both science and society (Fernandes *et al.*, 2019; Gonçalves *et al.*, 2014; Posani *et al.*, 2019). Endorsed by international doctrinal documents as the UNESCO Recommendation on the Historic Urban Landscape (UNESCO, 2011), and the UN Sustainable Development Goals (United Nations, 2015), heritage conservation is becoming a condition sine qua non for sustainable development.

Tools to support decision-making have been developed to encourage design decisions to integrate economic aspects, cultural significance and environmental performance (Havinga *et al.*, 2019; Ornelas *et al.*, 2020; Roders *et al.*, 2008). Regulations, recommendations of best practices, and principles for intervention have been established internationally (UNESCO, 2011, 2013, 2015; ICOMOS, 2003, 2011a, b; Australia, 2013).

Sustainability assessment tools are essential to support design decisions in heritage conservation processes. These tools have the potential to contribute to the implementation of sustainability objectives at the management level (Ornelas *et al.*, 2020; Leus and Verhelst, 2018), and to assess the sustainability of adaptive reuse and conservation projects in heritage buildings (Boarin *et al.*, 2014). However, the literature shows that the existing sets of indicators are insufficient to ensure an adequate baseline assessment of heritage buildings to sustainability before conservation interventions (Gonçalves *et al.*, 2021). This baseline assessment is of utmost importance to inform the future steps of design, with a balanced integration of environmental and cultural factors (Gonçalves *et al.*, 2021; Appendino, 2018; Correia *et al.*, 2013), and to establish limits of acceptable change (Havinga *et al.*, 2019). According to practitioners, there are insufficient tools to support decision-making in built heritage conservation, and the existing tools and methodologies are too complex, difficult to access and very time-consuming (Gonçalves *et al.*, 2019, 2021; Perovic *et al.*, 2016).

Earlier research focusses on the selection of a core set of indicators for the sustainability assessment of heritage buildings, covering all the central aspects of sustainability according to international standards (ISO, 2011). The suggested set of indicators is suitable for existing buildings, and identifiable at the building scale, providing information about the sustainability of building attributes and values on a baseline assessment. The present research relates the resulting set of 23 core indicators for sustainable conservation with the related building attributes, to build a tool for the baseline assessment of heritage buildings and support decision-making towards sustainable conservation. This tool is then applied to different case studies of 20th century heritage in the Netherlands, to test its applicability and clarity of the formulated indicators.

2. Materials and methods

The construction of the assessment tool was based on literature regarding sustainability and built heritage. The selection of core indicators (Gonçalves *et al.*, 2021) crossed indicators from two BSA (building sustainability assessment) methods – one focussed on heritage buildings (Versus) and one focussed on regenerative design (Living Building Challenge), with the recommendations from the ISO 21929-1 standard on indicators for sustainability in building construction (ISO, 2011).

To structure these indicators, this research uses as a starting point the framework of [Kuipers and De Jonge \(2017\)](#), that aims at guiding the “observation of an inherited building in its present state in a coherent manner”. In this framework, the building is understood as a composed interrelation of layers that determine its physical coherence, as defined by [Brand \(1995\)](#). To the six general-purpose shearing layers defined by Brand (site, skin, structure, space plan, services and stuff) [Kuipers and de Jonge \(Kuipers and De Jonge, 2017\)](#) add another layer, specific to heritage buildings, the spirit of place, to include the intangible features of the place. The selected core indicators for sustainable conservation were organised according to these seven building layers of heritage buildings, allowing for a gradual recognition of the building in its varied levels. The tool was developed as an online questionnaire, with Qualtrics software, through sets of binary items on a Likert scale.

The building passport for sustainable conservation (BPSC) was applied to different case studies of 20th century heritage by Heritage and Architecture students, at TU Delft, the Netherlands, in two different stages. In both stages, students applied the building passport after surveying and analysing the building, and before initiating the design process. Also in both cases, students were acquainted with the concepts and analysis methods proposed in the framework of [Kuipers and de Jonge \(Kuipers and De Jonge, 2017\)](#), further detailed in “Designing from Heritage”. In the first stage, between May 2020 and July 2020, a group of 20 students applied the BPSC to the Priorij Emmaus, in Maarssen, Utrecht the Netherlands, without any introductory explanations to the concepts covered. This stage of the research allowed to collect quantitative data and to verify the applicability and variability of responses towards the same building. In the second stage, between March 2021 and April 2021, a group of five students applied the BPSC to different V&D department store buildings in the Netherlands (Leiden, Haarlem and Maastricht). In this case, students applied the building passport twice: first, the BPSC was applied without previous knowledge of the concepts target by the indicators; later, the BPSC was applied again after discussing the scope of each indicator in a collective session. This stage allowed collecting qualitative data on the clarity in the formulation of indicators and limitations of the developed tool.

3. Building passport for sustainable conservation

3.1 Indicators and building layers

In the current research, the previously selected set of core indicators was organised in a BPSC: a tool for a qualitative baseline assessment of the building values for sustainability, in a simple and accessible way. As identified in the literature ([Ornelas et al., 2020](#); [Shetabi, 2015](#)) the indicators for sustainability assessment were organised according to building attributes or components, and then distributed in seven building layers. This option allows relating the sustainability performance with the value of each building attribute, and thus reduces complexity, and supports the identification of limits of acceptable change. These seven layers are defined as follows:

- (1) Site: relation of the building with the surrounding urban landscape.
- (2) Skin: the building envelope and interface with the exterior.
- (3) Structure: the support construction systems.
- (4) Services: the infrastructures, such as plumbing, electrical systems, heating and ventilation.
- (5) Space plan: the interior layout and distribution of spaces.
- (6) Stuff: furnishings and furniture.
- (7) Spirit of the place: intangible aspects related to building’s meanings over time.

In each building layer, several attributes were identified, contributing to further detail in the assessment. As such, the layer “Skin”, for instance, includes the attributes “shape”, “materials” and “techniques”, while the layer “services” includes the attributes “water system”, “energy and heating”, and “ventilation” (Kuipers and De Jonge, 2017). In the layer “Spirit of Place”, Kuipers and De Jonge (2017) refer to community and place relationships. These building layers and attributes were thus related with the sustainability indicators (Gonçalves *et al.*, 2021) as described in the diagram in Figure 1. As an example, the layer “spirit of place” is related with the indicators “places to gather and connect” (community and public spaces), “place-based relationships” (integration with cultural context, historical events, traditions) and “environmental features” (integration with surroundings: colours, textures, materials, views and craftsmanship) (Kellert *et al.*, 2011).

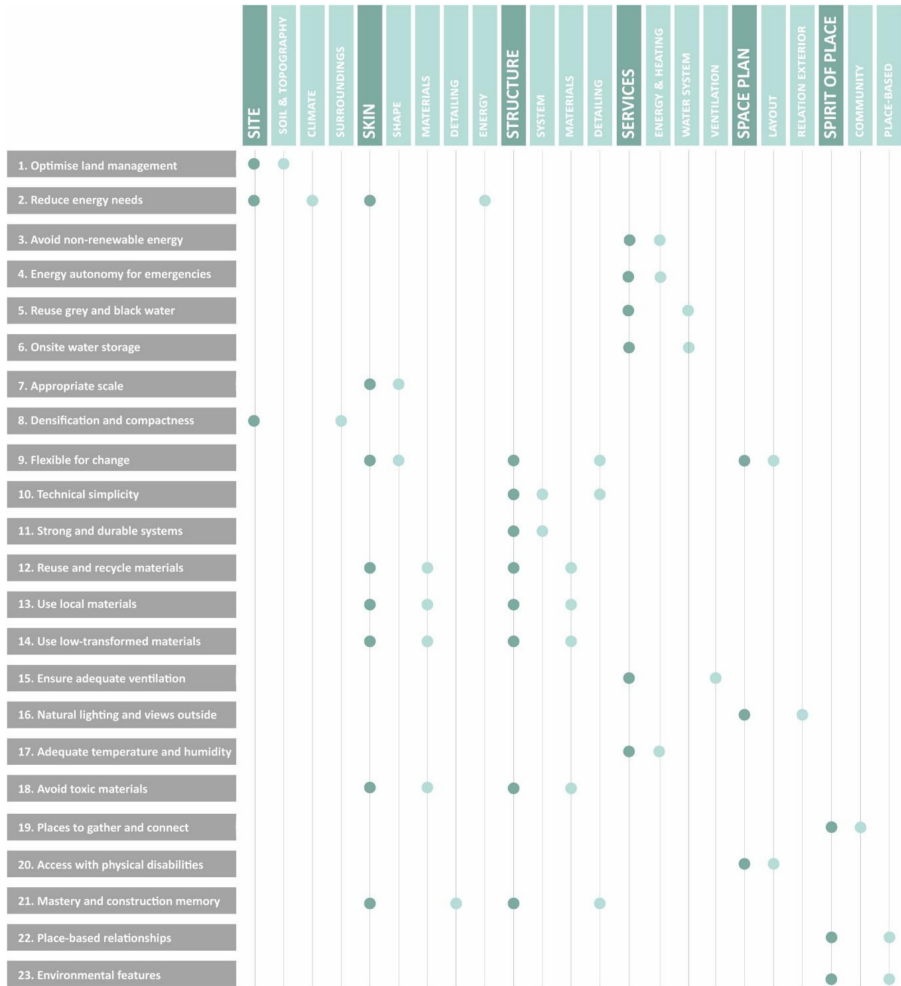


Figure 1. Distribution of the indicators according to building layers and attributes

3.2 Structure of the tool

The BPSC seeks to tackle some of the main challenges identified by the practitioners in previous literature (Gonçalves *et al.*, 2019), namely availability, complexity and accessibility of information. Thus, the BPSC was developed as an online and mobile-friendly questionnaire, using a concise set of indicators that allow identifying priorities and opportunities for the redesign stage (Figure 2). As identified in previous assessment methods (Gonçalves *et al.*, 2021; Ornelas *et al.*, 2020; Living Future, 2019), the BPSC allows surveyors to assess the sustainability performance of each attribute through a 5-point Likert scale, providing more detail in the evaluation than “yes”/“no” questions in qualitative assessments (ISO, 2011).

All the core indicators were considered as mandatory prerequisites with equal levels of importance for the sustainability assessment. The Likert scale with five points (“no”, “mostly not”, “partially”, “mostly yes” and “yes”) was used to establish rules of normalisation, with the answer “no” rated as 1 point, and the answer yes rated as five-points. Even though no explicit weights were applied to prioritise some indicators over others, the fact that some building layers consist of more building attributes determines the implicit weight of the contribution of each layer for the overall assessment of sustainability. The final rating, consisting of a total of 270 available points, is presented in four categories with descriptive labels (see Table 1). Together with the descriptive label, the overall assessment presents a transparent identification of the building attributes with higher and lower scores.

4. Sustainability assessment of 20th century heritage: case studies

4.1 Presentation of the case studies

The BPSC was applied by Heritage and Architecture students in their design studios focussed on the revitalisation of 20th century heritage: the Priorij Emmaus, in Maarssen and the V&D department stores in Leiden, Haarlem and Maastricht.

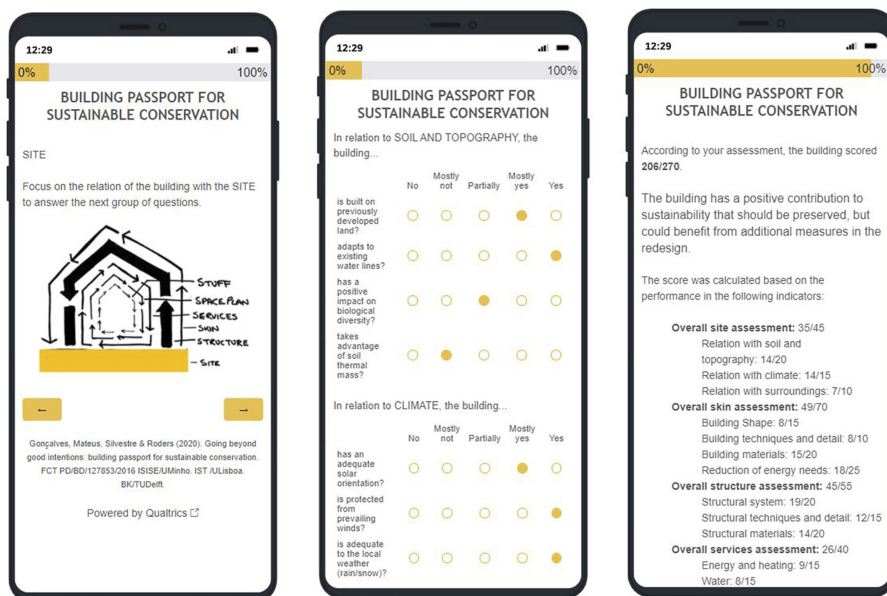


Figure 2. Mobile version of the BPSC of built heritage

Label	A	B	C	D
Description	The building has valuable contributions to sustainability that should be preserved in the redesign	The building has a positive contribution to sustainability that should be preserved but could benefit from additional measures in the redesign	Despite some positive aspects, the building offers some wider redesign opportunities to improve its performance regarding sustainability	The building presents some major issues that should be addressed in the redesign to improve its performance regarding sustainability
Points	217–270	163–216	109–162	1–108
% score	>80%	>60%	>40%	<39%

Table 1.
BPSC rating categories

The Priorij Emmaus is a monastery designed by architect Jan de Jong and built between 1964 and 1966 in Maarsse, in the province of Utrecht, in the Netherlands. It is an exemplary of post-war religious architecture, from the “De Bossche” school, characterized by sobriety and a strict system of proportions, the “plastic number”, based on ratios found in nature (Pilz and Bergsma, 2016). The building is understood as a part of Nature, aimed at providing shelter. It is a two-storey volume flowing around a courtyard and built against a slope, with one storey partially underground. It is mainly built with concrete, brick and wood, materials widely available in the Netherlands. The Priorij Emmaus was listed as a national monument in May 2016 (Rijksdienst voor het Cultureel Erfgoed, 2016).

The V&D buildings were department stores built by the Vroom and Dreesmann company, one of the largest chains of department stores in the Netherlands, founded in 1887 and bankrupt in 2016. During the 20th century, this commercial chain built large commercial buildings with rich ornamentation representing its corporate identity, all-over the Netherlands. The strategic location in the inner-city centres and the configuration as an urban landmark is characteristic of this typology (Witkamp *et al.*, 2021).

In Haarlem, the V&D department store was designed by Jan Kuijt in “De Amsterdamse” school style and built in 1934. In terms of materiality, the building results of a combination of concrete, limestone, red brick and stained glass. The eight storey-building is integrated in an urban fabric offers a contrast with an urban fabric on which small lots are predominant and is even one of the reasons the building was listed as national heritage, in November 1999 (Rijksdienst voor het Cultureel Erfgoed, 1999). In Leiden, the V&D department store was built in 1936, designed by the architects Leo and Jan van der Laan. It is built of concrete, limestone, and yellow brick. It is listed as national heritage since October 2000, as a representative of a department store of the 1930s in the traditionalist style (Rijksdienst voor het Cultureel Erfgoed, 2000). As the V&D in Haarlem, also the V&D in Maastricht was originally designed by Jan Kuijt, in 1932. Today the building results of a combination of interventions over time. The integration has a significant part of the urban fabric, the architectural integrity of the façade and the detailed ornamentation in limestone are some of the reasons for the classification as municipal heritage (Gemeente Maastricht, 2013).

4.2 Sustainability assessment of the Priorij Emmaus

The results of the application of the BPSC to the Priorij Emmaus building show consistency in the assessment by different users, with 53% of participants coinciding in the classification of the building in the second level of sustainability: “the building has a positive contribution to sustainability that should be preserved but could benefit from additional measures in the redesign”. The small standard deviation on the overall

assessment ($M = 2.58$; $SD = 0.69$) shows a good concentration of the values around the mean, which reflects low variability in respondents' assessments. Spirit of the place is the layer with more participants recognising positive contributions for sustainability that should be conserved (26.3% classification A; 63.2% classification B). In the opposite direction, the layer "Services" is classified as the least sustainable one by almost 80% of the respondents (68.4% classification C; 10.5% classification D), pointing the need to improve performance regarding sustainability. Table 2 shows the frequency of classifications according to building layers in the sustainability assessment of the case study.

Figures 3 and 4 presents a resulting BPSC of the Priorij Emmaus building, with the average results assessed by the participants. This assessment tool allows identifying major opportunities for the redesign of the building, and also valuable attributes to conserve for the future generation. In the layer "Services", the major issues of the building are related with the water management (collection, storage and reuse), while in the layer "Skin" participants reflect concerns related with energy needs (insufficient thermal insulation and protection of windows). The layer "spirit" is considered the one with more positive contributions for sustainability, namely by offering spaces for the community to gather and connect with local culture and traditions, and with the ecological features of the place. The interior-exterior relationships (in the "space plan" layer), the use of long-lasting and durable materials (in the "structure"), and the use of materials locally produced (in the "skin") are also valued as positive contributions for sustainability in the Priorij Emmaus building.

Being accessible online, in a computer or mobile format, this tool is easily accessible, and was applied by a total of 23 students within an average 30-min timeframe. The short time of the assessment process, however, is only possible if the work of research and documentation is previously conducted, informing the assessment. Thus, while technically the BPSC is applicable in *in situ* assessments, its accuracy relies on the collection and analysis of extra information through a desk-assessment process. The BPSC seems to be a positive contribution to summarize and qualitatively assess the sustainability level of the building, after research, as stated by the participants: "the tool was very useful as it is a very systematic approach to assess value across the different layers. The result of the questionnaire was very similar to what we had achieved with our manual value assessment, so it works rather well and a lot quicker".

4.3 Sustainability assessment of the V&D department stores

In the first application of the BPSC to the V&D department stores, without explanatory introduction to concepts and indicators, the three buildings (Leiden, Haarlem and Maastricht) achieved a classification B, recognising positive aspects that contribute to sustainability that should be preserved, while some fragilities need to be improved.

In the V&D Leiden the building shape, the techniques and detail (providing visual richness with a variety of textures and detailed ornaments), the place-based relationships (with connections to historic events and local identity) and the relation with the context and

	A (1)	B (2)	C (3)	D (4)
Site	0%	73.7%	15.8%	10.5%
Skin	0%	89.5%	0%	10.5%
Structure	0%	84.2%	5.3%	10.5%
Services	0%	21.1%	68.4%	10.5%
Space	10.5%	73.7%	5.3%	10.5%
Spirit	26.3%	63.2%	0%	10.5%
Overall	0%	52.6%	36.8%	10.5%

Table 2. Average frequencies of the sustainability rating of the building layers

BUILDING PASSPORT FOR SUSTAINABLE CONSERVATION

Building Identification



Building: Priorij Emmaus

Architect: Jan de Jong

Year: 1964

Function: monastery

Monument number: 53226

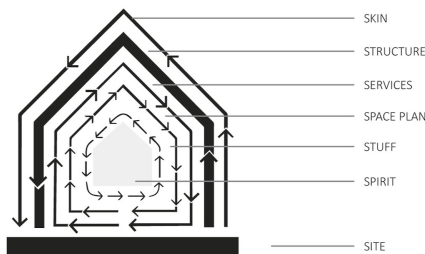
Status: national monument

Building Location



Diependaalsedijk, Maarsse, Utrecht, The Netherlands

Sustainability Assessment Summary



The most positive aspects are:

- the connection with local culture and traditions;
- the transitional spaces;
- the use of durable and long-lasting materials;
- the simplicity of the building structure.

The least positive aspects are:

- insufficient thermal insulation;
- lack of energy autonomy strategies;
- no rain water collection;
- no water treatment or reuse.

B

The building has a positive contribution to sustainability that should be preserved, but could benefit from additional measures in the redesign.

Figure 3. Front page of the BPSC of the Priorij Emmaus with the general rating, most positive aspects, and least positive aspects

BUILDING PASSPORT FOR SUSTAINABLE CONSERVATION

BPSC of built heritage



Figure 4. Back page of the BPSC of the Priorij Emmaus with detailed classifications per layer and indicator

surroundings (located in an inner-centre, contributing to increase urban density and ease access to diverse amenities) emerge as the main positive aspects. In the other hand, the materials in the skin layer (not reused, not recycled and considered not locally produced or low-transformed), the energy needs of the building (the inexistence of thermal insulation, double glazing or climate control strategies) and the water infrastructure (with no systems for water collection and reuse) are pointed out as the most negative ones. Despite the survey and analysis emphasising the significance of the V&D for Leiden's community in the past, the assessors rated the relation of the building with the community with a low score (8/15), since the building is currently vacant, and thus not accessible to the public.

In the V&D Haarlem the detailed ornaments on the façade are also rated as highly valuable. The space layout, in particular referring to the accessibility without barriers and the multifunctionality of the space, is also considered one of the positive aspects that should be preserved. As happened in the assessment of the V&D Leiden, the materials (both in skin and structure), the energy needs and the services have the lowest rating. But unlike V&D Leiden, in the V&D Haarlem the evaluators considered the relation with the community as a valuable aspect (12.5/15). In this case, the building was not assessed in its current situation but by the potential evidenced by its past situation, before vacancy.

Materials, services and relation with community were the lowest scored indicators in the V&D Maastricht, confirming the results in Leiden and Haarlem. The most positive aspects were the building shape (scale considered adequate to the function and costs), the structure (both the system resilience to natural hazards, durability and safety, and the details, showing evolutionary processes over time and adaptation to technical innovation), and the place-based relationships.

The three buildings share the same typological characteristics, such as scale, location in inner cities, materiality and rich ornamentation. In common the assessment of the three buildings highlights as most positive aspects the technique and details and the place-based relationships, while materials, energy needs and services appear as common priorities that should be addressed in future redesign interventions.

In the V&D Leiden, the two evaluators discussed the indicators and worked together in the assessment, resulting in very similar classifications (171/270, and 165/270), in the V&D Haarlem the two students analysed and assessed the building independently resulting in more discrepant results (166/270 – label B, vs. 122/270 – label C). In this case, the most different results appear in the indicators “relation with the context and surroundings”, “building shape”, “space layout” and “relation with community”. Variance in the assessment of the indicators is explained by different interpretations of the scope of application of the BPSC, focussing on the current state of the building or in the situation before vacancy (e.g. “relation with community”, “scale adequate for function”) or different interpretation of the meaning of the indicators. For instance, in the indicator “in relation the context and surroundings, does the building allow for easy access to basic services?” was correctly interpreted by one of the evaluators as the proximity to basic services in the surroundings but interpreted by the second evaluator as the basic services provided by the building to the surroundings. A third issue emerged in the filling of the questionnaire to assess the building's sustainability, illustrated in the layer “building shape” by the indicator “the scale is adequate for maintenance and operation costs”: when the necessary information to assess the indicator is lacking, the evaluators may assume subjective perspectives and assess the building based on assumptions (for instance, “the building is now vacant because it was too big to operate and maintain sustainably”).

The second application of the building passport, after an explanatory introduction of each indicator and the scope of the BPSC as a baseline assessment of the current situation, shows no relevant differences in the most positive and least positive layers and attributes of the building. In the V&D Haarlem, context and surroundings, detail and techniques in the layer

skin and place-based relationships are the most positive aspects identified; while materials, energy needs and water infrastructure remain as the least positive ones. The biggest differences between the before and after application of the BPSC emerged in the layers on which previously differences between evaluators were bigger, specifically: “relation with context and surroundings”, “building shape”, “space layout” and “community”, demonstrating that further clarifications of the indicators may be needed to ensure an objective assessment. The results show that after explanations on the scope of the tool and the indicators, the two evaluations were balanced and the differences between evaluators reduced, reaching a consensual level C (135/270 and 148/270), for the V&D Haarlem.

5. Discussion and conclusions

The application of the novel BPSC to the case studies showed that it successfully contributes to reveal the baseline characteristics of heritage buildings regarding sustainability while answering the challenges identified by practitioners in the field. The questionnaire format of the BPSC guides the user through complex issues using simple qualitative parameters that reflect the visible reality, minimising the dependence on expert technical skills, and, thus, the time and cost of the process.

Distributing the assessment indicators according to building layers, allows to ease the assessment process and to identify on which building attributes need to be targeted for improvement in future interventions. This tool also allows identifying the most positive contributions of the building for sustainability, establishing limits of acceptable change. By highlighting the most positive and the least positive aspects identified in the baseline situation, the BPSC allows systematising actionable information for the redesign processes.

The core set of indicators used is adequate for heritage buildings, allowing to recognise contributions to sustainability beyond materiality and environmental performance. By including indicators related to the three dimensions of sustainability – environmental, economic and social – but also related with aesthetic, craftsmanship and cultural identity, the BPSC allows to unveil a broader range of values of heritage buildings. In the case of the Priorij Emmaus building, the BPSC allows recognising the contribution of the building for community welfare, by providing spaces to gather and connect with others, emphasising the need to preserve the physical attributes that support intangible values. In the application of the BPSC in different V&D buildings results in common positive evaluations of the techniques and detail, relation with context and surroundings and place-based relationships, suggesting the potential of the BPSC to identify and characterise ensembles of heritage buildings with similar typological characteristics.

From the experimental applications of the BPSC three main potential limitations were thus identified, that may result in variability of results of the assessment: (1) misunderstanding the scope of application of the tool as a baseline assessment; (2) misunderstanding the meaning of indicators, requiring further explanations to the users; (3) the need to make assumptions, resulting from lack of information about the existing situation, requiring further desk work.

The results of the application of the BPSC confirm the contribution of this tool to reach consensual assessments of the contribution of heritage buildings for sustainability before interventions. The BPSC of built heritage provides a common language that can be used between different stakeholders and ensures that assessment of future (and past) interventions may be carried out in comparative terms, comparing the impact of the intervention with the performance of the initial situation.

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