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# Marija Miloshevska Janakieska, Martina Zbašnik-Senegačnik, Kiril Gramatikov, Manja Kitek Kuzman: ARHITEKTOVO DOJEMANJE STEKLENE FASADE IN BIVALNEGA UGODJA V POSLOVNIH STAVBAH V MAKEDONIJI ARCHITECT'S PERCEPTION OF GLASS FACADE AND LIVING COMFORT IN OFFICE BUILDINGS IN MACEDONIA

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## IZVLEČEK

Bivalno ugodje je v arhitekturi opisano kot stanje fizičnega udobja, svobode, prijetnega načina življenja, odsotnost stresa in dobrega počutja uporabnikov stavbe. Steklo pozitivno vpliva na bivalno ugodje, saj zagotavlja naravno dnevno svetlobo in povezavo z zunanjim prostorom ter tako ustvarja zdravo okolje v stavbah. Po drugi strani pa imajo zastekljene površine negativen učinek, kot so občutek mraza pozimi, pregrevanje poleti, učinek bleščanja in še več.

Da bi bolje razumeli uporabo stekla in dobili vpogled v težave in ovire pri stavbah s steklenimi fasadami, je bil analiziran vzorec poslovnih stavb v Makedoniji. V raziskavi so bile na podlagi anketnega vprašalnika narejene primerjave stališč arhitektov, njihova ozavešenost in preference o steklenih fasadah v Makedoniji. Študija temelji na anketnem vzorcu 67 arhitektov, ki so uporabili spletno aplikacijo anketnega vprašalnika, s stopnjo odziva 24%. Rezultati kažejo, da obstaja pozitiven odnos do uporabe steklenih fasad v Makedoniji. Hkrati se kažejo težave pri ozaveščanju in pripravljenosti za vključevanje novih tehnologij zasteklitev fasad. Te ugotovitve so lahko uporabne za tržne priložnosti, prepoznavanje ovir pri vključevanju steklenih fasad ter kot predlogi vsebin za delavnice, seminarje in druge informacijske mehanizme za izobraževanje arhitektov v Makedoniji.

## KLJUČNE BESEDE

steklena fasada, poslovna stavba, bivalno ugodje, Makedonija

## ABSTRACT

Living comfort in the architecture is described as a state of physical easiness, freedom, pleasant lifestyle, a relief from the stress and the well-being of the building's users. Glass positively affects the living comfort, because it provides natural day-lightning and connection with outer space, thus enables creating a healthy environment in buildings. On the other hand, glazed surfaces also have a negative effect, such as cold feeling in winter, overheating in summer, glare effect and more.

A sample of office buildings in Macedonia has been analysed, in order to understand the interest in using glazing technologies and to get a good overview of the problems and obstacles regarding glass facades. In this study, using a survey questionnaire, architect attitudes, awareness and preferences regarding the use of glass facade in Macedonia, are compared. The study is based on a sample of 67 architects using on-line survey, with a response rate of 24%. Results suggest that there is a positive perception in regards to the usage of glass facades in Macedonia, while at the same time, indicates problems in the awareness and willingness in incorporating glazing technologies. These findings can have implications for market opportunities, identifying barriers to glass facade adoption, and content for workshops, seminars, and other outreach mechanisms for architects in Macedonia.

## KEY-WORDS

glass facade, office building, living comfort, Macedonia

UVODNIK  
EDITORIAL  
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ARTICLE

RAZPRAVA  
DISCUSSION  
RECENZIJA  
REVIEW  
PROJEKT  
PROJECT  
DELAVNICA  
WORKSHOP  
NATEČAJ  
COMPETITION  
PREDSTAVITEV  
PRESENTATION  
DIPLOMA  
MASTER THESIS

## 1. INTRODUCTION

Human health and comfort have been perceived as the most important parameters during evaluations of indoor environments. Developing countries are limited by extreme environmental conditions, outdated construction techniques and scarce financial resources, which is why they struggle to adopt costly technologies aimed at achieving improved interior environments (Manzano – Agugliari, et al. 2015, p. 737). Therefore, one of the most important things for architects and engineers when designing a building is providing living comfort and well-being for the users. New sustainable designs incorporate the living comfort as crucial part together with the economic and environmental aspects (Akadiri, 2011, p. 127). Measuring progress towards sustainability therefore requires accounting tools that measure progress in terms of the socio-economic and ecological imperatives (Gibberd, 2018).

An essential role of architecture is to provide occupants' safety, health, physiological comfort, physiological satisfaction and productivity. Many building designers have been preoccupied with style and form-making, disregarding environmental quality and human satisfaction in and around the built environment.

Living comfort consists of several aspects (Akadiri, 2011; Manzano – Agugliari, et al. 2015; Andrade, Viera and Braganca, 2012; Markelj, 2016 and Browning, Ryan and Clancy, 2014): thermal comfort, daylighting, natural ventilation, acoustic comfort, safety and risk prevention, functionality and aesthetics (Praznik, Butala and Zbašnik-Senegačnik, 2014, p. 425).

The design of modern houses is orientated towards low energy consumption and users' comfort. Thus, investors and architects aim at maximizing the use of natural solar radiation gains, taking into account the orientation of a building and its transparent areas. With suitable technological development and appropriate use, glass is nowadays becoming crucial construction material that can improve the living comfort in the interior of the building. Incorporation of large and properly oriented glazed facade areas represents a great potential for achieving environment-friendly and energy-efficient buildings. The appropriate positioning of glass areas enables better energy performance of a building, where the solar gains obtained through the glazing can be evidently higher than the transmission losses through the same glazing areas. A comparison of transmission losses through the building envelope and possible solar gains through the glazing is of great importance in defining the optimal size of the glazing areas and performing a suitable selection of the glazing type. Further attention to the solar protection devices must be ensured (Ber, et al. 2014 and Leskovar and Premrov, 2012).

A number of studies treat the influence of the glazing on the internal conditions in and the energy performance of the buildings. A parametric study of heating and cooling demand was performed in order to determine optimal design for office windows for Swedish climates (Bülow-Hübe H, 2001), where the shape and size of the glazing have major influence on thermal comfort. Moreover, office module with two types of switchable glazing and one solar control glazing unit was used in three different climates; Stockholm, Brussels and Rome. The study shows that larger window areas

increase the cooling demand but if glazing types with lower solar transmittance are used, the difference in cooling demand between different window areas decreases (Persson, 2006).

The influence of windows on the energy balance of apartment buildings in Amman is investigated by using self-developed simulation software (SDS) based on the ASHRAE tables for solar heat gain calculation and cooling load factor for latitude 32°, where Amman city is located (Hassounah, Alshboul, and Al-Salaymeh, 2010). The purpose of the analysis of (Marino, Nucara, and Pietrafesa, 2017) was to verify the existence of an optimal size of the window surface, allowing for minimum overall energy consumption and improving the comfort for the users. The study was performed on an office building whose structure and configuration represent a typical reference case of the Italian building stock. Nevertheless, the authors suggested further investigation within future research, such as the influence exerted by the type, position and shape of the window.

Results of an analytical study of the functioning of glazing at two different yet interacting levels: at the level of the building as a whole, and at that of glazing as a building element was research in a study in Slovenia (Jordan and Zbašnik-Senegačnik, 2011). A research for the optimal proportion and appropriate orientation of glazing surfaces for locations in Athens and Sevilla suggests that the optimal solutions in such cases should avoid overheating (Premrov, Zigat and Leskovar, 2018). An experimental study of indoor thermal environment near a full-scale glass facade with different types of shading devices under varying climatic conditions in winter was presented by (Bessoudo et al. 2010).

In spite of a number of different studies presented, there is still a lack in studies that specifically examine a comprehensive understanding of architect perceptions related to glass facade influence on the living comfort, especially in Macedonia. As such, we selected architects as the key target group in this research effort as they are key decision makers in the selection of materials in the construction sector. Furthermore, architects communicate with all other participants in the project in every phase. In addition, some studies found architects to be environmentally conscious specifiers of construction materials, and, as such, are an important target group for research particularly as environmental and sustainability issues are becoming more salient issues generally (Singhaputtangkul, et al. 2014).

Similar study was performed by (Kuzman et al. 2018) using questionnaire for determining architect perceptions of different construction materials: engineered wood products of selected countries in Central and Southeast Europe.

This study aims to improve understanding of both disadvantages and advantages of applying glass facade to office buildings in Macedonia. At the beginning, analysis on a sample of office buildings in Macedonia were made in order to understand the situation and the interest in using modern glass facade technologies. Furthermore, in the main part of the study, using a survey questionnaire, the architects' perception of glass facade influence on the living comfort and indicators of problems in glass facade application in office buildings in Macedonia were perceived.

## 2. ANALYSIS OF OFFICE BUILDINGS IN MACEDONIA

In previous study (Analysis of office buildings with glass facade in Macedonia, 2018<sup>1</sup>), a research of the application of glass facade in office buildings in Macedonia has been done. The interest in glass facades is increasing lately, especially in the last few decades, according to information from system for issuing building permits where all data for the buildings are updated. The greatest interest is predominantly among office and administrative buildings, national institutions, commercial buildings and sports facilities.

In order to understand the situation in Macedonia and the interest in using modern glass facade technologies, about 30 office buildings were analyzed. The reason why office buildings were selected is mainly because they usually have a larger glazed facade area compared to other types of buildings. Furthermore, investors are motivated to use high technology materials and systems in office buildings with purpose to achieve attractive exterior. Buildings with bigger volume and larger facade surfaces, which most often do not have adequate protection against solar radiation, were selected. The analyzed buildings have different volumes and different dimensions, as well as different number of floors, from 4 to 10. The size of the glazed surface and the type of glass used for the glass facade also varies for different buildings. Double-glazed glass or single-laminated glass is most commonly used, while triple insulating glass is very rare. The construction of the glass facade is usually made of aluminum profiles.

The total analyzed area of the facades was 132 112m<sup>2</sup>, from which 58 729m<sup>2</sup> was a glazed surface, or 44% of the facade was glazed, while 56% was a non-transparent part of the building envelope, expressed in percentage. Glazing size ranged from 44% for the eastern and western facades, 49% for the southern facade and 43% for the northern facade.

The protection against solar radiation is crucial for buildings with a large glass surface, because it reduces the need for mechanical cooling. Despite this fact, very little attention is paid to the process of designing devices for solar control when using glass facades in office buildings in Macedonia. Only 29% of the analyzed buildings had full protection from the sun, which was provided through external elements such as large eaves that are thrown over the facade or appropriate lines of brilliance laid linearly along the glazing. 15% had partial protection from the sun, such as minimal breezes placed on only one part of the facade. Even 56% of the facilities had no external devices for protection against solar radiation at all. However, it could be seen that the application of shading devices, which is extremely important for achieving living comfort and healthy environment in office buildings, increased especially in the last 3 years, compared to the period from 2000 to 2004, where the percentage of buildings with no shading devices is highest.

<sup>1</sup> The study was developed at the Department on Concrete and Timber Structures, Faculty of Civil Engineering, University "Sts. Cyril & Methodius", Skopje, Macedonia

## 3. ARCHITECTS' PERCEPTION OF LIVING COMFORT IN OFFICE BUILDINGS WITH GLASS FACADE IN MACEDONIA

### 3.1 Objectives

The overarching goal of this study was to identify architects' perceptions regarding potential advantages/benefits and disadvantages/ challenges in using glass facades in Macedonia and their influence on the living comfort in the buildings, especially office buildings. Based on these perceptions, we hope that communication mechanisms and messaging to increase architect understanding of glass facades in Macedonia will be identified.

### 3.2 Methods

A survey questionnaire was constructed and developed by an international group of architects from Macedonia and Slovenia. The study methods included a two stage survey; in the first stage, personal interviews were conducted, and then, based on input from these in-person interviews, the second stage an exploratory web-based survey was designed. The survey questionnaire was in English (Table 1).

The target population of the survey included practicing architects, with lists compiled from members of professional architect societies and associations in Macedonia, the Chamber of Certified Architects and Certified Engineers of the Republic of Macedonia. Respondent data were collected through the on-line survey (the instrument was programmed in Free Online Surveys, a free web survey software); random sampling of these association populations was used. The main advantage of the Internet Surveys is the speed and low financial consumption. Pictures could be included among the questions, and people respond more honestly. The risk of not answering the entire survey exists, but less than on paper surveys, as well as it is only possible to contact people with e-mail and internet access. Therefore, an e-mail / website method is one of the most recommended. The only drawback is not being able to generalize the results to the entire population, but nowadays the problem of not having access to the Internet is declining. (Ibáñez, 2015, p. 23). Based upon similar studies (Damery and Fiset, 2001; Hwang and Shu, 2011 and Hincapié, et al. 2011) a response rate of 15–35% is considered adequate for analytical purposes for business/corporate surveys. Taking into account an expected response rate within this range and a sampling error of 10% (Dillman, 2011) we sent out 280 questionnaires. The survey process took place from mid-July to late August 2018. We received 67 valid responses. Taking into account non-deliverables (e.g., invalid email addresses or out-of-business firms); the response rates were 24%. Although the reasons for low response rates are unknown for this study, often, the main reasons for nonparticipation in surveys are non-appealing survey topic, or the length of the questionnaire (Fan and Yan, 2010).

The questionnaire was divided into four parts. The first part included demographic questions about respondent gender, profession and experience. The second part was composed of questions about living comfort, followed by the third part with questions about the influence of the glass facade on

Table 1: Online survey - The influence of the glass façade on the living comfort in office buildings.

1	Indicate how different aspects influence living comfort.
2	How important is natural daylight for achieving living comfort and healthy environment in the buildings?
3	Which aspect influences the most on the living comfort in summer?
4	Which aspect influences the most on the living comfort in winter?
5	Which types of buildings are most suitable for using glass facade?
6	Do you think that glass facades have a positive impact on the living comfort of the buildings?
7	Indicate which parameter can contribute the most in achieving living comfort in office building when using glass facade?
8	Mark aspects in which the glass facade can have positive impact on the living comfort in the office building?
9	Mark aspects in which the glass facade can have negative impact on the living comfort in the office building?
10	What is the main problem for failing to achieve living comfort in the buildings?
11	Do you think that living comfort could be achieved in office buildings with glass façade without using devices for solar control?
12	Which devices for solar control can achieve best protection from sun radiation in summer?
13	There are several ways of getting information about glass facades. Which is the most important?
14	What kind of information would you like to have?
15	In your opinion, is there increased use of glass facades in your country in the last 5 years?
16	What influence the most in the decision of the architects to use glass façade in designing buildings?
17	What is the major problem in the functioning of a glass façade building?

the living comfort. The last part had questions about the problems when using glass facade and information sources and information needs of architects.

## 3.2 Results

Majority of all respondents work in the field of architecture, but few of them are working in the field of building construction, or project management, interior design and structural engineering. Respondents had an average of 5–15 years of experience (63%), followed by 15 to 25 years of experience (18%). Only few of them had experience less than 5 years and more than 25 years. 40% of respondents were men and 60% women.

### 3.3.1 Living comfort

In the first part of the survey, the respondents were asked to rate different living comfort aspects on the scale from 1 to 5 (1 being the least and 5 being the most influential) about their influence on the living comfort. The

Table 2: Respondents ranking different aspects according to their influence on the living comfort

Aspects of living comfort	1	2	3	4	5	Average
Thermal comfort	2%	2%	14%	28%	<b>54%</b>	<b>4.30</b>
Daylight	0%	2%	8%	22%	<b>68%</b>	<b>4.56</b>
Humidity	2%	2%	32%	<b>35%</b>	29%	<b>3.87</b>
Natural ventilation and indoor air quality	2%	0%	8%	22%	<b>68%</b>	<b>4.54</b>
Acoustic comfort	0%	8%	<b>39%</b>	31%	22%	<b>3.67</b>
Safety and risk prevention	3%	6%	19%	16%	<b>56%</b>	<b>4.16</b>
Functionality	2%	0%	9%	31%	<b>58%</b>	<b>4.43</b>
Aesthetics	3%	3%	25%	<b>41%</b>	28%	<b>3.88</b>
Visual comfort	0%	5%	19%	<b>44%</b>	32%	<b>4.03</b>
Health and well-being	2%	3%	9%	22%	<b>64%</b>	<b>4.43</b>

responses are given in Table 3. The most important aspect which influences the most on the living comfort is daylight, followed by natural ventilation and indoor air quality, while the least important aspect which influences the least is the acoustic comfort according to the respondents' opinion (Table 2). The cells reflecting highest percentage are bold.

Respondents were also asked for their opinion about the importance of natural daylight. Results show that natural daylight is considered extremely important for achieving living comfort and healthy environment in the buildings (58%). Only 1% of respondents think that natural daylight is not so important.

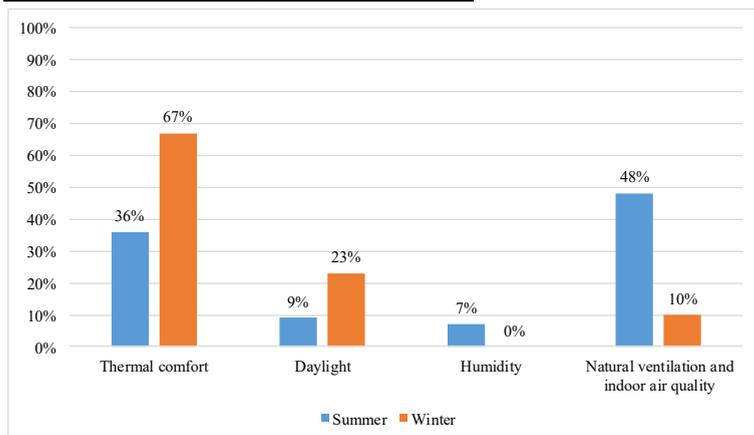
In addition to the rating of the living comfort aspects, respondents were also asked to select aspects that have major influence on the living comfort in summer and in winter. For the summer, natural ventilation and indoor air quality was chosen as the most influential. On the other hand, thermal comfort was chosen as most influential for the winter. Humidity is chosen as the least influential aspect for both summer and winter (Graph 1).

### 3.3.2 The influence of the glass facade on the living comfort

Respondents were selecting the type of building which are most suitable for using glass facade: office, industrial and residential buildings. On the first place were office buildings. Additionally, on the question whether the usage of glass facade has a positive impact on the living comfort, 79% of the respondents answered positive.

Moreover, for achieving living comfort in office buildings when using glass facade, the respondents indicated in the first place the characteristics of the glass as most important parameter (41%), followed by the orientation of the glass (24%). The size of the glazing is chosen as the least important parameter (Graph 2).

Graph 1: Aspects that influence the most on the living comfort in summer and in winter according to respondents.



Furthermore, we asked the respondents to rate the aspects in which the glass facade can have positive impact on the living comfort in the office buildings. They answered that the most positive impact is obtaining natural daylight and reducing the costs for electricity, followed by gaining heat from sun radiation in winter and reducing the costs for heating (Table 3)

Table 3: Respondents ranking different aspects in which glass facade can have positive impact on the living comfort.

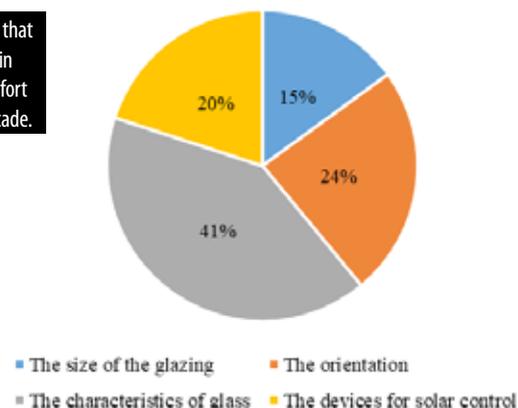
Positive impact of the glass façade on the living comfort	1	2	3	4	5	Average
Gaining heat from sun radiation in winter and reducing the costs for heating	2%	0%	24%	36%	<b>38%</b>	<b>4.08</b>
Natural daylight and reducing the costs for electricity	2%	2%	17%	28%	<b>51%</b>	<b>4.24</b>
Connection with outer space	3%	8%	23%	27%	<b>39%</b>	<b>3.91</b>
Health and well-being of the users	3%	3%	18%	37%	<b>39%</b>	<b>4.06</b>
Natural ventilation (if some of the parts of the façade are not fixed)	6%	8%	27%	<b>31%</b>	28%	<b>3.67</b>

On the other hand, respondents reported that overheating in summer and need for mechanical cooling is the most negative impact that the glass facade has on the living comfort, while losing heat in winter is on the second place. Bad sight view is not a significantly important factor that influence negative on the living comfort (Graph 3).

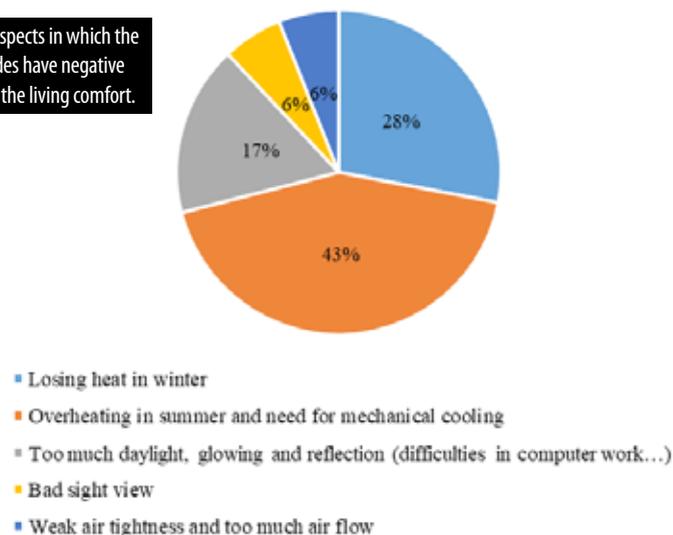
### 3.3.3 Problems when using glass facade, information sources and needs of architects/promotional methods

Despite the string of positive features that the glass facades can provide for a building, there are certain obstacles and problems that prevent its usage, especially in Macedonia.

Graph 2: Parameters that contribute the most in achieving living comfort when using glass facade.



Graph 3: Aspects in which the glass facades have negative impact on the living comfort.

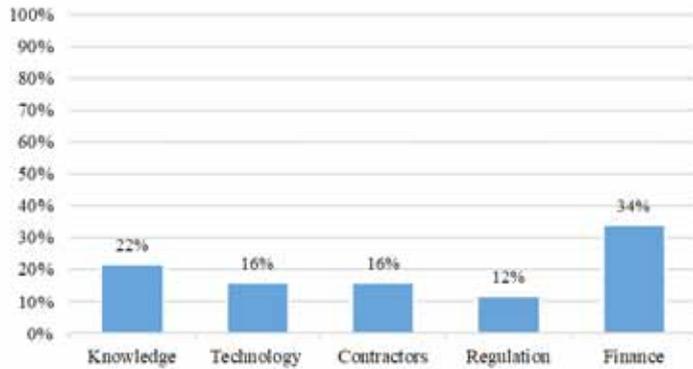


Finance was given as a main problem for failing to achieve living comfort in the buildings in Macedonia according to respondents' opinion (Graph 4).

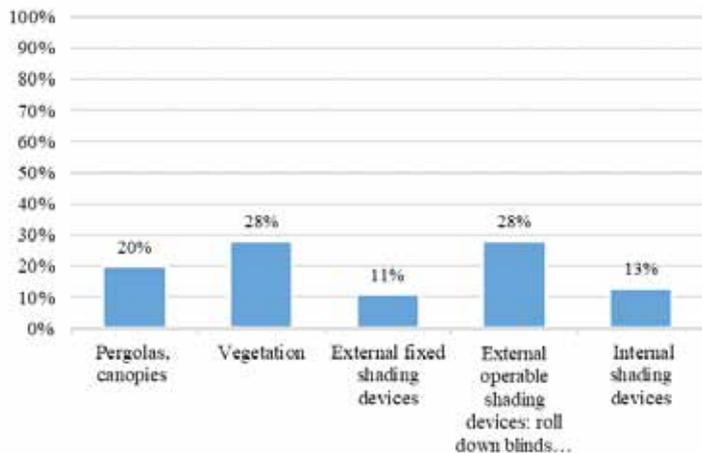
51% of the respondents think that living comfort could not be achieved in office buildings with glass facade without using devices for solar control. In addition, the best protection from sun radiation in summer can be achieved using vegetation and external operable shading devices (Graph 5).

Given the importance of learning about products on the job, respondents were queried about various methods of obtaining information to support their firms and profession. Selections were made based on the following list of informational sources: Internet, from building companies, through manufacturers, through architect associations, and from homeowners. The respondents were asked to rate the ways of getting the information from 1 to 5 (1 being the least and 5 being the most). Building companies were chosen as the most important way of getting information about glass facade (Table 4).

Graph 4: Problems for failing to achieve living comfort .



Graph 5: Devices for solar control which can achieve best protection from sun radiation in summer according to the respondents.



Graph 6: Information needs for glass facades.

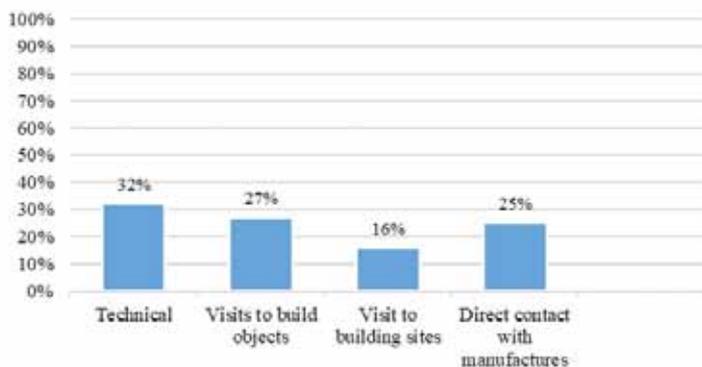


Table 4: Respondents ranking different ways of getting information about glass facade.

Information	1	2	3	4	5	Average
Internet	0%	2%	36%	20%	<b>42%</b>	<b>4.02</b>
Building companies	2%	3%	16%	<b>44%</b>	35%	<b>4.07</b>
Manufactures	3%	6%	21%	27%	<b>42%</b>	<b>3.96</b>
Architect's associations	11%	11%	22%	22%	<b>33%</b>	<b>3.52</b>
Users	5%	8%	17%	22%	<b>48%</b>	<b>4.00</b>

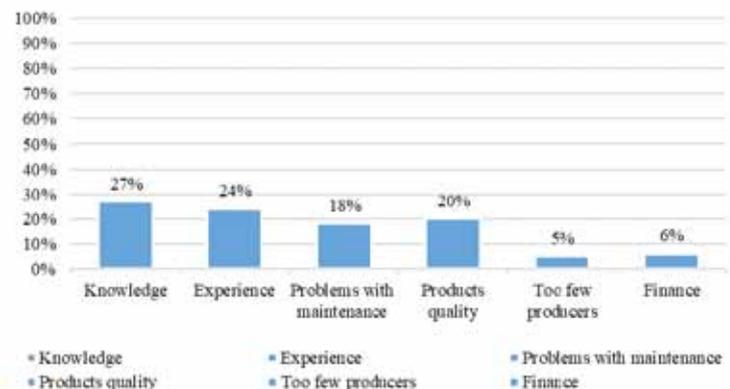
Respondents were also asked about the effectiveness of various information sources in terms of learning about glass and glass facade relative to architectural applications. Specifically, they were asked to identify ways that they would like to get information about glass facade, through 1) technical specifications; 2) visits to completed structures; 3) visits to building sites under construction; and 4) direct contact with glass façade manufacturers.

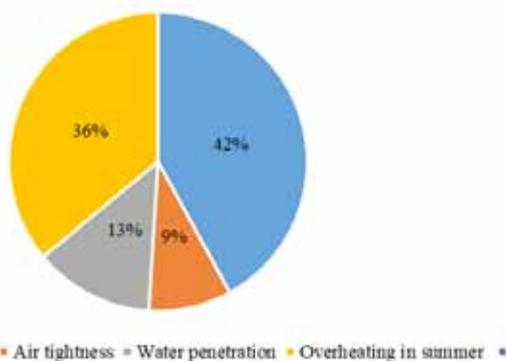
Respondents noted that obtaining information through technical specifications was the top rated preference, followed by visits to completed structures (Graph 6). In last place was through visits to building sites under construction.

On the question about their perception regarding application of glass facades in the last 5 years in Macedonia, 67% of the respondents think that the usage is increased. Moreover, respondents were asked to identify the main aspects that influence the most in the decision to use glass facade when designing buildings. The lack of knowledge is pointed as a main aspect for not using glass facade, followed by the lack of experience, low products quality and problems with maintenance (Graph 7).

Finally, respondents were asked about the problems in functioning and maintenance of a glass facade building. Cleaning of the glass (42%) is a major problem, followed by overheating in summer (36%) (Graph 8).

Graph 7: Factors that influence on the decision of the architects to use glass facade in designing buildings.



**Graph 8: Problems in functioning and maintenance of a glass facade building.**

#### 4. DISCUSSION AND CONCLUSIONS

Glazing affects the energy balance of the building or part of the building (offices), as dynamic processes take place through glazing facade surfaces: transmission heat losses and solar irradiation (Jordan and Zbašnik-Senegačnik, 2011, p. 53). However, appropriate size and positioning of glazed areas can enable better energy performance of a building, where the energy from the sun obtained through the transparent part of the envelope can be clearly higher than the transmission losses through the same part (Leskovar and Premrov, 2012, p. 94).

When analyzing the buildings in Macedonia, one tendency of glazing can be concluded which is not related to the orientation towards the east, west, north or south, but to the orientation of the building towards the main street. Thus, the largest glazed surface of the building is most often placed on the facade that is oriented towards the main street, where the access to the building is most commonly located. The reason for this is that this facade is being considered as the most attractive facade and it is in the focus of the passers-by. Architects and investors usually do not pay so much attention on the facades on the back side of the building, so there are usually no large glass facade surfaces, but only windows for functionality of the premises.

Regardless of the fact that protection against solar radiation is crucial for buildings with a large glass surface, it can be concluded that in this segment very little attention is paid to the process of glass facade design in the administrative buildings in Macedonia. Only 29% of the buildings have full protection from the sun, which is provided through external elements such as large eaves that are thrown over the facade or appropriate lines of brilliance laid linearly along the glazing. 15% have partial protection from the sun, such as minimal breezes placed on only one part of the facade. Even 56% of the facilities have no external devices for protection against solar radiation at all. This is a big problem because Macedonia is a country where high temperatures above 40 °C are reached in the summer, and very often there is overheating of the inner space which demands additional energy for mechanical cooling. Almost everywhere where there are no external sun protection devices, interior elements such as curtains, venetians and others

are installed, but these devices have a much weaker effect. However, application of shading devices increased especially in the last 3 years, compared to the period from 2000 to 2004, where the percentage of buildings with no shading devices is highest.

In addition, an online survey was conducted to collect data from over 60 respondents. The results show that there is a positive perception in terms of using glass façade in buildings in Macedonia.

The most important aspect which influences the most on the living comfort according to respondents' opinion is daylight, which can be provided using glass as a transparent material in buildings. On the other hand, the least important aspect which influences the least is the acoustic comfort which also goes in favor of glass facade usage, because the glass facade has a lower sound insulation compared to walls. Also, natural daylight is considered extremely important for achieving living comfort and healthy environment in the buildings.

According to this survey, office buildings are most suitable for using glass facade which can even improve the living comfort inside the buildings. The most important factor for achieving living comfort is considered to be the characteristics of the glass, from which the glass facade is made.

The most positive impact from the glass facade can be seen in obtaining natural daylight and reducing the costs for electricity, followed by gaining heat from sun radiation in winter and reducing the costs for heating. On the other hand, the most negative impact from the glass facade on the living comfort inside the office buildings is the overheating in summer and the need for mechanical cooling. Therefore, it is extremely important, architects and engineers to design devices for solar control in the early stage of the design.

Finance was given as a main problem for failing to achieve living comfort in the buildings in Macedonia according to respondents' opinion.

In terms of architects' opinion on whether there has been increased use of glass facades in the last 5 years, in Macedonia, the majority agree. There is in general a lack of knowledge of the principles of design options in using glass facades, especially in the office buildings in Macedonia. Results show that building companies are leading source of information for architects. Architects also need more technical information to better understand the glass facades application.

Architects could be good advocators for an increased use of glass facade but increased efforts must be placed to increase their knowledge. Demonstration projects are vital to show the various actors teamwork with glass facade in practice; e.g. collaboration among representatives of the production, architects, builders and housing associations, to better understand the technical and the business potential of glass as a building material. To gain more knowledge of glass as a material, more diverse group should be targeted in this region, e.g. including contractors and civil engineers. Moreover, knowledge about protection of solar radiation through devices for solar control is needed, when using different glass facade systems.

Using the information obtained in this study will contribute to an understanding of the application of glass facade in Macedonia. It is important to integrate technical specifications and also experience to ensure understanding of the functional and aesthetic performance of glass facade from design to construction to use. As the authors believe that the increased and appropriate use of glass facade may be an important element of a more sustainable future built environment, more information about use and perceptions is needed.

With a review of enhancing the knowledge about glass facades' influence, we aim to focus our further studies onto the perception of the users of office buildings with glass facades, because they are directly influenced by the living comfort.

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