Norwegian architects' and civil engineers' attitudes to wood in urban construction

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Abstract

Norwegian architects' and civil engineers' attitudes to using wood in major urban building constructions were investigated. Wood currently has a relatively small share of the market in urban construction. The principal objective was to develop knowledge about the mechanisms influencing key decisions when choosing building materials, and how, by taking heed of these mechanisms, to increase the use of wood as building material in urban building constructions. Structural interviews (n=15) and a quantitative survey (n=203) was carried out to acquire further knowledge about the specifiers making the decisions regarding choice of material, as well as the criteria forming the basis of the choice of material to be used when building in urban areas. The criteria investigated included attitudes towards the physical and mechanical properties of wood, perceived risk of using wood as a building material, and the environmental properties of wood. The knowledge status and use of information sources among the specifiers was also investigated.

Factor analysis revealed seven factors influencing the intention to use wood as a structural material. The three most important factors were perceived risk of using wood, previous experience with wood and fire-related properties of wood. The results give insights into the specification process, provide information for firms that would like to market wood as a construction material and give suggestions for how to position wood as a construction material in urban areas.

1 Introduction

Today, the market share of timber in urban areas is low, particularly compared to construction materials such as concrete and brick. A better understanding of the mechanisms that influence key specifiers in their choice of building materials is needed, in order to understand how the industry can market wood as a construction material in urban areas. In this paper, the focus is on factors influencing architects' and structural engineers' use of wood as a load-bearing material in urban construction.

2 Previous research

Table 1 shows a brief overview over previous research in the field. A thorough review of the literature is presented in Bysheim & Nyrud (2009).

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Table 1: Previous research

Important factors influencing choice of building material	Author
Previous experience with wood, perceived behavioural control, building height.	Bysheim & Nyrud (2009)
Knowledge and experience, common knowledge, building type, building codes, example buildings, tech. solutions, economic and environmental issues.	Roos et. al (2008)
Codes, cost, performance, infrastructure in design and construction industry.	O'Connor et al. (2004)
Dimensional stability and uniform quality important. Fire, price and environmental properties less important.	Wagner & Hansen (2004)

3 Methods

Using theoretical models by Emmitt & Yeomans (2008) and Ajzen (1991), a model for the specifiers' decision making process was developed. Based on the model and previous research (Emmitt & Yeomans, 2008; Bysheim & Nyrud, 2009) an interview guide was developed. Six building projects in urban areas in Norway were chosen as case studies, and a total of 15 interviews were conducted among key players in the construction industry, such as engineers, architects and builders.

3.1 Structured interviews

The interviews were mainly focusing on three different main themes:

1. Knowledge and previous experience with wood as a building material
2. Important criteria for the selection of building materials
3. Role of decision makers and stakeholders in the building process

3.2 Survey

The results from the structural interviews, along with findings in previous research, formed the basis for a quantitative survey among key specifiers in the Norwegian construction sector. The criteria investigated included:

1. Attitudes towards the physical and mechanical properties of wood
2. Perceived risk of using wood as a building material
3. The environmental properties of wood
4. The knowledge status and use of information sources among the specifiers

5. Choice of building materials in the different stages of the building process

An invitation to a web-based questionnaire was sent by email to 2374 Norwegian architects, engineers, builders and contractors. This resulted in 203 answers, yielding a response rate of 8.6 percent. The educational background of the respondents were mainly architecture (N=139) and engineering (N=60). The questions in the questionnaire used a seven-point scale (1=to a small degree; 7=to a large degree). High value reflected a stronger preference for wood, except for items regarding risk and fire. Seven items were reverse-scored.

4 Results

4.1 Structured interviews

Some common features in the six case projects were identified: Most of the specifiers had previous experience with using wood. In the cases where wood had been used extensively the builder had a positive attitude towards using wood in the project. Also, wood had been chosen at an early stage in the specifying process. The specifiers who were interviewed were also satisfied with the use of wood in the case projects.

4.2 Descriptive statistics

Figure 1 to 5 shows mean values for selected items from the survey. The values reported are mean values for the various items. Figure 1 shows which of the actors involved in the specification process that was perceived as most influential by the architects and engineers. The actors perceived to be most influential were engineer, architect and contractor. Public authorities and real estate agencies were perceived as having little influence over the choice of structural materials, while the builder had a somewhat moderate influence.

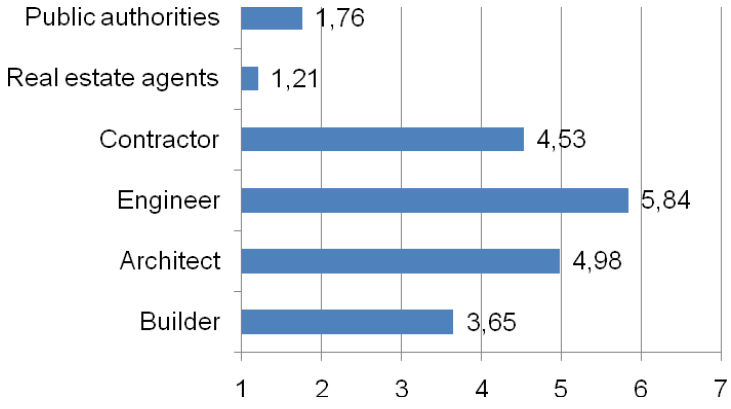

Figure 1. To what degree did the following actors influence the choice of structural material? (1=to a small degree; 7=to a large degree)

Figure 2 shows when decisions regarding the choice of building material for structural purposes were made. The most important phase, as perceived by the

respondents, were the pilot project, with the detailing phase and the sketch project ranked second and third respectively. The programming and construction phases of the building phase were perceived as least important phases regarding the choice of structural material.

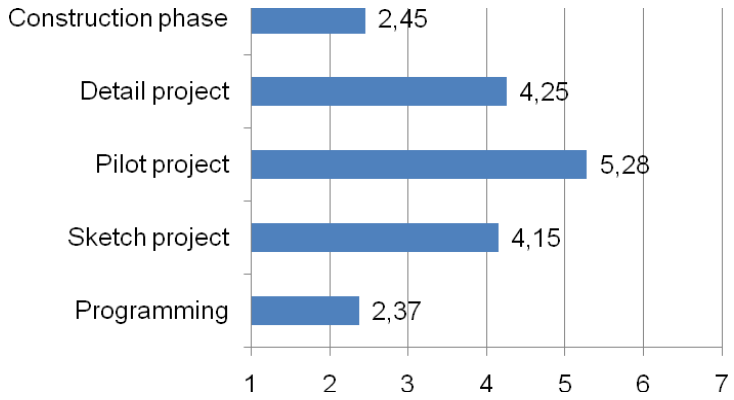

Figure 2. At what stages of the specification process were decisions regarding choice of primary construction materials made? (1=to a small degree; 7=to a large degree)

Figure 3 shows which information sources that are most commonly used by the architects and engineers. Internet, magazines and product information were the most commonly used sources for information among the respondents. Publications from research institutes in Norway were also used.

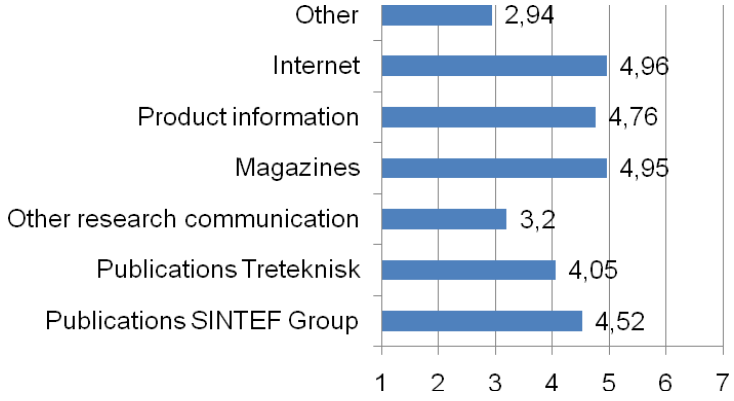

Figure 3. Indicate to which degree you use the following information sources (1=to a small degree; 7=to a large degree).

Figure 4 shows which subject areas the respondents wanted more knowledge about the use of timber. The respondents indicated a strong preference for more information about the use of timber regarding sound insulation, moisture and climate related issues, surface treatment of wood, fire protective measures and how to use wood in structures (score ≥5) and architecture (score 4,81).

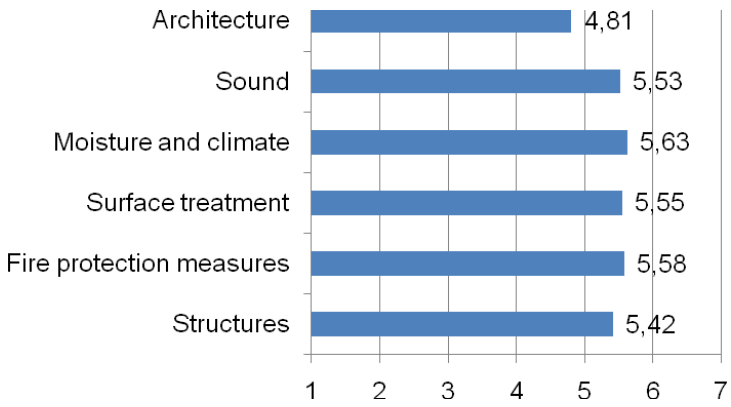

Figure 4. In which subject areas do you want more information about using wood? (1=to a small degree; 7=to a large degree)

4.3 Factor analysis

Fifty-six items from the questionnaire regarding criteria for the selection of building materials were subjected to exploratory factor analysis with maximum likelihood extraction method. The suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of loadings of .3 and above. The Keyser-Meyer-Oklin value was .634, above the recommended minimum threshold of .6, and Bartlett's test of sphericity reached statistical significance (.000), supporting the factorability of the correlation matrix (Pallant, 2007).

Factor analysis revealed the presence of 17 components with eigenvalues over 1.0, explaining 71.1% of the variance. To aid in the interpretation of the 17 components, oblimin rotation was performed. A minimum loading threshold of .4 was used. This revealed a simple structure (Pallant, 2007), with most components showing strong loadings, and all variables loading substantially on only one component. After inspecting the scree plot and examining the results of a parallel analysis, it was decided to retain ten factors for further analysis.

Twelve items did not load on any of the factors in the first analysis, and were removed from further analysis. A change in the scree plot was detected after the third round of analysis and a second parallel analysis supported the decision to reduce the number of factors to seven. A total of 26 items were removed after first five steps of factor analysis. After the fifth step all remaining items loaded substantially on one of the seven factors. Cronbach's Alpha (CA) was calculated to measure the internal validity of the scales, revealing a problem with negative covariance among the items, violating reliability model assumptions for the items measuring attitudes towards the environmental properties of wood. These items were removed from further analysis. The CA values were below .7 for two of the factors, so the mean inter-item correlation (IIC) was calculated for the items loading on the different factors. All scales had good or acceptable values for internal validity, except the scale measuring experience with building different building parts in wood, which had a poor value

for internal validity (.505) (Pallant 2007). Values for reliability are presented in table 2. The final seven-component solution explained a total of 72.1% of the variance. Explanation of variance for each factor is presented in table 2. The items included in table 2 are explained in the appendix.

Table 2: Factor analysis

Item	Factor						
	1	2	3	4	5	6	7
ExpBuilding1							,618
ExpBuilding2							,720
ExpBuilding3							,789
ExpPart1							,516
ExpPart2			,864				
ExpPart3			,603				
Intention1	1,028						
Intention2	,550						
Percbehcont1						,506	
Percbehcont2						,847	
Percbehcont3						,549	
Normengineer						,492	
Visual1					-,764		
Visual2					,791		
Visual3					,847		
Visual4					,625		
Fire1				,863			
Fire2				,889			
Fire3				,827			
Risk1		1,006					
Risk2		,795					
Risk3		,673					
Riskmaintn				,418			
Var. expl.(%)	23.2	12.1	10.9	9.2	6.8	5.7	4.2
IIC	.654	.669	.708	.595	.591	.368	.468
CA	.790	.856	.505	.856	.786	.698	.776

5 Discussion

The interpretation of the results from the structural interviews, the quantitative survey and the factor analysis was consistent with previous research (Emmitt & Yeomans 2008; Bysheim & Nyrud 2009; Wagner & Hansen 2004; Roos et al. 2008; O'Connor et al. 2004) suggesting experience, perceived risk, fire properties, visual properties and perceived behavioural control as important factors influencing the choice of wood as a structural material. The factor

analysis indicated that the following four factors were most important for architects' and engineers' use of timber as a structural material in urban areas:

- Intentions to use wood as a structural material in urban areas
- Attitudes towards the perceived risk of using wood
- Previous experience with wood in structures and wood surfaces
- Attitudes towards fire properties of wood

Intentions explain 23.2% of the variance in the data set. This variable will in a subsequent analysis be used to predict specifiers' intentions to use of wood as a structural material in urban areas. The results indicate that firms that would like to market wood as a construction material in urban areas should focus on using the familiarity of wood construction in different building parts and types. When marketing new wood products or building concepts, incorporating building techniques that are already familiar to architects and engineers when promoting wood as a structural material can be one way of reducing the perceived risk of using wood. Examples of successful wood construction projects in urban areas should be available to architects and engineers in order to minimize perceived risk (budget overruns, etc.), and workshops were more experienced architects and engineers share their expertise and knowledge with less experienced colleagues is one way of transferring knowledge and expertise. Also, updated technical and professional information about the fire related properties of wood should be readily available to architects and engineers.

References

Ajzen, I. 1991. The theory of planned behavior. Organizational Behavior and Human Decision Processes 50:179-211.

Bysheim, K., and Nyrud, A.Q. 2009. Using a predictive model to analyze architects' intententions of using wood as a structural material. Forest Products Journal 59:65-74.

Emmitt, S., and D.T. Yeomans. 2008. Specifying Buildings: A Design Management Perspective. Elsevier, Amsterdam. VII, 261 p.

O'Connor, J., R. Kozak, C. Gaston, and D. Fell. 2004. Wood use in nonresidential buildings: Opportunities and barriers. Forest Products Journal 54:19-28.

Pallant, J. 2007. SPSS Survival Manual: A Step by Step Guide to Data Analyzing Using SPSS for Windows. McGraw-Hill ; Open University Press, Maidenhead, the United Kingdom. 335 p.

Roos, A., L. Woxblom, and D. McCluskey. 2008. Architects', and Building Engineers, and Stakeholders' Perceptions to Wood in Construction – Results from a Qualitative Study. In: Bergseng E., Belbeck G, and Hoen H. (ed).

Scandinavian Scandinavian Forest Economics No 42, 2008., proceedings of the biennal meeting of the Scandinavian Society of Forest Economics. Lom, Norway, 6.- 9. April 2008.

Wagner, E., and E. Hansen. 2004. A method for identifying and assessing key customer group needs. Industrial Marketing Management 33(7):643-655.

Appendix

Explanation	Item
Experience with wood in apartment buildings	ExpBuilding1
Experience with wood in buildings for commercial purposes	ExpBuilding2
Experience with wood in public buildings	ExpBuilding3
Experience with wood used as facade material	ExpPart1
Experience with wood in primary construction	ExpPart2
Experience with wood in wood surfaces (flooring, etc.)	ExpPart2
I want to use wood in primary constructions	Intention1
I plan to use wood in primary constructions	Intention2
I am qualified to do the building design in projects with wood	Percbehcont1
It is easy to use wood in the projects I design	Percbehcont2
If I want to, I can use wood in projects were I do the design	Percbehcont3
The engineers attitude towards using wood	Normengineer
Wood is visually appealing	Visual1
Visual aspects are important when choosing wood	Visual2
Wood is easy to combine with other materials	Visual3
Wood is suitable for my design tasks	Visual4
Use of wood increase the risk of damage in case of fire	Fire1
Wood used as a facade material increase the risk of fire	Fire2
Wood used as a structural material increase the risk of fire	Fire3
Using wood increases the risk of budget overruns	Risk1
Using wood increases the risk of delays in a project	Risk2
Using wood increases the risk of building-related errors	Risk3
Risk of maintenance problems increases when using wood	Riskmaintn