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ATTITUDES OF ACTIVE AND UPCOMING ARCHITECTS TOWARDS WOOD: THE CASE STUDY IN SLOVAKIA

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ABSTRACT

The attitudes of architects towards wood as a construction material are presented in the paper. Attitudes were surveyed, analysed and compared between two groups of architects: the sample of university students of architecture (upcoming architects) and the sample of active architects. A questionnaire survey was used to gather data. Based on the results, the fact that the upcoming architects perceive properties of wood more positively could be stated. The most of the active architects do not propose wood as a construction material and prefer substitute materials on a silicate base especially in cases of civil and industrial buildings. In Slovakia, mistrust continues to be found towards wooden constructions where fire resistance remains the most negatively perceived property of wood. It is followed by properties as durability of wood, and resistance to weather conditions.

Key words: architects, wood and substitutive materials, building constructions, attitudes towards wood

INTRODUCTION

The main objective of this paper is to compare attitudes of two groups of architects (university students of architecture and active architects in practice) towards wood as a building construction material in Slovakia. The wood as a constructing material for buildings is used very long time. Consumers' studies indicate that "wood has exceptional physical and mechanical properties and its effect on the human body is beneficial" (KAPUTA and KALAMÁROVÁ 2014, p. 59). Also, the need for such studies arise from global initiative to use renewable resources (such as Bio-economy or Circular Economy) as well as for low energy consuming buildings – so-called Green buildings. Wooden constructions and buildings are recently designed as low energy consuming. Moreover, wood as a construction material has negative emission balance. It means, the amount of carbon stored in this wood during the period of tree growing is higher comparing to the amount of carbon emitted during the process of complete wood processing and utilisation of wooden building during its life cycle (ŠTEFKO, 2008). This is a strong argument in discussion about environmental suitability of wood products and products made of substitutive materials. Wood has also some defects which influence its mechanical and physical properties. The attitudes of architects towards wood were reviewed in several papers e.g. KOZAK and COHEN 1999, O'CONNOR *et al*. 2004, BAYEN and TAYLOR 2006, BYSHEIM and NYRUD 2009, KOZAK *et al*. 2009; ROBICHAUD *et al*. 2009, KAPUTA and PALUŠ 2014, KAPUTA and KALAMÁROVÁ 2014.

HEMSTRÖM *et al*. (2011, p. 1013) in their study examined Swedish architects' perceptions, attitudes and interest towards steel, concrete and wood frames in multi-storey buildings. Their results indicate that architects considered concrete as the most suitable material for multi-storeys buildings (3–8 storeys) especially for its engineering aspects (e.g. fire safety, stability). But they also mentioned that interest towards wood among Swedish architects was large. (HEMSTRÖM *et al*. 2011, p. 1020). MARKSTRÖM *et al*. (2018) in their paper also mentioned that Swedish architects have positive attitude to engineered wood products. They also described the factors which influence extension of use of wood products among architects: "environmental concerns, perceptions of the aesthetic appearance, amount of experience, influence over material selection, level of knowledge of engineered wood products, and the architects' attitude towards using engineered wood products in buildings" (MARKSTRÖM *et al*. 2018, p. 40). ASDRUBALI *et al*. (2017, p. 330) in their paper concluded that "engineered wood is one of the most interesting and innovative materials for buildings". They stated that generally wooden buildings cause lower environmental impacts than masonry buildings. The advantages of wooden buildings are related to: construction phase (lower embodied energy) and wooden materials used in the building are recyclable at the end of the life cycle. ŠVAJLENKA *et al*. (2017, p. 1601) in their experimental study concluded that method of construction based on wood are modern, environmentally friendly, cleaner and healthier in comparison with other construction technologies. They compared a house built as a panel wood construction with a traditional masonry construction. The study says that "wooden buildings consume 54% less embodied energy and generate 35% less SO_2eq. emissions (acidification potential); the production of CO_2 emissions (global warming potential) reaches a negative value; hence, the reduction of emissions for wooden constructions versus masonry constructions is 156%. As for economic parameters construction time is 48% shorter (this fact reduced noise, dust pollution and production of waste). There were 15% lower construction costs – this fact can be considered as a good motivator for investors. The lower weight of the panel wood construction – the requirements on material and product transport are lesser – also CO_2 emissions are lesser – CO_2 emissions produced during transport, ranging from 30% to 57%, depending on transport distances". THOMAS and DING (2018) mentioned that in Australia the use of timber products in residential development is limited. The construction industry has negative impact on the environment and as a solution they see using of timber as a renewable source. PAROBEK *et al*. (2016) state that the wood origin from sustainably managed forests can compete on the present environmentally sensitive markets. TOPPINEN *et al*. (2017, p. 1) conducted a study among Finish and Swedish experts with in-depth knowledge and experiences of the usage of wood in multi-storey construction in the Nordic region. They also mentioned that the wooden multi-storey constructions mean new business opportunity in the emerging bioeconomy. Their respondents (panellists) "perceive that the emphasis on sustainability is mainly driven by the changing regulation reflecting societal needs, and only a few experts saw it as echoing directly from changing individual consumer needs."

According to the report of CTBUH (2017) which deals with the tall building industry, there were nearby 40 complete, under construction or planned projects using mass timber – engineered wood products in June 2017 all around the world – comparing to just a one building (over eight stories tall) in 2008. TOPPINEN *et al*. (2018) see wooden multi-storey construction as a sustainable housing solution in emerging material-based bioeconomy.

Most of the above-mentioned facts lead us to conduct this research.

MATERIALS AND METHODS

To achieve the goal, we used a questionnaire survey to obtain data. The questionnaire was constructed online using a google docs document form. The link on the online questionnaire was distributed via e-mails to students of architecture and active architects during the year 2015. Students were from of the Faculty of Architecture, Slovak University of Technology in Bratislava, studying master's degree. This group consisted of 98 students in study programme "Architecture". They were marked as "upcoming architects" for the purpose of this study. The link was distributed through a lecturer (as the "first mover") to his students on the Faculty of Architecture. Thus, we used a snow ball sampling method.

The second group of respondents were active architects. The e-mails with link to the questionnaire were sent to a sample of 100 listed members of the Slovak chamber of the architects (total of 100 after rejecting all the non-functioned e-mail addresses).

Finally, 61 questionnaires have been analysed – 35 students of architecture and 26 active architects. So, the response rate was 36% in the sample of students. The sample of active architects is represented by 26 respondents (out of 100 contacted) what means the 26% response rate.

The questionnaire contained basic instructions followed by questions regarding the use of wood and wood products or substitutive materials for construction purposes. Responses on the following questions are analysed in this paper:

- Do you propose wood as a construction material for certain kind of buildings?
- What kind of material do you prefer in residential buildings proposal?
- How do you assess selected properties of wood as a construction material?

Closed and semi-closed questions have been used. Likert's type scale was used for answers construction where "1" means marginal positive expression and "5" means marginal negative expression ("3" means indifferent attitude – neither yes/neither no).

For evaluation of the collected data, a frequency analysis and cross-tabulations were used to find out relations between the status of the respondents (upcoming and active architects) and their answers to the selected questions. To examine relations between the variables in contingency tables, the Pearson's chi-squared test was used at a level of significance $p<0.05$ as well as a nonparametric Mann-Whitney U test for 2 independent samples was employed. To assess the degree of association between two variables in contingency tables we used Cramer's V coefficient and the Pearson contingency coefficient. We took into consideration only those contingency tables where the following assumptions were met: all expected counts E_{ij} are > 1 and, at the same time, more than 80% of expected counts E_{ij} are > 5 (LUHA 2007). Since the above assumptions were not met during analysis, we merged respondents' answers into the three groups of responses – positive, indifferent and negative. The tested hypothesis was based on assumption about the different attitudes between the upcoming architects and active architects. To describes some differences among both groups of respondents we have used also modes and weighted means which were calculated from five-point Likert's type scale.

RESULTS AND DISCUSION

The differences in attitudes between the upcoming architects and the active architects are analysed and discussed in this chapter. Five statistically significant differences were revealed in the frame of all the analysed questions (Table 1).

Tab. 1 Statistically significant differences in attitudes of the two samples of architects (upcoming architects: n = 35; active architects: n = 26).

Questions' content		Pearson chi-square			Pearson contingency	Cramer's V
		Chi-square	df	p		
Q1	Proposal of wood as a structural construction material and its components in **civil** buildings	13.36976	2	0.00125	0.4239978	0.4681628
	Proposal of wood as a structural construction material and its components in **industrial** buildings	10.21620	2	0.00605	0.3787523	0.4092416
Q2	Preference for **wood** as a construction material - residential buildings	22.19544	2	0.00002	0.5165141	0.6032079
	Preference for **metal** as a construction material - residential buildings	8.319396	2	0.01561	0.3464324	0.3693014
Q3	Assessment of **sound-insolation properties** of wood (noise reduction. acoustic properties)	7.800263	2	0.02024	0.3367128	0.3575936

First, respondents were asked if they propose wood as a construction material in some of the following types of buildings: residential, civil, industrial, technical, and small architecture. In the case of civil buildings, a statistically significant dependence was found on p = 0.001, where the contingency coefficient was 0.424 and Cramer V had a value of 0.468. It is considered to be a moderate up to strong dependence. More than 50% of the surveyed upcoming architects would design wood and its components as a construction material for civil buildings. It is much higher comparing to the share of active architects (about 11.5%). Nearly 70% of active architects do not propose wood as a construction building material in public buildings. More than 19% of active architects have expressed a neutral attitude on this issue.

A similar situation to the previously described is in the case of industrial buildings. There is a statistically significant dependence (at the level of significance p = 0.00605) between the respondent status and the use of wood and its components in designing industrial buildings. The strength of relation is moderately strong according to the contingency coefficient (C = 0.379) and Cramer's V (V = 0.409). More than 80% of active architects in the sample claimed that they do not propose wood as building material in industrial buildings while almost 20% expressed an indifferent attitude. Over 51% of the upcoming architects would not proposed wood as well while about 17% had indifferent attitude.

Among other types of building (residential, technical, and small architecture) any statistically significant dependencies have been proved.

Regarding a kind of material preferred by architects in residential buildings proposal the two statistically significant dependences were proved (Table 1, Q2). First in relation between the architects' status and preferences for wood and second in relation between the architects' status and preferences for metal (as construction material). The strength of relation is moderately strong up to strong according to the contingency coefficient (C = 0.517) and the Cramer coefficient (V = 0.603). Thus, the preference of wood and wood products as a construction material in residential buildings is dependent on the status of the respondent. The upcoming architects expressed a positive attitude (about 86%), compared to the active architects, with nearly 47% (only about 6% of the upcoming architects) having a neutral attitude towards wood as a construction material. Almost 27% of active architects preferred wood as building material in residential buildings while the same percentage do not prefer.

The analysis in the contingency tables proved the statistically significant dependence (at the significance level p = 0.016) between the status of the respondent and the preference for metal as a construction building material (Table 1, Q2). The relationship strength according to C = 0.346 and Cramer V = 0.369 is moderately strong. The higher share of preferences for metal to be proposed in residential buildings is in the sample of the upcoming architects (about 46%). Such a preference had just about 11.5% of the active architects while up to 61.5% of them do not prefer metal in residential buildings (contrary to about 34% of the upcoming architects).

Table 2 introduces preferences for material in designing residential buildings. Differences are substantial, over 85% of the upcoming architects preferred to propose wood and wood products and only up to 8.6% of them do not prefer. Unlike the active architects, where more than a quarter of them have expressed a negative attitude towards this material.

Tab. 2 Preference for materials in designing of residential buildings (upcoming architects: n = 35; active architects: n = 26).

	Strength of preference	Wood and wood products	Brick	Concrete/ Aerated concrete	Alternative materials	Metal
Upcoming architects (%)	The most	**54.29**	**57.14**	25.71	17.14	**5.71**
	More	**31.43**	28.57	34.29	34.29	**40.00**
	Neutral	5.71	8.57	22.86	28.57	20.00
	Less	**8.57**	2.86	14.29	17.14	22.86
	At all	0.00	2.86	2.86	2.86	11.43
Active architects (%)	The most	15.38	**46.15**	**15.38**	11.54	3.85
	More	11.54	**30.77**	**26.92**	11.54	7.69
	Neutral	46.15	23.08	30.77	34.62	26.92
	Less	**19.23**	0.00	19.23	26.92	**46.15**
	At all	**7.69**	0.00	7.69	15.38	**15.38**

The active architects the most preferred brick (up to 77%) and concrete, respectively aerated concrete, as silicate materials widely used in Slovakia. Here, the brick is followed by concrete/aerated concrete, wood and wood products, alternative materials, and metal as the least preferred material (61.5% do not prefer metal).

Interesting findings came from the group of active architects where higher shares of them have expressed independent attitudes towards surveyed materials. We assume that it relates to the fact that the choice of materials is to a certain extent also in the hands of investors, respectively future owners and other stakeholders. MARKSTRÖM *et al*. (2018) also mentioned in their paper that architects have moderate influence regarding material selection. HEMSTRÖM *et al*. (2011, p. 1020) stated that main contractor, structural engineer and building commissioner have strong influence on the choice of frame material in buildings.

The last analysed responses of the both groups of architects deal with their assessment of selected properties of wood as a construction material. Respondents have responded at the scale: very positive (1) to very negative (5). As in the previous case, the scale has been adjusted for the purpose of dependency analysis in the contingency tables into the three categories: positive, neutral and negative attitude. There were 13 selected properties of wood to comment. There was only one statistically significant dependency (Table 1, Q3) between the respondent status and the sound-insulating properties of wood (noise absorption, acoustic properties) at the significance level p = 0.020. Here, the strength of the relation according to the contingency coefficient C = 0.337 and Cramer's V = 0.358 is mild up to moderate. The upcoming architects perceived the sound-insulating properties of wood positively (over 65% of them), unlike the active architects where only about one-third of them have the same attitude. Almost 54% of the active architects have an indifferent attitude. An interesting result is that neither one respondent has marked the marginal negative attitude.

Table 3 shows the modes, weighted means and the ascending order of all the surveyed wood properties according to weighted means. The differences between the two samples of architects are in the assessment of following wood properties: fire resistance, natural defects of wood, and versatility of wood. All those properties are perceived more positively by the group of upcoming architects. Properties as durability of wood, fire resistance, and resistance against weather conditions were mostly assessed with indifferent (respectively negative) attitudes by both groups of architects. Here, the modes have reached minimum values of three (Table 3, marked in grey colour). Moreover, most of the active architects have expressed such an indifferent attitude also towards "natural defects of wood".

Tab. 3 The assessment of the surveyed wood properties.

Properties of wood as a construction building material	Upcoming architects		
	Mode	Weighted mean	Order according to mean
Comfort in housing	1	1.17	1
Environmental and ecological friendliness	1	1.43	2
Aesthetics properties	1	1.49	3
Uniqueness of wood	1	1.66	4
Health and safety properties	1	1.8	5
Thermal-insulation properties	2	1.86	6
Versatility of wood	**1**	**1.86**	**6**
Sound insulation properties	2	2.34	7
Natural defects of wood	**2**	**2.37**	**8**
Easy renovation	2	2.4	9
Durability of wood	3	2.77	10
Fire resistance	**3**	**3.06**	**11**
Resistance against weather conditions	3	3.17	12
	Active Architects		
	Mode	Weighted mean	Order according to mean
Comfort in housing	1	1.42	1
Aesthetics properties	1	1.62	2
Health and safety properties	1	1.62	2
Environmental and ecological friendliness	1	1.69	3
Uniqueness of wood	1	1.69	3
Versatility of wood	**2**	**1.77**	**4**
Thermal-insulation properties	2	2.15	5
Sound insulation properties	2	2.31	6
Easy renovation	2	2.31	6
Durability of wood	3	2.69	7
Natural defects of wood	**3**	**2.73**	**8**
Resistance against weather conditions	3	3.08	9
Fire resistance	**4**	**3.27**	**10**

There are some findings from studies carried out among consumers dealing with their attitudes to wood as a construction material. We took into consideration consumers view because they are also involved in the selection of materials. TOPPINEN *et al*. (2018) claimed that positive image of the wood construction industry must be strengthened especially among stakeholders as residents and end-users. GOLD and RUBIK (2009) in their paper presented findings regarding timber as a construction material in general and timber frame houses among the German population. They found that "prejudice regarding the deficiency of timber as a construction material and of timber frame houses, in terms of fire resistance, durability, and stability, persists in the minds of consumers", but also "timber as a construction material and timber frame houses have a positive association with well-being, aesthetics, and eco-friendliness" (GOLD and RUBIK 2009, p.303). Similar results contain the study of HU *et al*. (2016). They conducted a survey about The Chinese consumers' attitudes towards timber frame houses. Hu *et al.* (2016, p. 841) commented their findings in the same way as in the previous study: "prejudice regarding the deficiency of timber houses, in terms of fire resistance, durability, and stability, persists in the minds of consumers", but also "Chinese consumers have positive attitudes towards some typical characteristics of wood such: natural, cosy living, aesthetics, and environmentally friendly" (HU *et al*. 2016, p. 849). In general, it could be stated that the most frequent prejudice regarding wood as construction material is his weak fire resistance. In that way it is perceived by end-users as well as by architects (Table 3). On the other hand, authors as ŠTEFKO *et al*. (2014) claimed that wood is combustible material and wooden structures are burning in case of fire, but in contrast to steel and concrete structures, wood maintains a static load rating for a longer time.

Several authors have explored motivators and barriers that affect the use of wood as a building material among architects, engineers, building designers and other professionals. GOSSELIN *et al*. (2016) analysed non-residential building case studies and scientific literature and they found that main motivations for using wood in non-residential buildings are linked to sustainability, technical aspects, costs (cost reduction), building erection speed and aesthetic (and/or pleasant atmosphere) of wooden construction. They also pointed out the main barriers: national building codes, lack of expertise (e.g. lack of expertise of the staff working with wood), costs, material durability, technical aspects, culture of the industry and material availability. As for technical aspects of wood GOSSELIN *et al*. (2016, p. 559) pointed out problematic technical aspects of wood which are: acoustic performance, stability and wood shrinkage, humidity, technical defects, protection against vermin, insects, rot, wind, earthquakes, water etc. BYSHEIM and NYRUD (2009, p. 72) concluded in their study that "architects' intentions to use wood in urban construction are influenced by previous experience with the use of wood as a structural material in urban construction, perceived behavioural control over the use of wood as a structural material, and attitudes toward using wood as a structural material in buildings higher than three stories." BAYNE and TAYLOR (2006) in their study summarized most promising timber building applications in Australia according to the results from three focus groups which consisted from architects, engineers, building designer and projects managers. The churches, community centres, commercial offices, and commercial services (medical centres, vet clinics, schools, swimming pools etc.) are worthy timber building applications. Architects also mentioned that smaller buildings would be more promising non-residential opportunities (churches, community halls etc.). Based on the results (Table 3) it could be concluded that Slovakian upcoming and active architects have similar attitudes as foreign architects and other professionals from the building sector. The fire resistance, durability and resistance against weather are important factors that affect the use of wood as a construction material.

Some above-mentioned barriers and technical aspects for increasing use of wood in building constructions could be overcome thanks to new technologies. SONG *et al.* (2018) in their study presented effective way to transform natural wood into a high-performance material, they stated: "*Here we report a simple and effective strategy to transform bulk natural wood directly into a high-performance structural material with a more than tenfold increase in strength, toughness and ballistic resistance and with greater dimensional stability. This strategy is shown to be universally effective for various species of wood. Our processed wood has a specific strength higher than that of most structural metals and alloys, making it a low-cost, high-performance, lightweight alternative*" (SONG *et al*. 2018, p.224). So, a densified wood could have a large usage in the construction industry. According to the results of our survey, the advantages of wood are related to comfort in housing, eco-friendliness and aesthetic properties. These three aspects have also been mentioned in the other studies (e.g., GOLD and RUBIK 2009, HU *et al.* 2016, GOSSELIN *et al.* 2016, MARKSTRÖM *et al.* 2018). We could assume that if the described advantages of wood will be combined with the properties of densified wood, the popularity of the use of wood in constructions will increase.

As for above-mentioned "prejudices" regarding wood (among professionals) we recommend pay more attention at spreading knowledge on wood and its utilisation at the schools related to building sector. MARKSTRÖM *et al.* (2018, p. 40) also mentioned that Swedish architects must increase their knowledge about quality over time, fire resistance, acoustic performance, moisture resistance and financial aspects of engineering wood products. Their results indicated that active architectures and recently educated architects did not have high level of knowledge regarding the mentioned aspects of engineered wood products. KOZAK and COHEN (1999) also mentioned the issue of learning about wood and its properties in schools for architects.

CONCLUSION

The buildings are long term property and their designing and construction is a longer and delicate process. It involves number of stakeholders such as contractors, designers, architects, civil engineers, building construction supervisors, but also the future owners and residents.

OLŠIAKOVÁ *et al.* (2016) analysed and compared the changes in chosen consumer requirements for wood products in 2004 and in 2014 in Slovakia. The main conclusion is that the customers have not changed their consumption behaviour towards wood as a material. They stated that the most important wood products parameters influencing consumers' behaviour are mainly the quality and the material and the price is no longer the essential customers' requirement. GOSSELIN *et al.* (2016) consider the cost related to building as one of the barriers for using wood as a construction material. But if the price is no longer the strongest factor that influences consumers buying behaviour (as mentioned in the case of Slovakia), the use of wood and the wood products should increase especially in a case of residential buildings. Naturally, coniferous timber is the most used for construction purposes. LOUČANOVÁ *et al.* (2016) concluded that innovation activities in wood processing industry in Slovakia will move towards the innovations of processing technologies and will be related to the processing of coniferous raw wood material. OLŠIAKOVÁ *et al.* (2016) and LOUČANOVÁ *et al.* (2015) recommended to implementing an innovative strategic business model that emphasise wood and wood products compared to substitute materials. The use of substitute material is predominant and supposedly this stay will last, but development brings still new market opportunities for wood applications.

The new business model towards sustainability in wood construction industry should include not only new co-creators but also stakeholders as residents or end-users (TOPPINEN *et al.* 2018). Architects and others professional from construction industry should offer customers alternative solutions of building structures. Wooden building constructions have relevant advantages in comparison with silicate buildings. As mentioned ASDRUBALI (2017) or ŠVAJLENKA *et al.* (2017) buildings based on wood cause lower environmental impacts. THOMAS and DING (2018) concluded that construction industry has a negative impact on the environment and they see a solution in the use of timber as a renewable source. TOPPINEN *et al.* (2017) mentioned that wooden multistorey constructions mean a good business opportunity and also TOPPINEN *et al.* (2018) consider wooden multistorey construction as a sustainable housing solution for the future. If advantages of wood (e.g. eco-friendliness, aesthetics properties, cosy living etc.) will be combined with new wood processing technologies (e.g. densified wood - described in SONG *et al*., 2018) the weaknesses of wood (e.g. fire resistance, problems related to humidity, stability, durability etc.) could be considerably reduced. This step could be the step forward into an innovative new business model in the construction industry and forest-based sector in general. The stakeholders must work to overcome traditional prejudices regarding wood properties among laic persons and professionals. Such knowledge spread among architects, civil engineers and other professionals could form their attitudes towards the wood in a positive way.

Summing up the study findings, the upcoming architects preferred wood as construction material more than the active architects when designing:

- civil buildings (over 50% of the upcoming architects; almost 70% of the active architects do not preferred wood),
- industrial buildings (31% of the upcoming architects in contrary to 80% of the active architects who do not preferred this material),
- residential buildings (almost 86% of the upcoming architects preferred wood in contrary to 47% of the active architects with indifferent attitude).

Regarding residential buildings, an interesting finding is that a considerable share of the upcoming architects preferred also metal as a construction material (more than 60% of the active architects do not preferred this material). It could be claimed that the sample of the upcoming architects have a more positive attitude towards the wood. Similar findings have proved study of KAPUTA and PALUŠ (2014), where a higher share of Slovak younger architects (up to 35 years old) is projecting wood as a construction material in residential buildings (as well as in civil buildings and small architectures) comparing to older generation of architects. If preferences of younger generation of architects change in time – due to years spend in practice – is a suggestion for further research. Wood is a versatile and the only renewable construction material, but still in a minor position comparing to silicate materials on the Slovak construction market. Considering building categories, the most wood constructions proposals are within residential buildings while other categories (especially civil and industrial buildings) are predominantly represented by materials substitutive to wood.

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