The influence of sustainable features on liquidity of houses in the Czech Republic

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Abstract. The construction industry has a significant impact on the environment, and it especially affects the level of greenhouse gases. It also reduces the greenhouse gases through constructing and operating sustainable buildings. Sustainable buildings include buildings that meet basic sustainable principles, namely environmental, social, and economic. Sustainable buildings are very often associated with certified buildings (LEED, BREEAM). However, sustainable buildings do not have to be certified to fulfill the idea of sustainability. The question is, how much does sustainability affect the selling prices of houses. A database of 570 sold houses in the district of Brno – venkov in the period of years 2017 - 2019 was compiled. It was found that 5.6% of the houses featured some sustainable aspects, such as heat recovery systems, natural construction materials and all alternative technologies. The factors of liquidity were considered and evaluated. In case of the sustainable houses 3.0 % higher ΔP (difference between asking and market price) was detected. Influence on time on the market was not proven. Based on ANOVA analysis, the impact of sustainable features of houses on the selling prices was not found. Analysis was carried out by a semi-database of 122 houses sold in the year 2017.

1. Introduction
The construction industry has great potential to reduce greenhouse gas production, especially carbon dioxide. Reduction of greenhouse gas production can be achieved during design, construction and operation of buildings, i.e. sustainable buildings. Sustainable buildings have to be in harmony with three basic pillars of sustainability: economic, environmental, and social [1].

Current sustainability certification programs exist for the commercial sector of the construction industry (office buildings, large residential projects). The best known worldwide programs are LEED and BREEAM. However, these programs are not suitable for another sector of the construction industry - houses.

At first of all residential buildings could be family houses as well as block of flats. This article is focused only on family houses. If it mentions houses or it means only family houses like semi-detached as well as single-family detached home.

Houses usually do not attain certification due to high financial cost. However, many properties meet the conditions of sustainability even without certification. It is difficult to assess what constitutes “healthy” market conditions for sustainable residential buildings on the real estate market.

This paper focuses on the impact of sustainable aspects on the selling price of houses in the district of Brno – venkov (metropolitan area of Brno City) in the Czech Republic.
2. Literature review

2.1. Liquidity
The issue of indicator of market efficiency is frequently discussed in functioning economies in Western Europe, the USA, but also in Asian countries, such as Singapore and China. There are various indicators of market efficiency. The paper focused on two parameters of liquidity. First one is the difference between asking prices and market prices. The definition is \( \Delta P = PM / E(PA) \). The second one is time on the market, defined as \( \Delta T = TM – E(TA) \), which expresses bid time to sale (in this article \( \Delta T \) is similar to the time to the market - TOM). These two characteristics are observed for individual real estate/family houses. PM (market price) is a selling price with its unequivocal selling time (days), obtained from the real estate cadastre. Estimation of PA (asking price or list price) and TA (asking time) should be burdened with as little variance. Asking price and asking time needs continuous market monitoring [2].

Authors Hauring et al. focused on time on the market and difference between listing price and selling price. Research was conducted on the housing market in Columbus, Ohio. On simple model it was demonstrated that the behavior of the seller influences the list price. The research shows that the greater the variance of the offer distribution, the higher the seller will set the list price. Research also stated that the ratio of list price to expected sales price rises. The model predicts that in atypical properties, time one the market is greater and the list price is set relatively high, but the sellers are willing to lower the price [3].

Another USA research study focused on the list price and time on the market. Results show that physical characteristics of houses such as quality or size have a high influence on pricing as well as seller motivations, structure liquidity, seller age, race, and income. Results also show that sellers set the listing price as a tradeoff between time on the market versus transaction price, which depends on the liquidity of the property and the depth of the market [4].

Sirmands et al. point out that houses are made up of many characteristics that affect the price of real estate. In the article they divide variables into following categories - structural features, internal features, external features, natural environmental features, public services, neighborhood and location, marketing, occupancy and selling factors, financing issues. Most of these characteristics have positive effects except age, crime rate, percentage of school district minorities and vacancy [5].

There are many studies and researches focused on the influence of sustainability on the selling price of houses. However, these studies are very often focused on the specific field of sustainability. The following paragraphs contain an overview of the most important studies and results according to the field of sustainability.

2.2. Sustainable features
The literature concerning the topic of sustainable features on liquidity of houses in European countries we didn’t find. For this reason, the research from other parts of the world was analyzed.

The use of renewable energy is an important aspect of sustainability. All technologies dedicated to generating energy from alternative sources such as photovoltaic panels, solar panels, or heat pumps, are preferred to be used in houses to fulfill the basic principles of sustainability. These technologies are associated with higher acquisition costs as well as costs of maintenance and replacement. However, a study from Japan confirms a higher selling price (positive price effect) in case of block of flat with any alternative technology. This positive effect was found in residential buildings of two and more years old due to confirmed lower operation cost after the first heating season [6].

The positive price effect was also confirmed by a study of Nigerian prime residential market. This study was focused on the cost of energy savings and the quality of the indoor environment (including lighting, ventilation, humidity and others) [7].

US research which contained 25,272 houses in the time period from 2002 to 2009, found there was non-stationary green premium for houses with sustainable features in the mentioned period. The premiums were determined as -1.78% in 2002 and 2.37% in 2009. In the opinion of authors, the
reason was buyers becoming more conscious about the benefits of green features. According to the article, green premiums were also expected in markets with lower energy efficiencies demand due to the climate (heating, cooling) [8].

Another US study [9] focused on green certification in residential housing shows that there is statistically significant higher property value of houses with Energy star certification. It supports the theory that improvements to property should be captured in property price. However, for another certification program - EartCraft - the same positive effect was not found. Even the energy savings were equal. According to the authors, the explanation can be that buyers were projecting brand recognition into their pricing decisions.

With regards to the topic of alternative technologies and energy savings, it has been observed that low energy demand, evaluated through energy classes (also known as energy labeling), has positive influence on the selling price as well. Positive price effect is also confirmed by studies from the Netherlands [10] or Austria [11].

Quality of life is also a significant price settings factor and should be considered. According to research [12] there are indicators of residential environment quality, which residents prefer in the Czech Republic. Results vary, depending on the size of the city, and the most significant indicators are safety, noise level and accessibility of public transportation.

2.3. Construction materials
Another basic sustainable principle is the use of construction materials which are renewable, reusable, and in their natural form. Great examples of these suitable materials are timber and timber products, straw, woodwool, clay and others. Timber based houses mostly fulfill the idea of sustainability. There are studies that prove construction materials affecting selling price of houses [13], [14]. Results vary between countries and depend on the distance of the market with timber houses.

Material base (like timber, concrete, bricks) of houses can affect the price as well as the construction cost. There are studies focused on the influence of material base on the construction cost [15], [16].

3. Data
The microanalysis method was applied on the databases of the houses market in a compact area in the district of Brno - venkov. The district is located around Brno, the second biggest city in the Czech Republic. The district of Brno - venkov is a metropolitan area of Brno (approximately 222 300 inhabitants). In the south, there is an area of vineyards and in the north, it borders with a protected landscape area.

The first step in creating the database was collecting the asking price including all information provided in the advertisement. Real estate advertisements were continuously tracked on a weekly basis. The time period lasted from March 2017 to November 2019, which is 33 months. The core information from the Land Register was searched for every item (house) of the database. Based on the information from the Land Register, all items were fully identified.

The deleted bids were identified from the advertisements. The database was inspected and further information was gathered from the Land Register in September 2017, December 2017, September 2018 and November 2019. The selling prices of items were provided by the the Land Register.

The final database consists of items with complete information from advertisement and information from the Land Register. These items contain asking price, selling price and time on the market, among other things.

4. Methods
The influence of sustainable features of houses, listed in the database containing 570 items, on the factors of liquidity was considered. Items (houses) from the database were divided into two groups based on the sustainable features. One group of “non-sustainable houses” and the second one of houses which fulfill the principles of sustainability. All houses constructed as timber houses were
categorised as houses that fulfill sustainable principles. All houses which use any alternative technology, such as solar panels for hot water, heat pumps, photovoltaic panels or heat recovery systems, were also included in this group, as well as a few passive houses.

Factors of liquidity, especially ΔT (TOM) and ΔP, were evaluated by median and average, according to mentioned groups.

Although the database was monitored continuously for a clear boundary, it was divided into individual years 2017, 2018 and 2019, depending on when the family houses were sold. A semi-database of houses sold in 2017 was chosen for a detailed examination of sustainable features and their impact on the bid price, the selling price and time on the market.

The one-way Analysis of Variance (ANOVA) was used to determine the influence of sustainable features on selling prices of houses. The hypothesis is that the selling prices are the same both for sustainable and non-sustainable houses. Only the prices from year 2017 were tested due to the homogeneous data structure. Fourteen items (houses in bad technical condition) were excluded due to possible distortion. The tested database contained 108 items after excluding.

5. Results

According to the real estate market data in the area under investigation, the representation of houses that contained sustainable features was 5.6% over the course of the data collection (2017-2019). The number for the year 2017 was 11.5%.

The difference between time on the market in 2017 compared to the number for the whole period of time was caused by a larger number of items in the database and also a longer duration of the research. The research started in March 2017, which means that databases contain more items with longer time on the market in 2019.

The difference between prices (ΔP - average) of sustainable houses and non-sustainable houses in 2017 and in the summary (years 2017, 2018 and 2019) was 3.0% higher in sustainable houses. According to ΔP, the houses containing sustainable features were on a higher selling price than the houses without any sustainable features. The time on the market was on average 5 days shorter for houses without sustainable features. Table 1. shows results about the difference between time on market and difference between prices.

|                        | Items | TOM - average | TOM - median | ΔP - average | ΔP - median |
|------------------------|-------|---------------|--------------|--------------|-------------|
| Sustainable houses 2017, 2018, 2019 | 32    | 226           | 174          | 0.91         | 0.94        |
| Non sustainable houses 2017, 2018, 2019 | 538   | 221           | 185          | 0.88         | 0.91        |
| Sustainable houses 2017 | 14    | 140           | 116          | 0.92         | 0.94        |
| Non sustainable houses 2017 | 122   | 135           | 126          | 0.89         | 0.92        |

Based on the p-value equal to 0.109155 and the determined significance level of 0.05, the hypothesis is not rejected. Selling prices in the group of regular houses were equivalent to the prices in the group of houses which fulfilled sustainable principles. The ANOVA analysis confirms there is no influence of sustainable features of houses on the selling prices in the tested database of 122 houses sold in 2017. Houses in bad technical condition were excluded. These houses also affect factors of liquidity. Semi-database of houses sold in 2017 was examined in a more detailed way. Results in tab. 3 show that the excluded houses had lower ΔP - average and median, but time on the market was shorter. Table 2. shows results the one-way Analysis of Variance on all data examined and Table 3. shows results about the difference between time on market and difference between prices on samples from 2017.
Table 2. The one-way Analysis of Variance

Anova: single Factor

| SUMMARY |
|---------|
| Groups          | Count | Sum      | Average       | Variance       |
| Unit prices - sustainable houses | 14   | 374818.5235 | 26772.75168  | 119340976.5   |
| Unit prices - non-sustainable houses | 108  | 2338365.887  | 21651.53599  | 125437318.2   |

ANOVA

| Source of variation | SS          | df | MS          | F          | p-value       | F crit          |
|---------------------|-------------|----|-------------|------------|---------------|------------------|
| Between Groups      | 325040962.2 | 1  | 325040962.2 | 2.604977454 | 0.109155249    | 3.920124409     |
| Within Groups       | 14973225739 | 120| 124776881.2 |            |               |                 |
| Total               | 15298266701 | 121|             |            |               |                 |

Table 3. Results of ΔP and TOM in 2017

| Items                        | TOM - average | TOM - median | ΔP - average | ΔP - median |
|------------------------------|---------------|--------------|--------------|-------------|
| Sustainable houses 2017      | 14            | 140          | 116          | 0.92        | 0.94        |
| Non sustainable houses 2017  | 122           | 135          | 126          | 0.89        | 0.92        |
| Non sustainable houses 2017 - data for ANOVA | 108     | 136          | 132          | 0.89        | 0.93        |
| Non sustainable houses 2017 - in bad condition | 14        | 126          | 112          | 0.87        | 0.84        |

6. Discussion

The database contains 570 houses sold in the period from 2017 to 2019 in the Brno - venkov district. Only the houses sold in 2017 were tested for the influence of sustainable features on selling prices. There wasn’t found any influence of sustainable features on the selling prices of houses in the database of 122 houses sold in 2017 in the Brno - venkov district. ANOVA analysis was used.

According to literature review there is not unanimous opinion on the influence of sustainable features or sustainability to selling prices of houses. The best example is the study from the US [9], as it shows that pricing decisions can be also affected by the brand of the certification program.

Another example from the US informs that price can be affected by the conscience of buyers about the benefits of green features. The study from Japan confirms this idea as well. [6] There was a positive effect found in residential buildings (block of flats) of two and more years of age old due to confirmed lower operation cost.

The reason why any influence of sustainable features on the selling prices of houses was not detected can be the early stage of sustainable housing market in the Czech Republic, as the market is not developed. Sustainable features were found only in 5.6 % of the houses. In the author's opinion, there is no conscience of buyers about the benefits of green features as well as reports. [8] That's the reason why sustainable features do not affect selling prices of houses.

7. Conclusion

The construction industry represents great potential to reduce greenhouse gases production via buildings meeting basic sustainable principles in all stages of its life cycle, including the operation phase. This paper had the goal to answer how much the basic sustainable features affect selling prices of houses.

In an attempt to answer this question, a database of houses, featuring both houses with and without sustainable features, was compiled and evaluated.
The compiled database brings an overview of the market in Brno - venkov district in the period from 2017 until 2019. The database included 570 sold houses. Sustainable features were found in 5.6% of the houses. All alternative technologies such as heat recovery systems, as well as natural construction materials (timber) were considered to be sustainable features.

Factors of liquidity were assessed using basic statistical methods. The average difference of asking and selling prices ($\Delta P$) was detected to be 3.0% higher for sustainable houses than non-sustainable houses. On average, time on the market (TOM) was 5 days longer for houses fulfilling sustainable principles.

According to ANOVA analysis, there wasn’t found any influence of sustainable features on the selling prices of houses in the database of 122 houses sold in 2017 in the Brno - venkov district.

Next step of the research is to analyze the factors that influence the selling prices of houses in the Brno - venkov district. Research also can be explored to larger examined area, as well as to other types of buildings (recreation houses, flats). However, it is very laborious to find data and information.

8. References

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