Bachelor Thesis (LAS-MMW)

Final Version

The Sustainability of Certification Systems in the Building Sector

An evaluative study to the sustainability of certification systems in The Netherlands to label buildings on sustainability.

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Abstract

Increasing attention to sustainable development and sustainable practices led to the creation of various certification systems to assess and certify buildings and their surrounding environment upon sustainability. Despite some critics arguing about the vagueness of the concept, in practice common aspects are identifiable which fit the sustainability concept. Therefore, this study aims to provide insight into the extent to which certification systems actually consider these sustainable development aspects, while assessing buildings and their surroundings on sustainability. The indicators are identified from literature and aggregated into a conceptual model in several categories, i.e. issues (planet, people, prosperity), time and spatial dependency. Three widely used systems in The Netherlands are evaluated (GPR-*gebouw*, BREEAM-NL, LEED) and their websites and reports are analysed to do so. It is found that mainly the planet issue and time and spatial dependencies are considered, but the societal issues, i.e. people and prosperity, are lacking. It is recommended to pursue all the aspects, in order to strive for the twofold sustainable development agenda (ecological protection and societal equity) and to stimulate the built environment to act more sustainably. For further research it is advised to extend the scope to more used certification systems in different countries.

Keywords:

Certification system, sustainable development, indicator, planet, people, prosperity, time dependency, spatial dependency

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1. Introduction

In a world with an ever-growing population and a constant boundary of earth's natural resource capacity, it is becoming more and more important to act within these limits, i.e. to act sustainable. Blewitt (2014) states: 'Human actions have impacted seriously and negatively on our planet's ecosystems and will continuously do so, until we (humanity), do something about it.' These concerns in the last couple of decades led to the report *Our Common Future* by the World Commission on Environment and Development (WCED) or Brundtland Commission where the nowadays frequently used term sustainable development is introduced. According to the report, sustainable development 'seeks to meet the needs of the present without compromising those of the future' (Brundtland, 1987). In other words, act within the limits of the earth to prevent compromising the needs of the present and the future.

Nowadays, sustainability is becoming increasingly present in several sectors. The building sector, for example, receives increasing attention from world-wide and national policies for sustainable development. According to Berardi (2013), this attention is due to the substantial share of the total energy consumption and greenhouse gas emissions caused by the building sector in developed countries, 30% and 40% respectively. In the Netherlands, about 20% of all CO_2 emissions are emitted within the building sector (Vringer et al., 2016). This means that sustainability improvements in this sector are of great importance and can help towards sustainable development. In The Netherlands, sustainable building practices have a long history and the Dutch are one of the pioneers of using this concept. For example, due to the oil crisis in 1973, the political attention for these practices started to increase which led to the Dutch Energy Policy document in 1974 and some of the first subsidized sustainable buildings (Retzlaff, 2010). The constantly changing concept of sustainable building describes the development of this phenomenon. Whereas the concept was first related to some of the aspects of a building or home, it is now used as an integral concept: sustainable development of the whole built environment. Furthermore, according to Van Hal et al. (2000), the development of sustainable building practices is described as a process that started from idealistic ideas of pioneers to a concept in building policy and regulations that is indispensable.

As part of the developments in sustainable building practices, also assessment tools and certification systems were constructed. An assessment method is described as a 'technique that has assessment as one of its core functions but which may be accompanied by third-party verification before issuing a performance rating or label' (Cole & Valdebenito, 2013). In other words, these assessment methods could be used as a stand-alone method to assess the

sustainability of the built environment, but could also be used in a market-system to finally certify these buildings and label them as a 'sustainable building'. Often used systems in The Netherlands to assess and certify buildings are recognized as BREEAM-NL (Building Research Establishment Environmental Assessment Method), LEED (Leadership in Energy and Environmental Design) and GPR-*gebouw* (building) (*gemeentelijke praktijkrichtlijn)*. The various methods differ in approach and complexity to assess and certify buildings on sustainability (Zienergie, 2017). While GPR-*gebouw* is more a convenient design tool, BREEAM-NL is more complex.

Despite the already long persistent practices in the field of sustainable building in The Netherlands, there is still confusion about the meaning of sustainable development and what is meant by a sustainable building. According to Vermeulen (2017), this confusing is due to two reasons. First, sustainable development has to be described as 'the intended end-outcomes' (planetary- and human wellbeing) instead of mixing these with parameters describing means of policy inputs, throughputs and outputs. Secondly, it is due to the use of incorrect and misrepresenting various economic parameters. Furthermore, Berardi (2013) states: 'In the past, it was considered an objective and clear concept based on scientific evidence and consensus, whereas recently it has more often been reinterpreted as relative, socially rooted and contextually dependent.' He also states that the definition of a sustainable building is difficult, because of the time, scale, domain and social dependencies, which increases uncertainties. Considering these discussions nowadays, it is unclear how well the assessment methods to certify buildings on sustainability, actually fit the concept of sustainable development.

The purpose of this study is therefore to assess how well the currently used certification systems in The Netherlands to certify buildings on sustainability fit the sustainable development criteria and to identify critical aspects where potential improvements are possible. The study will focus on the three often used systems in The Netherlands. These are: GPR-g*ebouw*, BREEAM-NL and LEED. There are many aspects of buildings to assess, but the study will focus mainly on the systems for assessing and certifying whole buildings and their interconnected environment, because of the ongoing discussions about the definition of a sustainable building, instead of specifically building materials. By evaluating these three systems, a general overview of the certification systems to certify the built environment can be given, because BREEAM-NL is mainly used for utility building, LEED for companies and GPR-*gebouw* for housing (Bouwend Nederland, 2017; Troldtekt, 2017).

The study has been done to answer the following research question: '*To what extent do the currently used certification systems in The Netherlands, for assessing and certifying buildings and their surrounding environment on sustainability, fit the criteria of sustainable development?'* To acquire correct answers to this question, the study is done in twofold. First, an overview of the most widely used systems in The Netherlands to assess and certify buildings on sustainability is given. Secondly, the certification systems are seen over time and evaluated upon the sustainable development criteria, which result in possible future improvements.

By obtaining an answer to this question, the scientific knowledge about these certification systems and the concept of sustainable building could be expanded. This can result in certification systems that suit the sustainable development aspects more appropriately and therewith may help the built environment to become more sustainable. Namely, labeling programs seek to first, stimulate more environmentally friendly consumption patterns and second, to encourage 'productive structures, governments and other agents to increase the environmental standards of the products and services in the economy' (Galarraga Gallastegui, 2002).

2. Theoretical Framework

Based on a literature study to the meaning of the concept sustainable development and the characteristics of a sustainable building, various critical aspects could be found to help evaluating the different certification systems. Vermeulen (2017) argues in his article 'Substantiating the rough consensus on the three-dimensional concept of sustainable development as point of departure for indicator development' that in practice there is actually consensus about the concept sustainable development, despite the judgements of vagueness. He has mainly elaborated on three issues of sustainability, on how to reframe people, planet and profit (PPP) or social, ecological and economic (SEE) to planet and societal issues (people and prosperity). In this way, these could help to meet the original twofold meaning of sustainable development, namely fair equitable societal development and ecological precaution. Furthermore, Berardi (2013) has elaborated on the recent interpretations of sustainable development and a sustainable building in his article 'Clarifying the new interpretations of the concept of sustainable building.' In this article, he argues that sustainable development also include time and spatial dependencies, especially in the case of buildings.

The concept of sustainable development has to be seen as an 'integral ecological and societal fairness agenda', because they are equally important, mutually dependent and reinforcing (Vermeulen, 2017). To realize this integrality it is important to take into account the concept of system thinking, which will be discussed below. With this in mind, various aspects of sustainable development and thereby sustainable buildings will be discussed and merged into a conceptual model which helps to evaluate the different certification systems on sustainable development. The articles of Vermeulen and Berardi complement each other by the fact that Vermeulen elaborate mainly in general on the three issues of sustainable development, while Berardi add two more concepts to sustainable development which he applies to buildings.

2.1. System Thinking

By elaborating on the concept of sustainable development, it is important to take into account the concept of system thinking. Various definitions are given to this concept. According to Richmond and Peterson it is defined as 'looking at the big picture, while maintaining awareness of the interconnectedness of the components of the big picture' (Kelly, 1998). Senge defines it as 'a discipline for seeing structures that underlie complex situations' (Moore & Ausley, 2004). In other words, system thinking means thinking critically about the complex structures of the world and their relations which make up the system as a whole. The concept is already often

applied in the building sector, mainly within tools as Life Cycle Assessments (LCAs). Curran states: 'The most appropriate method for a holistic assessment is LCA, a systematic study of the life cycle and supply chain environmental effects of products, processes and services (Ortiz et al., 2009).

Thinking in terms of systems is important when defining sustainable development as a concept and indicators which can lead to this, because it encompasses multiple interconnected aspects which will be discussed below. Furthermore, when system thinking is applied sufficiently in working towards sustainable development in the built environment, the aspects discussed below have to be considered.

2.2. PPP/Triple P's

According to Vermeulen (2017), sustainability includes three issues (planet, people and prosperity). These issues has been constantly framed differently during history, which has created confusion about the sustainable development concept, especially the 'prosperity' term. After Elkington's book *Cannibals with forks* in 1998, about business behavior and their unsustainable practices, the framing of people, planet, profit became popular. The main point in this framing was, that economic decision-making had to be extended with considerations of environmental and social impacts (Fisk, 2010). But with the term profit as one of the sustainability issues, profit-making was put at the same outcome level as the environmental and social aspects, which distorted the original twofold framing of sustainable development discussed above. The framing of social, environmental, economic (SEE) also created confusion, because the term economic is often related to concepts of economic growth (Epstein & Buhovac, 2014). Vermeulen (2017) states: 'Any costs made in production, profits resulting from it and even the resulting economic growth in itself, are not elements of sustainable development.' In other words, any elements of internalities (all costs and benefits that are linked to goods and services brought on the market) do not relate to societal fairness and ecological protection and therefore not to sustainable development (Vermeulen, 2017).

Because of this confusion discussed above and incorrect use of economic parameters, the term prosperity as one of the sustainability issues has been proposed (European Commission, 2002; General Assembly UN, 2015; Vermeulen, 2017). This term refers to the 'macro-economic institutions that are essential for creating fair development' (Vermeulen, 2017). These are political institutions which enable an open political system, fair taxation, distributional systems and rules for free association. Furthermore, critical economic institutions

do relate to property rights and land and resource ownership, price formation and open markets and rights of workers and consumers. The reason behind this, is that inclusive political institutions combined with inclusive economic institutions are required to achieve development towards prosperity (European Commission, 2002; General Assembly UN, 2015; Vermeulen, 2017). Key issues of sustainability which could promote the core meaning of sustainable development (integral ecological and societal fairness) are therefore planet, people and prosperity.

To evaluate projects on these sustainability issues there is need for specific indicators as measurements, otherwise subjectivity and ambiguity will hamper the credibility of the evaluation. Indicators are 'well-justified measurements, representing a wider complexity in reality, but based on a convincing reasoning assumed to be valid for describing that complex reality' (Vermeulen, 2017). In other words, indicators help to grasp the complex reality of the world and therefore, to pursue system thinking. These are integrated as mid-points of the three issues that eventually should lead to two areas of protection via end-points which can lead to the twofold sustainable development agenda (planetary and human well-being). In figure 1 below, the integrated model is shown.

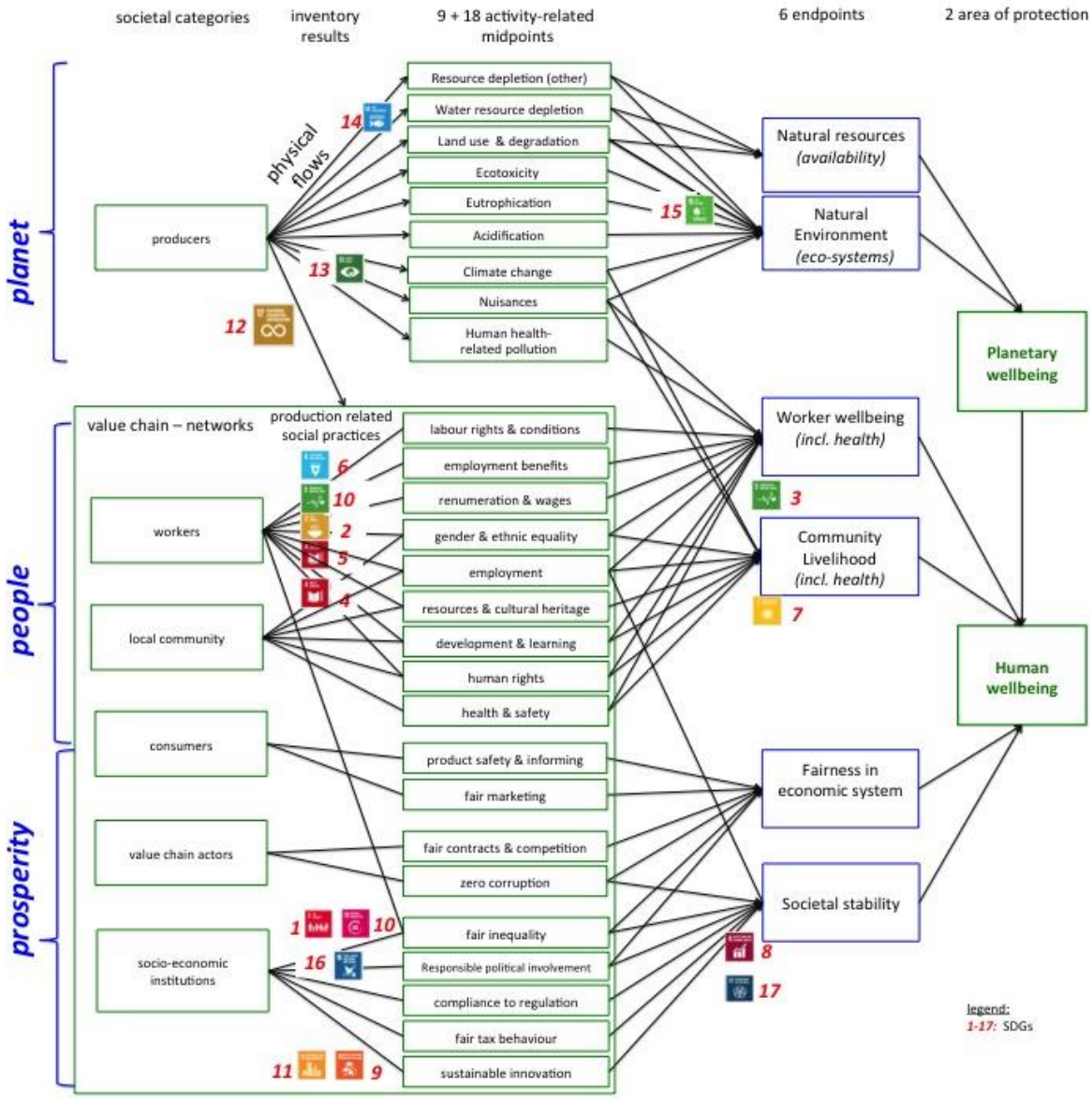

Figure 1: Integrated indicators for three sustainability issues (Vermeulen, 2017).

2.3. Time and spatial dependencies

According to Berardi (2013), sustainability comprises, besides the previous discussed issues, time and spatial dependencies. When looking at the definition of sustainable development from the Brundtland Commission in 1987, described in the introduction, it is clear that the term comprises intergenerationality and therefore, a long term perspective is necessary. But how further we look in time, the more uncertainty arises. Next to that, the concept of sustainability is constantly evolving and evaluated in one time frame, which requires an 'adaptive flexibility according to the available knowledge at any given time' (Berardi, 2013). This is called the *time dependency* of sustainability. This means that certification systems have to be adaptable to the most recent knowledge of the time frame of evaluation and that buildings also have adaptable

properties. When taking into account the time dependency of sustainability, buildings could 'increase the resilience of the built environment by adapting to the metabolism of its context' (Berardi, 2013 (a)). Besides that, there is *spatial dependency*, which represents the fact that sustainability is locally specific or locally interpreted. But the interconnections of systems, people and markets is the opposite of this local perspective. Besides, the impacts of actions span from local scale to global ones. Therefore, sustainability has to be evaluated constantly at several scale levels. In the case of sustainable buildings, the interconnections between the building and its environment requires that the scale of evaluation has to be determined case by case and that these interconnections are indispensable in sustainable buildings (Berardi, 2013 (a)). To make it more clear, a high skyscraper built in the desert can be evenly unsustainable as an ecological product that is promoted far from its production site.

2.4. Conceptual model

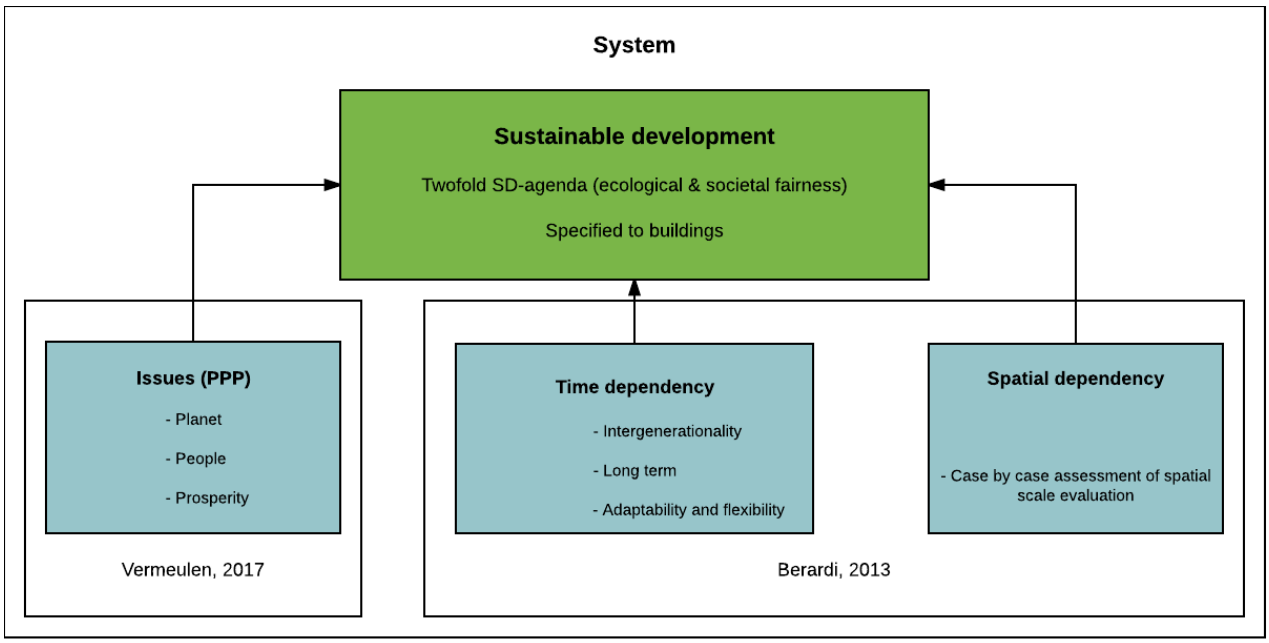

Figure 2: Conceptual model: sustainable development in building sector

In the conceptual model of figure 2 above, the various aspects of sustainable development and sustainable buildings, discussed above, are merged together. This aggregation is done for several reasons. First, working towards sustainable development requires to apply system thinking, because of the complex, multiple aspects. Second, this model is used for evaluating certification systems that certify buildings and their environment and therefore, sustainable development aspects including specifications to the built environment are included.

3. Methodology

For this thesis, an evaluative, qualitative case study is done to examine to what extent three implemented certification systems in The Netherlands for labelling buildings on sustainability actually fit the sustainable development criteria for buildings and which developments they have had. According to Baxter & Jack (2008) a case study approach is an appropriate research method when the behaviour of the object of study could not be manipulated, which is the case in this research. For conducting the study, three certification systems are examined: BREEAM-NL, LEED and GPR-*gebouw*, whereby the case is 'a phenomenon of some sort occurring in a bounded context', i.e. The Netherlands (Baxter & Jack, 2008).

These systems are chosen for several reasons. First, they are all used for different purposes, whereas BREEAM-NL is mainly used for utility building, LEED for companies and GPR-*gebouw* for housing (Bouwend Nederland, 2017; Troldtekt, 2017). Second, Although there are many certificates for various aspects of buildings, for example building components and phases, such as Fair Stone and Forest Stewardship Council's labels, this study has focused on integrated certificates of whole buildings and its relation with the surrounding environment (International Trade Centre, 2015). Lastly, many international integrated certification systems exist, such as Green Globes and Living Building Challenge, but the study focused on systems used in The Netherlands (Vierra, 2016). For these reasons, the mentioned systems are chosen to give a general evaluation of the most important integrated certification systems used in The Netherlands, to assess and certify buildings on sustainability.

For this research, it was a necessity to find general and detailed information about the workings of the three systems, which are gained by analyzing literature. This information was mainly found in grey literature, such as the general websites of these systems and their reports. Besides, information on the framings of the sustainable development criteria and specifics for buildings had to be gained. Therefore, scientific, peer-reviewed articles, books and grey literature were investigated to obtain information about these topics.

For the analysis of the found data, indicators were defined to operatize the data. The kind of data that was searched for resulted from the conceptual model described above in figure 2. This is about the performances of the certification systems on taking into account the three issues of sustainability (planet, people and prosperity) and time and spatial dependencies. The three issues are operatized by using indicators, which are discussed as the mid-points in figure 1 above. For operatizing the time and spatial dependency aspects, the performances of the

systems are discussed based on taking into account adaptability and flexibility in these systems and the buildings they certify. Furthermore it is discussed to what extent these systems take into account the spatial scale dependency by considering the surrounding environment in case by case evaluations. The results are shown in a table of evaluation as in the example of table 1 below, whereby the check mark means that the system considers the indicator measurement and the cross mark that no information was found about the indicator measurement. When no information was found, it is assumed that the system does not consider the indicator measurement.

Three certification systems				
Evaluation category	**Indicator measurement**	**GPR-*gebouw***	**BREEAM-NL**	**LEED**
People	Labour rights & conditions	✗	✓	✗

Table 1: Example three certification systems SD evaluation table

By having find these results, the different certification systems are relatively compared with each other on fitting the sustainable development criteria appropriately. Furthermore, developments throughout the history of each of the systems were taken into account to see what changes these systems have had and to formulate a possible future for the systems. This was done by comparing the different updates of these systems found in their archives.

4. Results

In this chapter, the results of the study to the three certification systems are given. Per system, an overview is given of the origin and working of the system which results in a table to evaluate the compliance with the sustainable development criteria discussed in the theoretical framework throughout history. After that, the tables are discussed and the three systems are compared with each other.

4.1. Overview of the systems

In table 2 below, the general characteristics of each of the certification systems are given.

Overview of systems			
System	**Developer**	**Year of development**	**Categories of assessment**
GPR-*gebouw*	W/E *adviseurs* (advisors)	1995	Energy, Environment, Health, User quality, Future value
BREEAM-NL	British Research Establishment. Incorporated in Holland by the Dutch Green Building Council.	2009	Management, Health, Energy, Transport, Water, Materials, Waste, Land use & Ecology, Pollution, Area management, Synergy, Sources, Spatial development, Welfare & Prosperity, Area climate
LEED	US. Green Building Council	2000	Integrative process, Location & Transportation, Sustainable sites, Water efficiency, Energy & Atmosphere, Materials & Resources, Indoor environmental quality, Innovation, Regional priority

Table 2: Overview of three certification systems

First, GPR-*gebouw* is developed by W/E *adviseurs* (advisors) in 1995, which is a consultancy company for sustainability in buildings, real estate and area development. It is developed for municipalities and regions, corporations, property owners, architects, consultants and project developers and care institutions (GPR software, 2017). The approval of a certificate has to be done by an expert or assessor (GPR software, 2017 (a)). The assessment is done in five themes, which represent their vision of sustainability according to their website: energy and environment (planet), health and user quality (people) and future value (profit) (GPR software, 2017 (b)). In the energy theme, energy efficiency is measured during the use phase of

a building by means of the EPC (energy performance coefficient). The EPC measures the performance based on building characteristics, installations and user behavior (RVO, 2017). The energy use during the production and demolition of the building materials are addressed in the environment theme. To assess the environmental performance of buildings, the *bepalingsmethode milieuprestatie gebouwen en GWW- werken* is used, which is a calculation method to assess the environmental performance of buildings during its life cycle using life cycle assessment (LCA). Health relates to: nuisance, air quality, thermic comfort and visual/light comfort, whereas user quality refers to the accessibility of the building, functionality, technical quality of building components, installations and facilities and the social quality, e.g. social safety. Lastly, future value represents future-proof facilities with sustaining quality, flexibility according to societal developments and the experience value of the building and its direct surrounding environment and visible sustainability systems for educational purpose.

Second, BREEAM-NL provides four different certificates: BREEAM-NL New building & Renovation for the assessment of newly built buildings since 2009, BREEAM-NL In-Use for the assessment of existing buildings on three levels since 2011: building, management and use. BREEAM-NL Area Development is used for the assessment of an area development since 2011. Lastly, BREEAM-NL Demolition & Dismantling is used to assess demolition projects since 2013. Because this certificate only certifies demolition processes instead of whole buildings and their surroundings, the study has left out this certificate for evaluation. When buildings are not in one of these categories, they could be assessed with a customized project named BREEAM-NL Bespoke (BREEAM-NL, 2017). The method is first developed by an English research centre named Building Research Establishment. The complete definition of the method is as follows: Building Research Establishment Environmental Assessment Method. The Dutch Green Building Council has made the method suitable for the Dutch market, hence the NL abbreviation (BREEAM-NL, 2017). BREEAM-NL pursues harmonisation, hence the certificates provide insight in the sustainability of projects internationally (BREEAM-NL, 2017 (a)). The sustainability performance of buildings is assessed using various credits (subjects) in different categories: management, health, energy, transport, water, materials, waste, land use & ecology, pollution, area management, synergy, sources, spatial development, welfare and prosperity and area climate (DGBC, 2012, DGBC, 2014; DGBC, 2016).

Lastly, LEED (Leadership in Energy and Environmental Design) is developed by the U.S. Green Building Council since 2000 and is made with the perspective to certify all sorts of

buildings, regardless in what phase of development the building is. Therefore, projects could by certified upon building design and construction, interior design and construction, building operations and maintenance, neighbourhood development and homes. Furthermore, LEED is a globally used certification system with projects in approximate 160 countries. (USGBC, 2017; USGBC, 2017 (a)). In LEED v4, the newest version of the system, projects are certified by gaining points in nine basic areas: integrative process, location & transportation, sustainable sites, water efficiency, energy & atmosphere, materials & resources, indoor environmental quality, innovation and regional priority (USGBC, 2017 (a); USGBC, 2017 (b)). These are now briefly discussed:

Integrative Process (IP): early analysis of the interrelationships among systems to support high-performance, cost-effective project outcomes.

Location and Transportation (LT): considers the existing features of the surrounding community and how this infrastructure influences occupant's behaviour and environmental performance.

Sustainable Sites (SS): focuses on restoring project site elements, integrating the site with local and regional ecosystems and preserving the biodiversity where natural systems rely on.

Water Efficiency (WE): addresses water holistically, taking into account indoor use, outdoor use, specialized uses and metering.

Energy and Atmosphere (EA): approaches energy from a holistic perspective, addressing energy use reduction, energy-efficient design strategies and renewable energy sources.

Materials and Resources (MR): focuses on minimizing the embodied energy and other impacts associated with the extraction, processing, transport, maintenance and disposal of building materials and considers a life-cycle approach.

Indoor Environmental Quality (EQ): addresses the various strategies and factors, air and lighting quality, acoustic design, control of one's surrounding, that influence the way people live, work and learn.

Innovation (IN): recognizes projects for innovative building features and sustainable building strategies and practices.

Regional Priority (RP): identifies distinct environmental priorities in areas to enhance the ability of project teams to address critical environmental issues.

4.2. Evaluation

The tables 3-5 below show to what extent each of the three certification systems comply with the sustainable development criteria discussed previously in the theoretical framework. Per system, various updates are given to examine the progressiveness in complying with the criteria. Table 6 shows the compliancy to the indicators of the three systems in their most recent version, combined in one aggregated table to compare.

GPR-*Gebouw*				
Evaluation category	**Indicator measurement**	**v4.1**	**v4.2**	**v4.3**
Planet	Resource depletion (other)	✓	✓	✓
	Water resource depletion	✓	✓	✓
	Land use & degradation	✓	✓	✓
	Ecotoxicity	✓	✓	✓
	Eutrophication	✓	✓	✓
	Acidification	✓	✓	✓
	Climate change	✓	✓	✓
	Nuisances	✓	✓	✓
	Human health-related pollution	✓	✓	✓
People	Labour rights & conditions	✗	✗	✗
	Employment benefits	✗	✗	✗
	Remuneration & wages	✗	✗	✗
	Gender & ethnic quality	✗	✗	✗
	Employment	✗	✗	✗
	Resources & cultural heritage	✗	✗	✗
	Development & learning	✗	✗	✗
	Human rights	✗	✗	✗
	Health & safety	✓	✓	✓
	Product safety & informing	✓	✓	✓
	Fair marketing	✗	✗	✗
Prosperity	Fair contracts & competition	✗	✗	✗
	Zero corruption	✗	✗	✗
	Fair inequality	✗	✗	✗
	Responsible political involvement	✗	✗	✗
	Compliance to regulation	✓	✓	✓
	Fair tax behaviour	✗	✗	✗
	Sustainable innovation	✓	✓	✓
Time dependency	Adaptability & flexibility	✓	✓	✓
Spatial dependency	Case by case evaluation of spatial scale	✗	✗	✗

Table 3: GPR-*gebouw* SD evaluation table

BREEAM-NL							
Evaluation category	**Indicator measurement**	**New & Renovation**		**In-Use**		**Area development**	**Total**
		v1.01	**v2**	**v1 old**	**v1 new**	**v1**	**All certificates**
Planet	Resource depletion (other)	✓	✓	✓	✓	✓	✓
	Water resource depletion	✓	✓	✓	✓	✓	✓
	Land use & degradation	✓	✓	✓	✓	✓	✓
	Ecotoxicity	✓	✓	✓	✓	✓	✓
	Eutrophication	✓	✓	✓	✓	✓	✓
	Acidification	✓	✓	✓	✓	✓	✓
	Climate change	✓	✓	✓	✓	✓	✓
	Nuisances	✓	✓	✓	✓	✓	✓
	Human health-related pollution	✓	✓	✓	✓	✓	✓
People	Labour rights & conditions	✗	✗	✓	✓	✗	✓
	Employment benefits	✗	✗	✗	✗	✗	✗
	Remuneration & wages	✗	✗	✗	✗	✗	✗
	Gender & ethnic quality	✗	✗	✗	✗	✗	✗
	Employment	✗	✗	✗	✗	✓	✓
	Resources & cultural heritage	✗	✗	✗	✗	✓	✓
	Development & learning	✗	✗	✗	✓	✗	✓
	Human rights	✗	✗	✓	✓	✗	✓
	Health & safety	✓	✓	✓	✓	✓	✓
	Product safety & informing	✓	✓	✓	✓	✓	✓
	Fair marketing	✗	✗	✗	✗	✗	✗
Prosperity	Fair contracts & competition	✗	✗	✗	✗	✗	✗
	Zero corruption	✗	✗	✗	✗	✗	✗
	Fair inequality	✗	✗	✗	✗	✗	✗
	Responsible political involvement	✓	✓	✓	✓	✓	✓
	Compliance to regulation	✓	✓	✓	✓	✓	✓
	Fair tax behaviour	✗	✗	✗	✗	✗	✗
	Sustainable innovation	✓	✓	✓	✓	✓	✓
Time dependency	Adaptability & flexibility	✓	✓	✗	✓	✓	✓
Spatial dependency	Case by case evaluation of spatial scale	✓	✓	✓	✓	✓	✓

Table 4: BREEAM-NL SD evaluation table

LEED				
Evaluation category	**Indicator measurement**	**v2**	**v3**	**v4**
Planet	Resource depletion (other)	✓	✓	✓
	Water resource depletion	✓	✓	✓
	Land use & degradation	✓	✓	✓
	Ecotoxicity	✓	✓	✓
	Eutrophication	✓	✓	✓
	Acidification	✓	✓	✓
	Climate change	✓	✓	✓
	Nuisances	✓	✓	✓
	Human health-related pollution	✓	✓	✓
People	Labour rights & conditions	✗	✗	✗
	Employment benefits	✗	✗	✗
	Remuneration & wages	✗	✗	✗
	Gender & ethnic quality	✗	✗	✗
	Employment	✓	✓	✓
	Resources & cultural heritage	✓	✓	✓
	Development & learning	✗	✗	✗
	Human rights	✗	✗	✗
	Health & safety	✓	✓	✓
	Product safety & informing	✗	✗	✗
	Fair marketing	✗	✗	✗
Prosperity	Fair contracts & competition	✗	✗	✗
	Zero corruption	✗	✗	✗
	Fair inequality	✗	✗	✗
	Responsible political involvement	✗	✗	✗
	Compliance to regulation	✓	✓	✓
	Fair tax behaviour	✗	✗	✗
	Sustainable innovation	✓	✓	✓
Time dependency	Adaptability & flexibility	✓	✓	✓
Spatial dependency	Case by case evaluation of spatial scale	✓	✓	✓

Table 5: LEED SD evaluation table

Three certification systems				
Evaluation category	**Indicator measurement**	**GPR-*gebouw***	**BREEAM-NL**	**LEED**
Planet	Resource depletion (other)	✓	✓	✓
	Water resource depletion	✓	✓	✓
	Land use & degradation	✓	✓	✓
	Ecotoxicity	✓	✓	✓
	Eutrophication	✓	✓	✓
	Acidification	✓	✓	✓
	Climate change	✓	✓	✓
	Nuisances	✓	✓	✓
	Human health-related pollution	✓	✓	✓
People	Labour rights & conditions	✗	✓	✗
	Employment benefits	✗	✗	✗
	Remuneration & wages	✗	✗	✗
	Gender & ethnic quality	✗	✗	✗
	Employment	✗	✓	✓
	Resources & cultural heritage	✗	✓	✓
	Development & learning	✗	✓	✗
	Human rights	✗	✓	✗
	Health & safety	✓	✓	✓
	Product safety & informing	✓	✓	✗
	Fair marketing	✗	✗	✗
Prosperity	Fair contracts & competition	✗	✗	✗
	Zero corruption	✗	✗	✗
	Fair inequality	✗	✗	✗
	Responsible political involvement	✗	✓	✗
	Compliance to regulation	✓	✓	✓
	Fair tax behaviour	✗	✗	✗
	Sustainable innovation	✓	✓	✓
Time dependency	Adaptability & flexibility	✓	✓	✓
Spatial dependency	Case by case evaluation of spatial scale	✗	✓	✓

Table 6: Three certification systems SD evaluation table

First, it can be recognized that GPR-*gebouw* considers all the criteria that belong to the planet issue. Probably, because it uses the *bepalingsmethode milieuprestatie gebouwen en GWW-werken* (method of determination of environmental performance of buildings and land-, road- and waterworks) as method to assess the environmental impact of buildings, which considers all these criteria during the whole life cycle, using life cycle assessment as starting point (SBK, 2011; GPR Gebouw Handleiding, 2017). Furthermore, the people issue is poorly considered: only the criteria health & safety and product safety & informing are addressed.

Reduction of noise pollution in- and outside and between buildings is, for example, one of the aspects with they consider (GPR Gebouw Handleiding, 2017 (a)). Also, the prosperity issue is insufficiently addressed. It only considers the compliancy with regulation and to what extent sustainable innovation is stimulated besides the regular aspects of evaluation. The compliancy to regulation is addressed by considering the standards of *het Bouwbesluit*, which are minimum regulations for health, safety, environment, energy efficiency and functionality (GPR Gebouw Handleiding, 2017 (b); Rijksoverheid, 2017). GPR-*gebouw* addresses the time dependency by considering future-proof buildings, but lacks in considering the spatial dependency by only considering the scale of the building itself (GPR Gebouw Handleiding, 2017 (c)).

Second, BREEAM-NL is also doing well in addressing the planet issue. Probably, because it also considers the *bepalingsmethode milieuprestatie gebouwen en GWW-werken* (DGBC, 2014). Furthermore, it considers more criteria of the people issue than GPR-*gebouw* by also explicitly mentioning the labour rights and conditions and human rights and taking into account cultural heritage and employment possibilities of the local community. The guideline states for example, in sustainable purchasing both environmental and social aspects are important and addressed, e.g. working conditions and human rights (DGBC, 2016). Also, cultural heritage is taken into account in area development by identifying, conserving and strengthening cultural historic valuables (DGBC, 2012). Furthermore, development and learning is addressed by examining the existence of formal meetings to discuss sustainability aspects (DGBC, 2012). The prosperity issue is poorly addressed, except for the fact that responsible political involvement is considered besides compliance to regulation and sustainable innovation by engaging with important stakeholders, e.g. local governments, to stimulate the local involvement and gain optimal assessments (DGBC, 2014). BREEAM-NL does consider the time and spatial dependency aspect by for example, taking into account the surrounding environment of the building of assessment.

Lastly, LEED also addresses all the planetary criteria. Next to that, it addresses the people issue insufficiently: only employment for the local community, cultural heritage and health & safety are addressed. The guideline states that LEED is encouraging ‘balanced communities with a diversity of uses and employment opportunities’ (USGBC, 2017 (c)). Furthermore, LEED also lacks in considering the prosperity issue: it only considers compliance to regulation and sustainable innovation. It does considers the time and spatial dependency aspects by taking into account adaptable buildings and the best spatial scale to certify,

respectively. From table 5 it can be seen that the evaluation started from version 2, because version 1 only was a pilot version.

From table 3 to 5 above, it can be seen that only BREEAM-NL had some progression in complying to the sustainable development criteria. On the one hand, from the analysis of the GPR-*gebouw* and LEED versions it resulted that these systems mainly had design adjustments and stricter criteria in their assessment categories between different versions, but that they did not comply with more sustainable development criteria throughout time. For example, they aggregated some criteria to be more holistic and clear. Furthermore, LEED also increased their percentage to reduce environmental harm, which are to be met before complying with their criteria. On the other hand, BREEAM-NL made some progression in complying with the criteria from the people issue, e.g. it considers labour rights & conditions, development & learning, human rights, employment of the local community and cultural heritage, which it did not consider in earlier versions. But after all, sufficient progression is lacking in all the certification systems.

Furthermore, it is notable that all three systems consider the compliancy with regulation. GPR-*gebouw* and BREEAM-NL are taking into account the previously mentioned *Bouwbesluit* when assessing buildings on sustainability, which are minimum requirements for buildings. BREEAM-NL is often called an above the law certification system, because its sustainable goals are more ambitious than the minimum regulations imposed by the government (DGBC, 2014). LEED certification also implies an above the law or above-code certification system and it supports to align the baseline-code with the more above-code goals (USGBC, 2017 (d)). Next to that, it is also notable that all three systems address sustainable innovation by providing more points for innovative buildings, i.e. with features which are not precisely considered by the assessment categories of the systems.

5. Conclusion and discussion

This paper started by highlighting the importance of certification systems to assess and certify buildings on sustainability to execute in accordance with clear sustainability criteria, since many debates about the vagueness of the concept. Multiple categories which include indicators, were identified from literature that fit the original twofold sustainable development concept: ecological protection and social equity. These were aggregated into a conceptual model to be used for the built environment: planet, people, prosperity, time and spatial dependency. Data collection was done by executing a qualitative case study to the workings of three certification systems (GPR-*gebouw*, BREEAM-NL and LEED) by analysing the systems' websites and reports. With the obtained results, the following research question could be answered: '*To what extent do the currently used certification systems in The Netherlands, for assessing and certifying buildings and their surrounding environment on sustainability, fit the criteria of sustainable development?'* In short, emphasis by all three certification systems is mainly given to the planet issue. Although, the people and prosperity issues are underrepresented, BREEAM-NL has made progression, mainly in addressing the people issue. Time and spatial dependencies are considered by all three systems, except for spatial dependency by GPR-*gebouw*.

With these results, it is clear that the twofold sustainable development agenda is implemented in a skewed way in these systems, because more emphasis is given to the planetary issues than societal issues. To pursue sustainable development sufficiently, it is argued that it has to be seen as an 'integral ecological and societal fairness agenda', because they are equally important, mutually dependent and reinforcing, which is well recognized in the supranational policy debates (Vermeulen, 2017). Therefore, these systems have to find ways to address sustainable development in a more integrative way while assessing and certifying buildings, to stimulate the built environment to act in a more sustainable way.

One way to achieve this, is to plead for stricter standards and norms in policy making, because government regulation is one of the factors which stimulate innovation. Government regulation is often used to compensate market failures in achieving 'socially desirable objectives, which can range from international competitiveness to environmental transformation' (Beerepoot & Beerepoot, 2007). The results show that all three certification systems address the compliancy to regulation and therefore, with stricter government regulations, sustainable innovations in buildings and their surrounding environment have to be made in order to achieve certificates. Furthermore, to address more criteria which belong to societal issues, e.g. fair contracts & competition, zero corruption, fair inequality, remuneration

& wages and labour rights, these processes have to be assessed back further in the value chain. For example, the organization Transparency International (TI) made a corruption index, which states that The Netherlands are fairly incorrupt in contrast with most of the other countries over the world (Ortiz-Ospina & Roser, 2016). Due to globalization many processes play a role in different parts of the world, such as constructing building parts. For that reason it is important to analyze and assess these processes in those regions to get a sufficient overview of the sustainability of a building and its surroundings, i.e. system thinking.

Despite the findings of this evaluative study, also some limitations are noticeable. First, the three certification systems have their own categories of assessment and present and explain their workings all in their own way at their websites and in their reports. This made it sometimes unclear which sustainable development indicators they addressed for what purposes and therefore, the preciseness of the results could be affected. Therefore, it would help if these systems are more in harmonization. Second, due to the fact that this study was a case study to three certification systems used in The Netherlands, generalization to other systems in different countries is inconvenient. However, the method used in this study and the recommendations which are given could be used to assess other certification systems.

This study provides first insight in the way three used certification systems in The Netherlands define sustainability and to what extent the implementation of this formulation fit the sustainable development concept according to literature. It would be useful to conduct a comparable research in a more elaborate way by evaluating more certification systems used in different countries. This would give a more general view of the used systems all over the world to evaluate buildings and their surrounding environment which could be compared with each other to identify critical aspects to improve and harmonize.

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