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Categorizing Building Certification Systems According to the Definition of Sustainable Building

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Categorizing Building Certification Systems According to the Definition of Sustainable Building

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Abstract. The availability of sustainable (or green) building certifications schemes is constantly increasing and it is not always easy to understand how the schemes on the market differentiate from each other. The purpose of this study is to create a better dialog between client and consultant in relation to building certification systems. Here it is relevant to give an overview and understanding of selected certification systems, and how they fulfil the definition of sustainable buildings. There is a great variation of how certification systems are structured and evaluated. Furthermore, "sustainability" is a word with many meanings and definitions, which is why sustainable certifications will also vary. In this study, certification schemes are categorized using a definition of sustainable buildings. This definition consists of a social, environmental and economic dimension of sustainability and in total 13 subcategories. The subcategories are based on recent years' publications concerning sustainable buildings from the Danish Building Research Institute and the Danish Transport and Construction Agency, which leans on the European CEN TC/350 standards for sustainable buildings. The certification schemes analysed are both of international, regional and local scale (Active House, BREEAM, DGNB, Green Star, HQE, LEED, Living Building Challenge, Miljöbyggnad, Nordic Ecolabel and WELL). The results show a large variation of the weight on the dimensions of social, environmental and economic sustainability within the 10 certification schemes included in the analysis. To be defined as a sustainable building certification, the three dimensions should be given equal weight according to the definition of sustainability. However, this is only the case for the DGNB certification scheme. A majority of the building certifications have the largest focus on criteria within the environmental dimension. Across the selected certifications this dimension account for an average of 51%. This indicates that certifications have "green" buildings as their main focus point. However, a certification such as WELL almost completely focuses on social sustainability (93%) due to its attention to the wellbeing of the user inside the building. The social dimension on average account for 43% with a large focus on the indoor environment. Overall, economy is only represented in the certifications to a very low degree (average of 5.6%), except within DGNB. There are aspects, which this categorisation method does not consider such as the ambition within the criteria. In addition, the values in the environmental and social dimensions potentially have an impact on the economic value of the building and thus the economic dimension indirectly becomes a focus, which is not visible through this method. However, the categorisation makes it easy to get an overview of the thematic content within the certification and thereby highlight the value of the certification. Furthermore, it could be of especially good use for non-technical clients.

1. Introduction

Sustainable development contains a balance between the three dimensions of sustainability: Social, environment and economy. This stems from the most frequent use of the term sustainability, which origins from the publication "Our Common Future" from 1987 by the UN-established Brundtland Commission. The general statement says that sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs [1]. Today, within the UN, there is still a comprehensive focus on the subject with UN 17 Sustainable development goals to transform the world [2].

When converting sustainable development to the building sector, the focus should be on the long perspective, which entails the importance of considering the entire building life cycle. The focus should also be on the broad perspective. This means that a sustainable building should not only be sustainable in itself but also on larger scales such as local, regional and global. Making a sustainable building means analysing and documenting this within the three dimensions [3]. For this paper subcategories of sustainability are defined using description on sustainable buildings on National (Danish) scale from the Danish Transport and Construction Agency [3], which corresponds with the European standards for Sustainability of Construction works [4].

The number of available sustainable (or green) building certification schemes are large [5]. While it is not long ago that applying this type of certification for your building was rare, the focus on certified buildings are still increasing and expanding across the world [6].

With so many options available and an increasing demand for certification of buildings, there emerges a task of deciding, choosing and carrying out a building certification. This task falls on the client and consultants. However, they may not yet have the knowledge or experience to substantiate their decisions or to enter into a good dialog on the subject, because the topic of sustainability and certification systems in the building industry is still relatively new. An overview and comparison of certifications therefore becomes relevant.

Few comparisons have been carried out on certification systems. These includes a comparison and review of five sustainable building rating systems based on Federal buildings in the U.S. [7]. A book presents and compares of a number of certifications systems where DGNB, BREEAM and LEED are compared in more detail in relation to structure and content [8]. In Denmark, a review of the larger certifications systems BREEAM, DGNB, HQE and LEED was also carried out in relation to choosing a common certification system within the building industry [9]. In relation to renovation of buildings, a small analysis of different evaluation schemes and certifications have also been carried out [10]. However, no studies have addressed the building certifications purely in relation to the sustainability aspects.

The purpose of this study is to create a better dialog between client and consultants about building certification systems. It is therefore relevant to provide an overview of how certifications provide sustainable values to a building. This can be shown in terms of how they fulfil the definition of sustainable buildings. Furthermore, how building certification may differ when it comes to sustainable buildings.

A selection of ten certification systems are analysed according to the definition of sustainable buildings. From a Danish perspective, they cover international, regional and local scale: Active House, BREEAM, DGNB System Denmark, Green Star, HQE, LEED, Living Building Challenge, Miljöbyggnad, Nordic Ecolabel and WELL.

An overview and analysis of the certification will also give in the publication Guide to Sustainable Certifications [11] by GXN in collaboration with SBi and an SBi report [12], which gives a more detailed description of the analysis.

2. Method

Figure 1 illustrates that the building certifications systems have their own structures. Therefore, it can be a challenge to understand the content of the certifications and how they are different from each other.

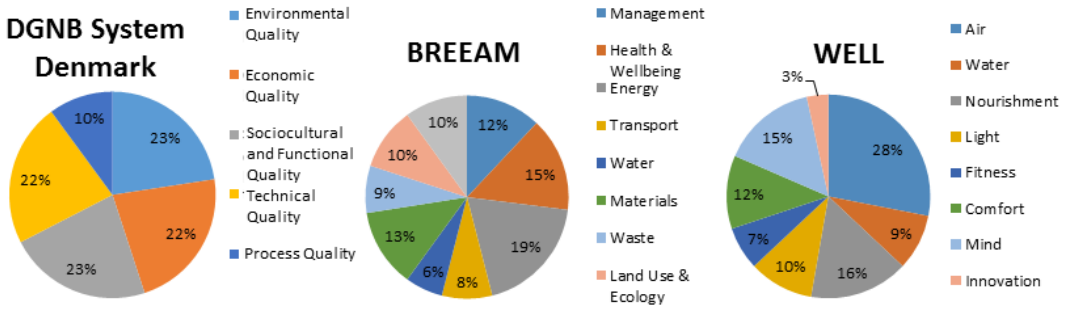

Figure 1. Three different sustainable building certificates each with their individual structures. The categories in the certification systems cannot be compared directly, it can therefore be difficult to distinguish the certifications and understand the value they each bring

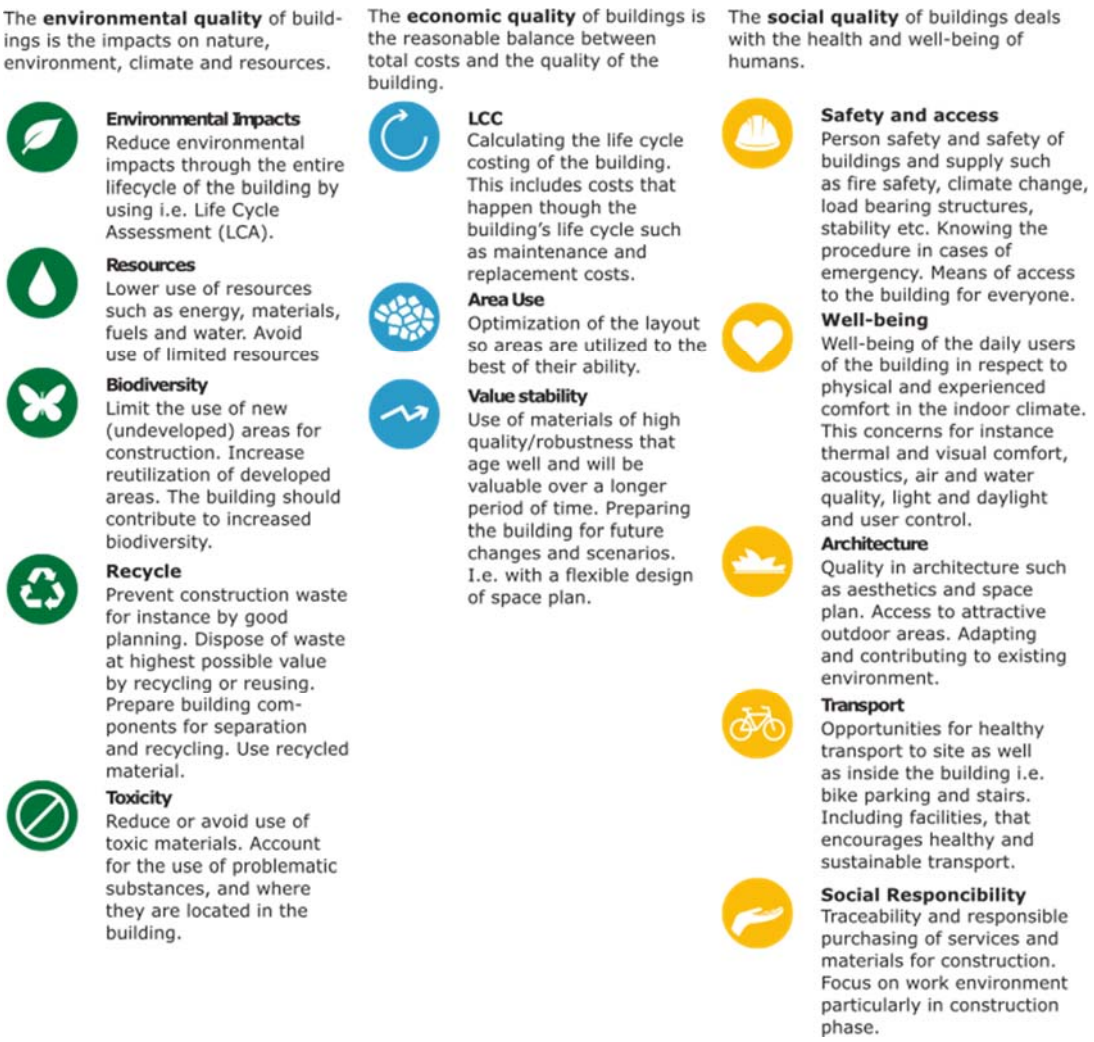

Figure 2. Sustainability of the building certifications are categorized within the three aspects of sustainability: Environmental quality, economic quality and social quality. Furthermore, they are divided into subcategories, which are described in the figure. The categories are defined from [3, 4]

A common definition of sustainable buildings is therefore used to analyse certification systems in order to get a better understanding of the certifications in the light of sustainability aspects.

Three aspects of sustainability have been defined for the analysis as well as a total number of 13 subcategories as shown in Figure 2. The criteria within the certification systems are then categorised within these. This means that the analysis is limited to the "theme" within the criteria in the certification system and does not include the ambition of the criteria. It should be noted that categorising always includes some subjective interpretation of the criteria.

2.1. Certification setup

Building certification systems often have different versions dependent on i.e. the building use. In order to have a similar basis all versions analysed are – where possible – of new construction and with office use. This means that certification versions that fulfil this is chosen above other versions and that criteria or credit that is only given to other building types are not included in the analysis. In cases where it has not been possible to use the prescribed building use, another building use is chosen as shown in table 1. An example of this is the Nordic Ecolabel, which does not certify office buildings and therefore apartment buildings are chosen as building use in this case. The certification manual for apartment buildings also includes other building types such as small houses and school buildings, but only the criteria which applies to the chosen building use is included in the analysis – which is the same principle used throughout the certifications.

Table 1. The table shows the certifications versions used in the analysis and which building type they are analyzed according to. When possible, the investigation was focused on new constructions with office use. In cases where this was not possible (i.e. no certification exists for office buildings), another type is chosen.

	Project Type	Building Use	Version	Reference
Active House	New construction	Residential buildings	2nd edition	[13]
BREEAM	New construction	Office	2016 *(issue 2.0, international)*	[14]
DGNB System Denmark	New construction	Office	2016 *(NKB16)*	[15]
Green Star	New construction	Office	2017 *(v1.2)*	[16]
HQE	New construction	Office	2016 *(international)*	[17]
LEED	New construction	Office	2017 *(LEED v4)*	[18]
Living Building Challenge	New construction	Office	2016 *(3.2)*	[19]
Miljöbyggnad	New construction	Office	3.0 *(version 170510)*	[20]
Nordic Ecolabel	New construction	Apartment building	2016 *(version 3.2)*	[21]
WELL	New construction	Office	2017 *(v1)*	[22]

2.2. Criteria types and weighting

The building certifications are divided into a list of criteria, which can be given a weight in accordance with the evaluation of the building in the certification. Criteria can exist on different levels, which means that there will sometimes be "deeper levels" with more specific criteria (or *demands*) within a criterion and there will be higher levels of criteria. In this analysis the level of criteria is defined as the level that would include enough data to sufficiently categorize the criteria.

Criteria that are concerned with process management and documentation are included in the analysis if they are included in the general certification manual. However, if these subjects are included in a separate manual that only deals with i.e. process management – such as the case in HQE – then this manual has not been included in the analysis.

Criteria are weighed according to the evaluation system in the certification, but this step also holds some choices in method. One of the issues is that some criteria are obligatory, while others give points or have a weighting of the total. In some certification systems such as i.e. DGNB System Denmark, there also exists minimum requirements within all or some criteria. This is to provide a certification that is focused across all criteria and subjects and not focused on optimising only some criteria. The aspect of minimum requirements is not visible in the analysis with the used method, but all obligatory criteria are analysed to count for as much as point giving criteria and where there is no hieratic in the evaluation of criteria, the criteria are weighted equally.

2.3. Categorising certifications

The criteria within the certifications are categorized into to the 13 subcategories shown in figure 2. The categorisation of criteria is based on the descriptions in the certification manual. The focus in the categorisation is to only categorise a criterion into the category where it has direct impact. This means that categories where the consequence of implementing the criterion could also produce an effect is limited.

The criteria can be divided into more than one category and in some cases where the subject of the criteria has been multidisciplinary design of the building or has to do with documentation or process, the criteria has been equally divided on all categories. This choice in method means that categories that have otherwise not been included in a certification becomes visible in the results because it is included in this equal distribution.

Despite a large number of subcategories, it is not always clear where a criterion belongs and there will consequently exists some subjective interpretation of the criteria, when it is categorized. In the analysis, the described goal of a criterion's (as described in the manual) is also included in the categorisation.

For instance, the planning of good and varied transportation to the building can belong in several categories. If the focus in the criterion is on healthy transportation such as good facilities for biking, it is placed within the social aspect of transport, however, if the goal of the criterion is to reduce environmental impacts from vehicle use it has been placed in the environmental aspect etc.

3. Results and discussions

Figure 3 shows a large variation of the value put on the three dimensions of social, environmental and economic sustainability within the ten certification schemes. To be defined as a sustainable building, the three dimensions should be given equal weight according to the definition of sustainability. This tendency is only seen for DGNB in Denmark, where table 2 shows a percentile distribution of 34, 29 and 37 on environmental, economic and social sustainability, respectively. The reason that the Danish DGNB system shows a distribution equal to the one defined in this analysis is because DGNB is developed based on the same standards [4].

In six of the ten systems, the majority of focus is on the environmental sustainability. This applies for Active House, BREEAM, Green Star, LEED, Miljöbyggnad and Nordic Ecolabel. These six certification systems show a similar distribution for the three dimensions where environment accounts for around 2/3rd of the weight in the certification, economy is very little represented and the social aspects represents the remaining 1/3rd. Across all certification systems, the average weight on the environmental sustainability is 51%. In the subcategories the main focus is on resources which accounts for half of the environmental aspect. Resources is usually focused on energy and water reduction and metering of systems.

None of the certification systems has the largest focus on economy, though DGNB Denmark focuses almost equally on the three sustainability aspects. The average weight on economy in the certification

systems is 5.6%, which stems mainly from life cycle costing perspectives and stability of value. In a certification such as the Nordic Ecolabel, the weight on the economic aspect comes from the method choice where categories concerning documentation or process are divided on all of sustainability subcategories. In this case, the method twists the image of the Nordic Ecolabel into an aspect that is not otherwise represented in the certification.

It can be argued that economy is so little represented in the certifications because most other criteria have an effect on economy. The two categories that are most represented overall in the analysis are resources – such as energy and water, which has an obvious economic aspect when reduced – and well-being, which has a high focus on indoor climate and therefore could heighten productivity of workers and thereby heighten the value of the building.

Four of ten certification systems focus mainly on the social sustainability. These are DGNB Denmark, HQE, Living Building Challenge and WELL. Within these four, HQE and Living Building Challenge have similar distribution of the three environmental aspects with approximately 2/5th weight on environmental sustainability, no significant influence from economic aspect and close to 3/5th on the social aspect. DGNB Denmark is different from the other certifications with its, as previously described, equal distribution on the sustainability aspects. WELL also distinguishes itself from the others with its very high focus on the social aspect (93%). The average weight on the social aspect is 43% across all certifications, with a substantial focus on well-being, which includes all aspects of improving the indoor climate of the building.

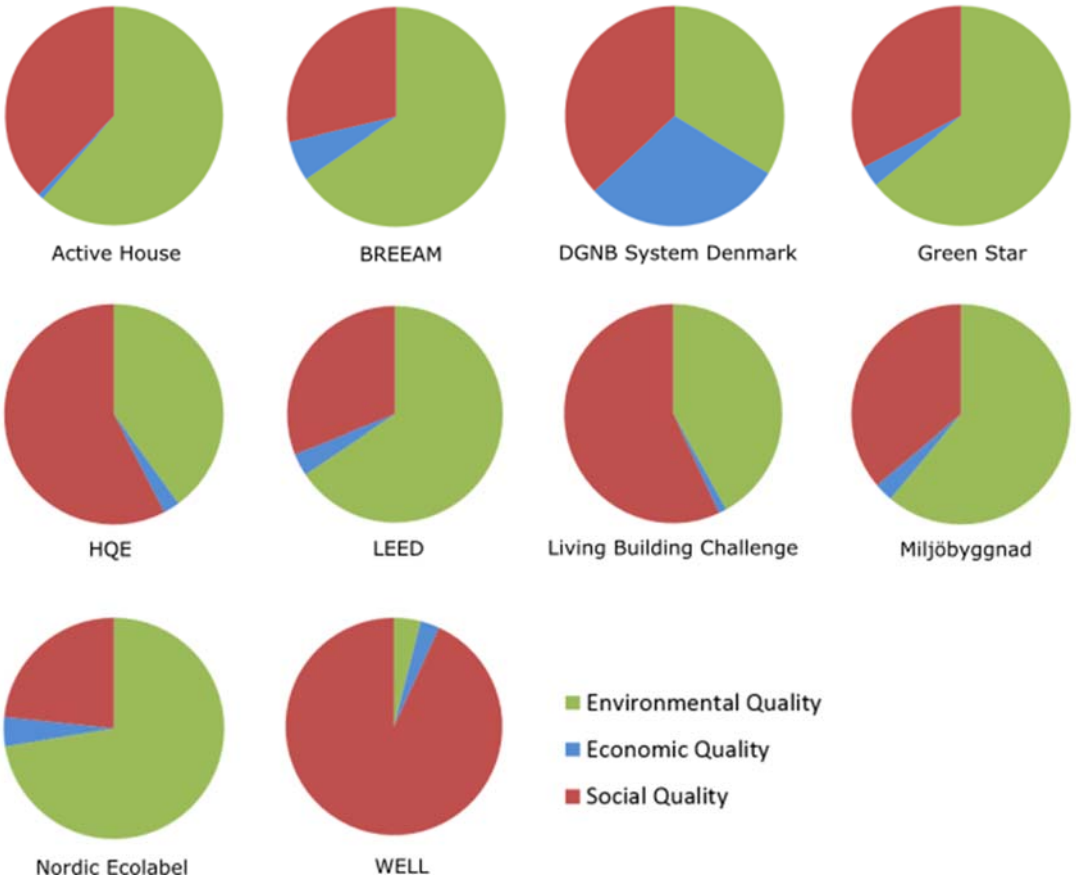

Figure 3. The three aspects of sustainability shown categorized and weighted within the ten building certification systems. Environmental sustainability is valued the highest in most certifications systems (7 systems) and is given the highest average value. Social sustainability is valued highest in three certification systems. Economic sustainability only shows to have a large value in the DGNB system Denmark.

Table 2. Distribution in percent from categorizing the certification systems into three aspects as well as the 13 subcategories. The results show that resources and well-being (which includes indoor climate) are generally valued highly in the majority of the building certifications.

	Active House	BREE-AM	DGNB DK	Green Star	HQE	LEED	LBC[a]	Miljö-byggnad	Nordic Eco-label	WELL
Environment	**61**	**65**	**34**	**64**	**40**	**66**	**42**	**61**	**72**	**4.0**
Environmental impacts	8.7	12	9.3	19	5.8	7.2	5.4	11	3.2	0.49
Resources	47	32	14	27	24	41	10	33	30	0.49
Biodiversity	0.46	10	2.6	9.5	2.4	7.6	13	0.0	3.5	0.49
Recycle	5.4	6.7	3.2	6.2	8.2	6.3	5.4	5.6	11	1.3
Toxicity	0.0	4.4	4.1	2.2	0.0	3.9	7.9	11	24	1.3
Economy	**0.82**	**5.9**	**29**	**3.2**	**2.4**	**3.3**	**1.2**	**2.8**	**4.3**	**2.9**
Life cycle costing	0.80	3.2	13	1.7	0.67	2.5	0.38	0.0	1.4	0.49
Area use	0.0	0.22	1.0	0.72	0.0	0.44	0.38	0.0	1.4	0.49
Stability of value	0.0	2.5	16	0.72	1.7	0.44	0.38	2.8	1.4	1.9
Social	**38**	**29**	**37**	**33**	**58**	**31**	**57**	**36**	**23**	**93**
Safety and access	0.5	5.6	6,3	4.5	1.8	2.9	5.4	0.0	2.4	1.7
Well-being	34	15	21	18	53	21	10	36	13	78
Architecture	0.58	2.4	7.6	7.0	1.6	2.2	23	0.0	1.4	6.4
Transport	0.35	1.6	1.3	0.72	1.2	3.3	5.4	0.0	2.3	3.1
Social responsibility	2.6	3.7	0.93	2.2	0.0	1.5	13	0.0	4.2	4.0

[a] Living Building Challenge

4. Conclusions

The analysis gives an overview of building certification systems in relation to the sustainable building aspects and categories.

It is obvious that weighting of criteria within a certification and ways of categorising the criteria has a large impact on the results. There is therefore an uncertainty in the results, which comes from the subjective interpretation of criteria and method choices used here.

However, the results still give a good indication of the sustainable values in the certification systems and shows overall tendencies and differences. From the ten certifications systems it is evident that the environmental aspect is valued most, on average, followed by the social aspect, and that these aspects are focused on categories of resources and indoor climate. The economic aspect is generally very little represented in the results, but economic aspects could easily be a consequence of the above-mentioned environmental and social categories, which is not visible in this analysis.

Comparing the certifications there are some apparent similar distribution of the three sustainable aspects for Active House, BREEAM, Green Star, LEED, Miljöbyggnad and Nordic Ecolabel with largest weight on environment. A similar distribution is also visible for HQE and Living Building Challenge with the most weight on social aspects. DGNB is distinguished with its equal distribution of the three sustainable aspects and WELL is almost entirely focused on the social aspect.

The results can be a resource for discussions between consultant and clients and it can work as a way to show and explain certification systems based on the definition of sustainable buildings.

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References

[1] Our Common Future – Brundtland Report. Oxford University Press, 1987
[2] Transforming our world: the 2030 Agenda for Sustainable Development. United Nations, 2015
[3] Bæredygtigt byggeri. *Trafik- og Byggestyrelsen*, 2016 (in Danish)
[4] EN 15643-1:2010. Sustainability of construction works – Sustainability assessment of buildings – Part 1: *General framework*. CEN/TC 350, 2010
[5] Worldgbc.org – World Green Building Council. Available at: http://www.worldgbc.org/rating-tools. Accessed 22-03-2018, 2018
[6] Worldgbc.org – World Green Building Council. Available at: http://www.worldgbc.org/news-media/worldgbc-annual-report-20152016. Accessed 22-03-2018, 2018
[7] K. M. Fowler, E. M. Rauch. Sustainable Building Rating Systems Summary. *Pacific Northwest National Laboratory*, 2006
[8] T. Ebert, N. Eßig, G. Hauser. Green Building Certification Systems: assessing sustainability: international system comparison: economic impact of certifications. München: *Institut für internationale Architektur-Dokumentation*, 2011
[9] H. Birgisdottir, K. Hansen "Test of BREEAM, DGNB, HQE and LEED on two Danish office buildings" in P Huovila, editor, SB11 Helsinki – World Sustainable Building Conference, Proceedings. Helsinki: RIL - *Finnish Association of Civil Engineers*, 2011, p. 879-887
[10] Stylsvig Madsen U, Beim A, Reitz A, Bang HL, (ed.). Value creation in building renovation: a mini-analysis of selected concepts for assessment of properties and qualities in construction. Copenhagen: CINARK (Kunstakademiets Arkitektskole), 2015. 96 s.
[11] Guide to Sustainable Certifications for buildings. Copenhagen: SBi, 2018 (not yet published)
[12] Analysis of sustainable certification schemes - additional material for publication "Guide to Sustainable Certifications. Copenhagen, 2018 (not yet published) (in Danish)
[13] Active House – the specifications for residential buildings 2nd edition. Active House Alliance, 2013
[14] BREEAM International New Construction 2016 – Technical Manual SD233 2.0. Watford: *BRE Global Ltd*, 2016
[15] DGNB System Denmark manual for kontorbygninger 2016. Copenhagen: Green Building Council Denmark, 2016 (in Danish)
[16] Green Star Design & As Built v1.2 submission templates. Barangaroo: Green Building Council of Australia, 2017
[17] HQE Scheme Environmental Performance Non Residential Building – Assessment scheme for the environmental performance of non-residential building under construction – HQE certified by Cerway. Paris: Cerway, 2016
[18] LEED v4 for Building Design and Construction. Washington D.C. U.S *Green Building Council* , 2017
[19] Living Building Challenge 3.1 – A Visionary Path to a Regenerative Future. Seattle: *International Living Future Institute*, 2016
[20] Miljöbyggnad 3.0 Bedömningskriterier för nyproduktion. Stockholm: *Sweden Green Building Council*, 2017
[21] Nordic Ecolabelling for – Small houses, apartment buildings and buildings for schools and pre-schools: version 3.2: 09 March 2016 – 31 march 2020. Stockholm: Nordic Ecolabelling, 2016
[22] The WELL Building Standard – v1 with Q2 2017 addenda. New York: *International WELL Building Institute*, 2017