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THE EFFICIENCY, ENERGY INTENSITY AND VISUAL IMPACT OF THE ACCENT LIGHTING IN THE RETAIL GROCERY STORES

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ABSTRACT

Over the last few years, topics of displaying, presentation, lighting, energy saving and issues related to the environment while selling the fresh food (fruits, vegetable, bakery products, meat) are becoming an important matter among traders. However, just bigger companies with transnational capital have devoted their attention to this issue yet. Generally, the energy costs make up 70% of operating costs in retail stores where the cooling system and lighting are the most energy consuming. Accent lighting in modern retails is largely involved in the overall design and atmosphere in shops and plays a crucial role in presenting the goods as well. Using of accent lighting can draw the customer's attention to a specific part of the sales area and achieve the overall harmonization in the store. With the rational using of combination of energy saving and effective accent lighting retailers can achieve not only attractive presentation of displayed products but also appreciable savings in the operation of their stores. It is the only factor that can be exactly measured and controlled. Using a Colour and Lux Meters we found out the intensity and color temperature of accent lighting used in domestic and foreign retail chains for the different kinds of fresh food products. Based on the obtained values we have compiled graphs, which are showing visual comfort. We also identified different types of accent lighting, which we assigned to their impact on emotional involvement of consumers. The starting points were the tests we conducted in simulated laboratory conditions. While searching of a compromise between effective and energy efficient accent lighting we take into consideration consumers' emotional response as well as the annual electricity consumption of different types of light sources. At the end we recommend options for energy-efficient, effective and spectacular lighting while using the optimal number of light sources and their logical organization, automatic control as well as using energy-saving LED lights or practical skylights. Improvements in energy efficiency of technical equipments could reduce the operating costs for retailers as well as enhance the attractiveness of displayed goods and customer satisfaction and thereby increase their sales.

Keywords: retailing; efficiency; visual impact; innovation; accent lighting

INTRODUCTION

Retailing consists of the final activities and steps needed to place merchandise made elsewhere into the hands of the consumer or to provide services to the consumer. In fact, retailing is actually the last step in a supply chain that may stretch from Europe or Asia to your hometown **(Dunne et al., 2013)**. Retailers play a major role in creating and adding value to final goods and services. This ensures that customers needs and wants are satisfied **(Cant, 2005)**. In today era retailing combines the function of retail and wholesale with the function of internal and external trade within one business entity **(Cimler et al., 2007)**. Every retail business, regardless of its financial background is associated with the application of various marketing tools. All the marketing tools that are applied in terms of retail chains are called retail marketing. Retail marketing can be considered as marketing, which can be applied in retailing. It represents all the activities related to the "4P" marketing (product policy, pricing, communication policy, and distribution policy) performed in retailing **(Horská et al., 2010)**.

There are economic tendencies, which fundamentally change the conditions in the global market **(Nagy et al., 2012)**. **Bárta et al. (2009)** emphasize that it is necessary to mind out the human behavior while the marketing application in business. New revolutionary technologies offer incredible potential for the application of marketing and marketing techniques. The retail market is changing with an unbelievable rate and a lot of businessmen are therefore trying to use innovative ideas, which could help them to distinguish themselves from their competitors **(Hallbauer, 2008). Das (2009)** states that while the consumer can pretend his behaviour, his brain activity tells about the true intentions of his purchase decision. One of the new approaches, which connect knowledge from neuropsychology, cognitive psychology and neuroscience with the environment of marketing decision-making, is called neuromarketing **(Vysekalová et al., 2011)**. Neuromarketing presents the relation of medical knowledge; technology and marketing, which through brain screens can help, understand incentives in the brain and how they are processed **(Lindstrom, 2009)**. Neuroeconomics, neuromarketing, neuroaesthetics and neurotheology are just a few of novel disciplines that have been inspired by a combination of ancient knowledge together with recent discoveries about how the human

brain works **(Legrenzi and Umiltá, 2011)**. However, having the best technology or the highest quality solution does not guarantee that prospects will always buy from you. But exciting new findings in brain research suggest that speaking to the true decision maker, the old brain will raise your effectiveness in communicating an idea or selling a product **(Renvoisé and Morin, 2007)**.

Neuromarketing uses a variety of tools and techniques to measure consumer responses and behavior. These include everything from relatively simple and inexpensive approaches, such as eye tracking (measuring eye gaze patterns), analyzing facial expressions, and behavioral experiments (for example, seeing how changes in product displays affect a consumer's choices), to more complex, sensor-based approaches, including biometrics (body signal measures) that measure perspiration, respiration, heart rate, and facial muscle movement (electromyography [EMG]), as well as neurometrics (brain signal measures) that measure electrical activity (electroencephalography [EEG]), and blood flow (functional magnetic resonance imaging [fMRI]) in the brain (Neuromarketing uses a variety of tools and techniques to measure consumer responses and behavior. These include everything from relatively simple and inexpensive approaches, such as eye tracking (measuring eye gaze patterns), analyzing facial expressions, and behavioral experiments (for example, seeing how changes in product displays affect a consumer's choices), to more complex, sensor-based approaches, including biometrics (body signal measures) that measure perspiration, respiration, heart rate, and facial muscle movement (electromyography [EMG]), as well as neurometrics (brain signal measures) that measure electrical activity (electroencephalography [EEG]), and blood flow (functional magnetic resonance imaging [fMRI]) in the brain **(Genco et al., 2013)**.

The structure and circulation of the space has been determined, the atmosphere and thematics of the space must be created through lighting, sound, materials and visual branding. These design elements have the greatest impact on the consumer behaviour in the store. One of the key requirements of operating equipment of modern retail stores is good quality lighting that enhances the image of these stores, attracts potential customers as well as focuses their attention on the displayed products what results in increasing of sales. The importance of good lighting is often still underestimated. However, lighting is incredibly important to any retail environment. General lighting, lighting to emphasise and coloured lighting can all give the store and the merchandise something extra and make them look more appealing. Lighting can bring drama into the store **(Floor, 2006)**.

Poor lighting can cause eye strain and an uncomfortable experience for the consumer. To minimize the possibility of eye strain, the ratio of luminance should decrease between merchandise selling areas. The next layer will complement and bring focus onto the merchandise; this lighting should be flattering for the merchandise and consumer. The final layer is to install functional lighting such as clear exit signs **(Israel, 1994; Lopez, 2003)**.

A case study of **Areni and Kim (1994)** found out that clearer interior store lighting act more positively on consumer perception in the form of time spent by browsing the goods in the store.

Characteristics of the lighting used in the retail food stores can be designed in various ways. The primary purpose of lighting is to improve the display of merchandise. Lighting systems can significantly increase the positive reaction of the consumer to products on display **(Piotrowski and Rogers, 2007)**. They contribute to make an impression about the visual quality of the environment in stores, but can also be used to disguise poor quality of products offered. Lighting is used not only for food accents lighting products, but also to create a photometric reactions in products to be sold in the stores **(Borusiak, 2009)**.

Store design is a fascinating multifaceted field **(Ebster and Garaus, 2011)**. Retail store design factors into window displays, furnishings, lighting, flooring, music and store layout to create a brand or specific appeal.

All the stores are using basic lighting, which is in many stores combined with the accents lighting. This one can play a decisive role, especially when selling the fresh products. Selecting the appropriate combination of different types of lighting in grocery stores undoubtedly contributes to building the image. One could say that the image is considered as the generalized and simplified symbol, which is based on the interplay of ideas, attitudes, views and experiences of man in relation to a particular object **(Kleinová and Kretter, 2011)**.

The image means that the thing is able to break out of the stereotypical average and become original, unique and different **(Banyar, 2006)**.

Basic lighting does not essentially very among the stores operating on the Slovak food market **(Nagyová and Machajová, 2008)**. Even though, the accent lighting is significant and the only one strong marketing tool for some types of unpackaged fresh food (fruits, vegetable, bakery products and meat products) there are still food store chains which do not attach to this element as much importance as they should do.

To choose strategy of presenting new launched as well as already existing products in retail grocery stores correctly by using the optimal mix of marketing tools, it can significantly contribute to the growth of retail turnover **(Kubicová and Kádeková, 2011)**. The matter of effective presentation of goods in retail stores is closely related to the issue of efficiency and energy consumption. Especially while using the lightning as a significant marketing tool it is necessary to take into account the energy consumption since lighting is one of the major cost items in retail stores. On the food market retailers should focus not only on the impressive presentation of the displayed goods but it is important to seek a compromise between the energy consumption of light sources and their effect on consumer perceptions.

Energy consumption of stores may vary greatly depending on their size and segment offered. By far the most energy power in food retailing is used for keeping food cold as well as for presentation of fresh products **(Horská and Berčík, 2013)**.

Global warming is increasingly changing climatic conditions as well as the natural environment. Combating the climate change has become one of the challenges of

today era. More and more retail stores mainly with the multinational capital ties operate on the market keeping in mind the previous fact. Foreign but also domestic retailers are increasingly becoming aware of the need to protect the environment and climate, which impact their business activities **(Jongen and Meulenberg, 2005)**. That is the reason why they are trying to build projects of so-called green stores using the energy-saving initiatives. Some of them are equipped with new-efficient technologies such as solar panels, wind turbines and geothermal wells of course according to the specifics of each individual store.

MATERIAL AND METHODOLOGY

"The Use of Neuromarketing in Visual Food Merchandising" conducted at the Department of Marketing at the Slovak University of Agriculture in Nitra.

The main objective of this paper is to highlight the efficiency, energy intensity and visual impact of the accent lighting in retail food stores in Slovakia and also to point out the retailing solutions that will contribute to the elimination of negative impacts on the environment. The aim of this paper is also to find a compromise between visual impact and energy consumption of different types of accent lighting in selected food store chains operating on the Slovak market and make proposals for the optimal operating and competitive energy lighting in the stores. While preparing this paper we used available book sources such as professional publications of domestic and foreign authors, print journals as well as information available on the different websites and library publications.

To obtain the underlying data we used:
- digital lux meter - Brand: Mastech, type: MS 6612
- digital color meter - Brand: Minolta II
- mobile device EEG (electroencephalogram) - brand EPOC
- 5 different types of lighting (halogen, metal halide-cool, warm-halide, LED, fluorescent)

The first part of the research was carried out in the field in order to measure values of accent lighting in the retail stores. These were used to compare and identify the different types of accent lighting. The measurements of basic and accent lighting for the different kinds of fresh products were made with the intention to find visual comfort in the most significant food store chains operating in Slovakia. To process the above mentioned we used Luxmeter (brand Master - tech) and Color meter (Minolta II). The obtained data were synthesized for each individual type of lighting and after we created a graph showing visual comfort when buying food in different retail stores. The second part of the research was carried out in simulated field conditions. The laboratory was set up to uncover preferences and emotional involvement of respondents by using different types of accent lighting. During the first phase of the laboratory research there was always couple of respondents who visually evaluated the different types of lighting in simulated conditions by means of a questionnaire survey. In simulated conditions we used five different types of lighting, which were designed to provide about the same luminous flux 600lux (except stand no.3) despite of some differences in power. The second phase of the research consisted of consumers´ neurological tests. The wireless EEG device was set on the respondent´s head to read its brain activity in real time. This device was sending data wirelessly with a frequency of 2.4 GHz to the control center where they were recorded into three software solutions. Individual light sources were used to illuminate the fruit (apples and oranges).

To process the obtained data we used basic methods namely comparison, selection and graphic presentation of data. Calculation of energy indicators is based on the following relation:

$$S = \frac{P * \quad t * \quad d * \quad m}{1000} \text{ in } (€)$$

P - Electric power of device (W)
T - Device´s time of use during the day (hours)
D - The number of days
m - Price per 1kW

Table 1 Technical parameters of different types of accent lighting in simulated conditions.

Station	Light Source	Power	Luminous flux	Colour temperature	Colour rendering index
1	Halogen lamp	160W	650lux	2700K	70CRI
2	Metal-halide lamp	70W	580lux	5000K	60CRI
2	Metal-halide lamp	150W	850lux	3000K	85CRI
4	LED lamp	60W	620lux	5600K	75CRI
5	Fluorescent lamp (tube)	72W	540lux	4100K	64CRI

RESULTS AND DISCUSSION

Based on measurements made within selected retail chain stores we made comparisons of the intensity and color temperature of accent lighting used for the fresh food (fruit and vegetable, bread and bakery products). After this we synthesized the conclusions of efficiency and energy intensity in these grocery stores. As the Figure 1 shows, the highest light intensity for fruits and vegetable is used by the Austrian retail chain Billa. On the other hand the lowest intensity of accent lighting was measured in the supermarket chain CBA as this retail tends to use basic lighting simultaneously as accent lighting for fruit and vegetables. Low values of accent lighting intensity for bakery products were measured at several local chains such as COOP, CBA, Nitra Zdroj but also in some foreign retail chains such as Lidl and Hypernova.

By measuring the color temperature of accent lighting in different retail chains we identified light source used and also the color of light emitted from accent lighting. In Figure 2 you can see that accent lighting used for fruits and vegetable in retail chains Tesco, Kaufland and Hypernova produces the warmest color. The light color

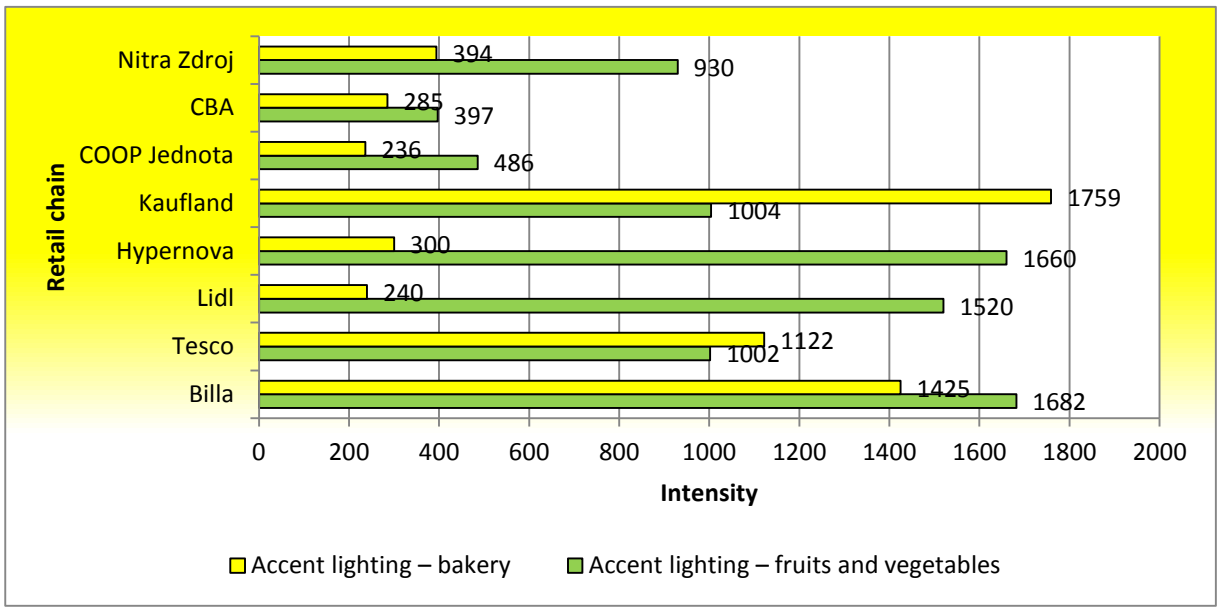

Figure 1 Comparison of accent lighting intensity for fruits, vegetable and bakery products.

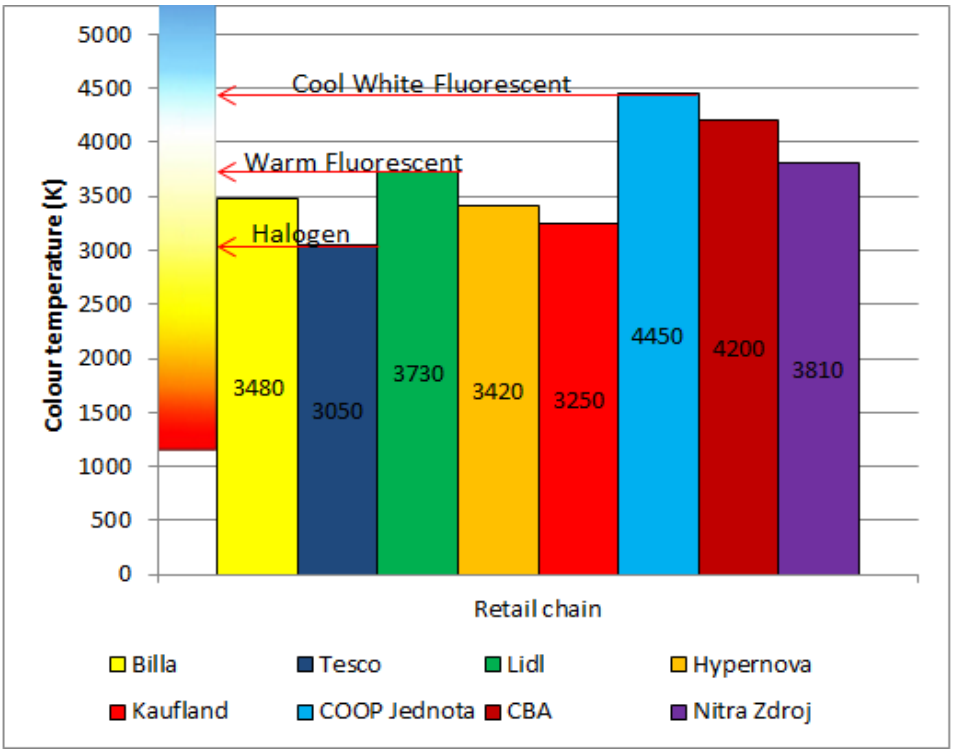

Figure 2 Comparison of accent lighting color temperature for fruit and vegetables.

emitted from the light source is a warm yellow which is typical for halogen light sources or fluorescent lights producing a warm yellow light as in the case of retails Lidl and Nitra Zdroj. Due to the fact that almost no chains operating in the Slovak food market do use LED light source, the coldest accent lighting used for fruits and vegetable has been observed in the COOP. Here the fluorescent light source producing white cold color is used.

As the Figure 3 is showing, for accent lighting used to light up the bread and bakery products retails chains Tesco, Kaufland and Hypernova are using light sources emitting the hottest color light in. Light sources that produce cool colors were used to light up bread and bakery products only in the stores of CBA where the basic lighting is also used as accent lighting for bread and bakery products.

Comparisons of the intensity and color temperature of lighting in five foreign and three domestic retail chains were used to compile graphs of accent lighting visual comfort in these retail food chains.

Based on the observed data and the created graphs of visual comfort we can state that in the case of accent lighting used to illuminate the fruits and vegetable the pleasant environment is typical for the retail chains as it can be seen from Figure 4. On the other hand for accent lighting used for bakery products several deficiencies were found. In Tesco and Kaufland chains there is very bright and unnatural environment causing colors distortion of displayed goods. CBA, COOP and Lidl mostly use accent lighting with a dark color environment for bakery

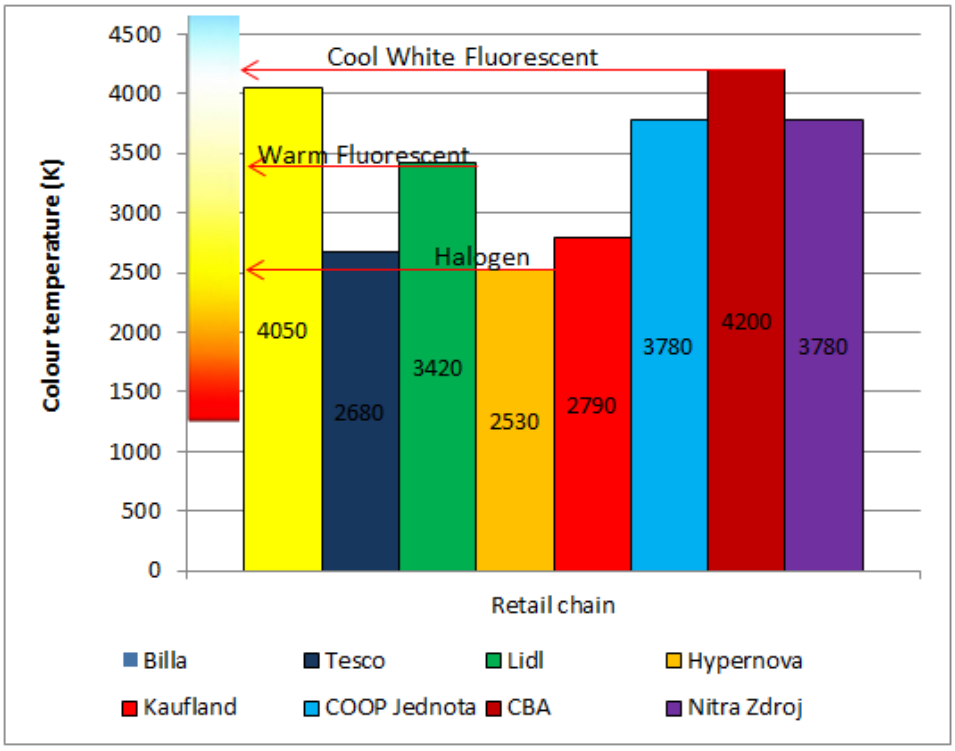

Figure 3 Comparison of accent lighting color temperature for bakery products.

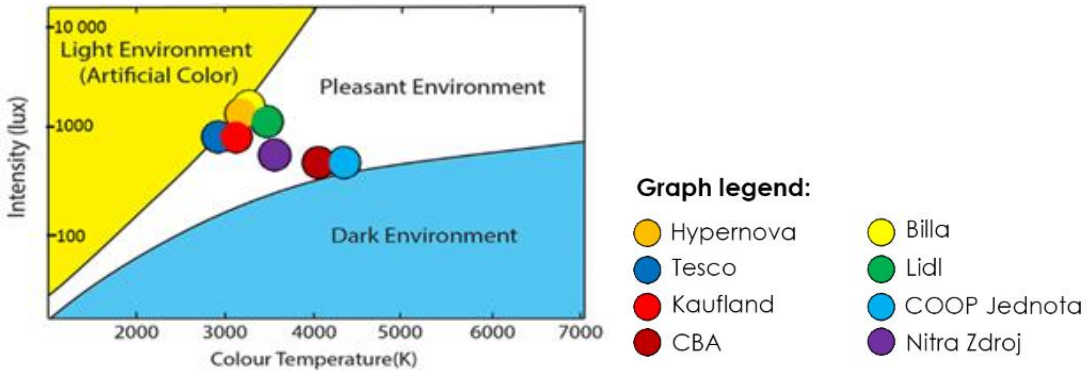

Figure 4 Visual comfort of accent lighting used for fruits and vegetables in retail chains operating in Slovakia.

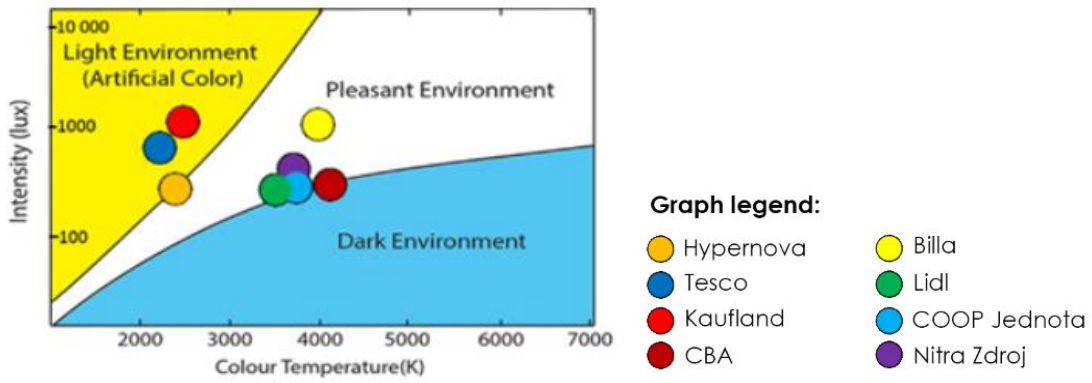

Figure 5 Visual comfort of accent lighting used for fruits and vegetables in retail chains operating in Slovakia.

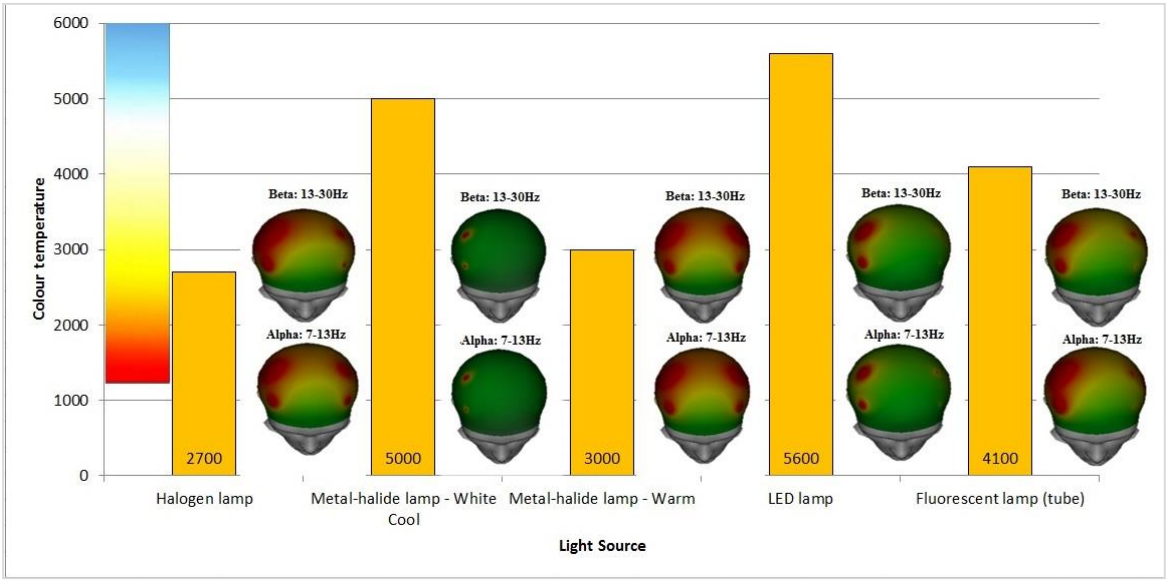

Figure 6 Comparison of respondent's emotional involvement within each type of accent lighting in simulated conditions.

products, which also causes some kind of deficiencies while presenting this type of good (see Figure 5). Lighting in retail chain Billa possibly Hypernova, Lidl or Nitra Zdroj can be considered as the optimal solution. Based on the underlying data and the fact that the stores are not using energy-saving LED light sources we can state that accent lighting creating too bright and unnatural environment contributes to higher energy consumption and lower operating efficiency of these technological resources.

In order to find a compromise among efficiency, energy intensity and visual impact of different types of accent lighting the place with simulated conditions for fresh food sales (fruits and vegetable). Figure 6 shows the respondent's emotional involvement in different types of lighting conditions. The greatest emotional response was observed with using the halogen and metal halide light sources producing a color temperature in the range 2700-3000 K. On the contrary the least impact on the respondent's emotions the cold light sources emitting light: LED and metal halide - cool white cause.

According to the figure 7 the most respondents consider halogen lighting as the most attractive one based on visual evaluation. This type of light source produces warm vibrant colors with a value of 2700K and intensity of 650lx and was used to illuminate the goods under the first stand. However, the disadvantage of this light source is higher energy consumption and its lower lifetime. According to the 40% of respondents the second most attractive type of accent lighting is metal halide lamp with a power of 150W.

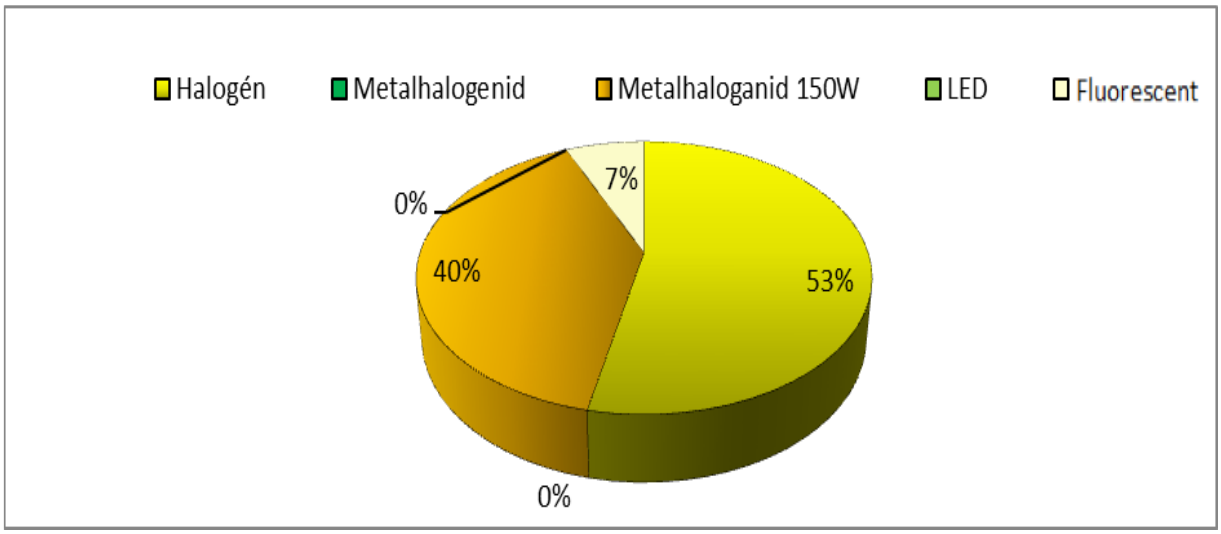

Figure 7 The most attractive accent lighting in simulated conditions - visual evaluation.

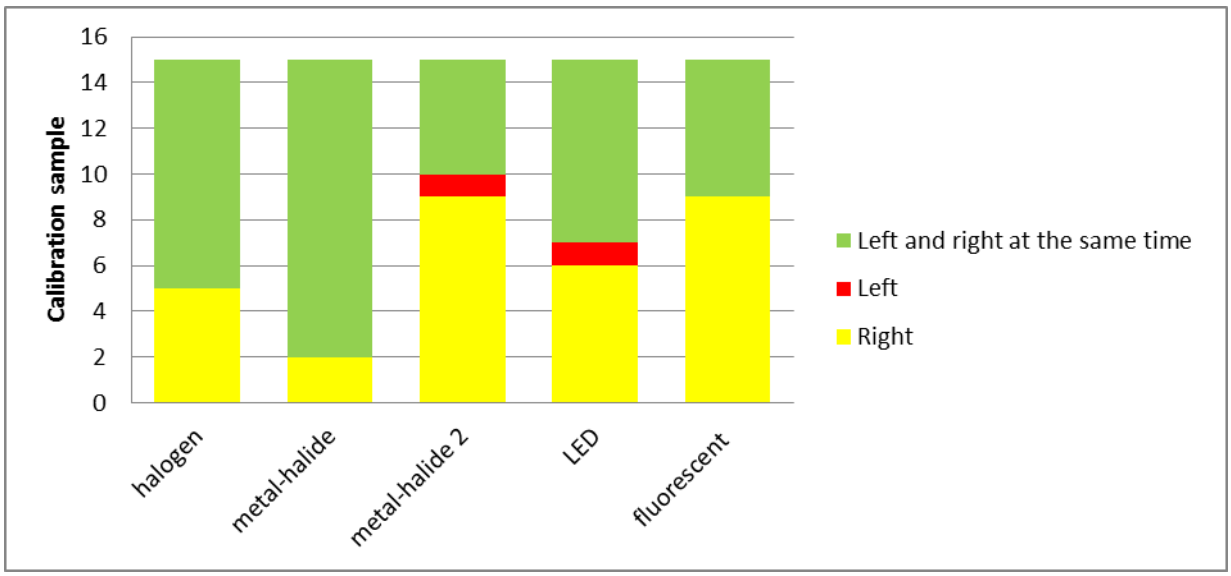

Figure 8 Monitoring the response in the different hemispheres while using different types of lighting - simulated conditions.

Reactions in different parts of the respondents' brain within each type of accent lighting vary what means that the light source does really affect consciously but also unconsciously on consumer response. Watching the origin of the responses in the right and left hemisphere enable us to identify which type of lighting evoked more emotional reactions. The response in the right hemisphere is considered as an emotional response so far the response in the right hemisphere reflects a rational reaction of the respondent. Figure 8 presents the emotional involvement of the respondents for each type of accent lighting.

The most emotional responses arose while using metal halide reflector with 150W. In questionnaire survey consumers rated this one as the second most attractive type of lighting also with fluorescent lighting source. On the other hand the least respondents' emotional reactions arose while using metal halide reflector with power 70W as well as halogen lamps. Paradoxically, the halogen light source was visually rated as the most attractive. Mostly the respondents' brain activity appears on the right side of the human brain, which is emotional hemisphere (less rational hemisphere). Just after this the activity extends also to the other parts of the brain. In general women are more emotional than men and also younger people react more emotional compared to older people. To illustrate in better way the brain activity in its different parts we compared the reactions of five different respondents while watching the fruits (apples and oranges) illuminated with metal halide reflector 150W (Figure 9).

To make this comparison we chose two men and three women in age between 24 and 44 years. Looking at the Figure 9 you can notice that greater emotional response rose in female brain as well as the largest brain activity was measured for the youngest respondent while the same incentive activity.

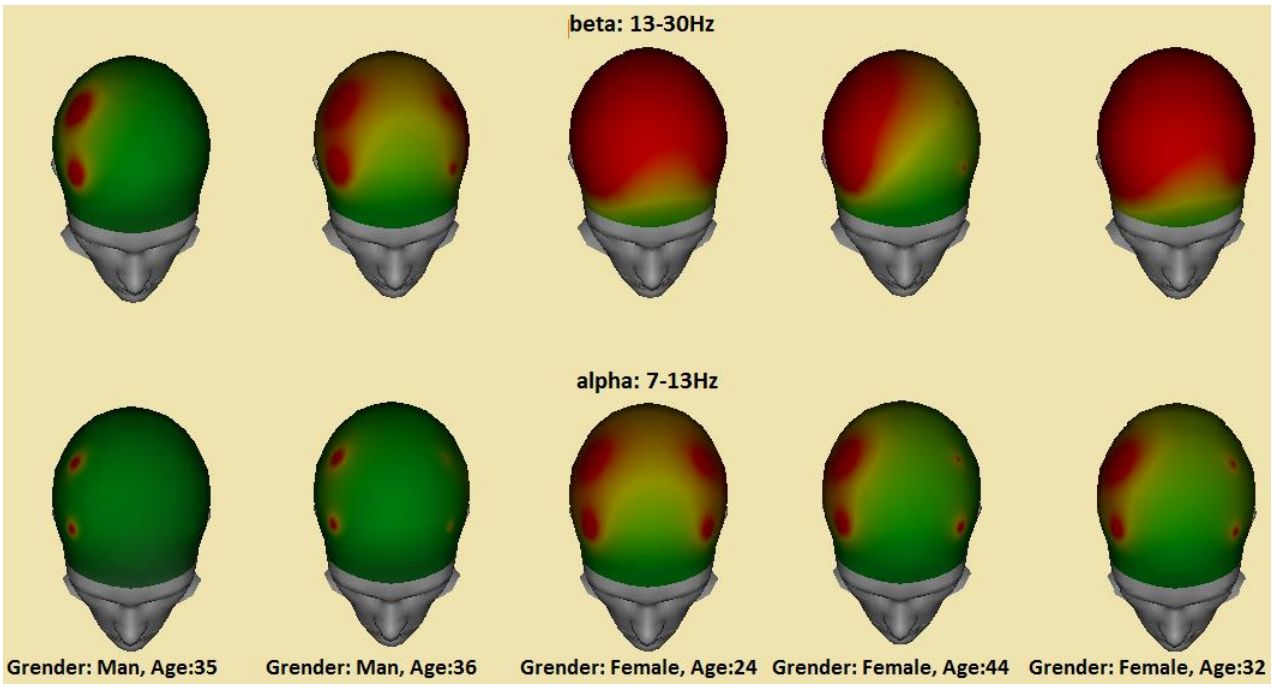

Figure 9 Comparison of respondents' brain activity - simulated conditions.

Table 2 Energy consumption for the different types of light sources.

Type of Light Source:	Halogen	Metalhalid	Fluorescent light source x 2	LED
Power (W)	160	70	72	60
Luminous Flux (lux - lx)	650	580	540	620
Initial Costs (€)	8	53	35	100
Cost of light body replacement in (€)	4.9	13.5	5.3	0
Cost of 30.000 hours operation	73.5	67.5	42.4	0
Lifespan (hours)	2000	6000	8000	35000
Ecology	High energy consumption	Difficult accessories	Mercury, heavy metals	ok
Energy consumption per 1 hour (€)	0.032	0.014	0.0144	0.012
Energy consumption per year (€)	187	82	84	70
Total costs per four year period (€)	826	408	379	280

Continual finding a compromise between reducing the energy consumption while using accent lighting and positive impact on consumer perception of the displayed goods can help trader to achieve savings in the operation of their stores. Lighting of modern retail is largely involved in the overall design and the resulting store atmosphere. The amount as well as type of lighting used in the stores is therefore always different. Anyway, traders are able to regulate their own expenses using the optimal number of light sources, their logical arrangement and automatic control by setting a time sensors either by using of energy-saving LED lights.

Table 2 shows the most common used sources of accent lighting in grocery stores on the Slovak market. Clearly the most widely used type of lighting is fluorescent lighting in Slovakia. The main reason is that it is characterized with relatively low costs and domestic retail chains still do not attach enough importance to the accent lighting. When calculating the energy consumption per four years period it shows the second largest cost savings compared with other types of light source. The negative aspect of this type is the fact that while manufacturing mercury and heavy metals are used what means that it does not contribute to environmental protection. The most energy-efficient is LED lighting according to our test results but at the same time it is characterized with higher initial costs which will return within over 4 years using. The other two types of lighting are used mostly in the international chains operating on the Slovak market food. There is more importance attached to their marketing effect than their energy efficiency.

CONCLUSION

Accent lighting plays an important role in each retail food store while presenting fresh products (fruits, vegetable, bakery products, meat) since it substitutes the packaging promotional function and significantly contributes to the increasing of the attractiveness of the displayed goods. Lighting is not only an important marketing tool that ensures the correct color rendering (color rendering index) of displayed products as well as the right store atmosphere. It is also the only factor that can be exactly measured and controlled. Make improvements by deciding for appropriate light source and energy intensity accent lighting retailers may reduce their costs, increase the attractiveness of the presented goods, contribute to the customer satisfaction and thus realize higher sales. Based on measurements and consumer neurotests we found out that there is the way how to find a compromise between effective and energy-saving type of accent lighting which can at the same time contribute to the cost effective store running. Go in hand with the environmental protection and energy saving we propose to replace traditional fluorescent tubes with the LEDs in retail stores or even in parking lots in front of the stores. The investment is indeed higher but good-implemented project of lighting renovation will return it. The main advantage of LED light sources is the availability of several variations of their color temperatures (cool white - warm white). We propose to choose the appropriate one based on the results of neuromarketing tests for different types of lighting. For the chain stores using accent lighting for the fresh food the better solution is to change halogen headlights to metal halide (warm white) lighting. Metal halide lamps have similar characteristics as halogen sources but they are less energy-intensive. For the fresh fruits and vegetable, the lightning has its specific role and not each type of lighting meets the before mentioned conditions such as color temperature, color rendering index and so on. In this case it is also possible to place automatic sensors and dimmers in underutilized spaces or during the time with less traffic in the store. The most expensive solution but also the most efficient one is to build practical skylights on the roofs of the retail stores. Such kind of design solution would contribute to significant energy savings as well as to create the most natural and comfortable shopping environment. The costs associated with the building of practical skylights could be returned in the form of reduced energy consumption and also satisfied customers when making purchases, which will contribute to increasing sales of the retail chain.

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