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Quality of life in green buildings: Are occupants of energy-efficient office buildings happier?

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***Abstract*—** With increasing global warming discussions, energy efficiency of buildings gains in importance. This trend is accompanied by a surge in building automation, in particular in office buildings. In this context, this paper focuses on the impact of energy efficient buildings on quality of life of occupants.

To this end, quality of life in office buildings of differing degrees of energy efficiency is analysed and acceptance of schemes to increase energy efficiency through building automation is investigated. Thereby, a literature review on quality of life and its constituting factors is provided. Moreover, factors influencing acceptance of technology are extracted. From literature, hypothesis are deducted and tested in a study with 1,443 occupants of office buildings.

Results indicate that the relationship between energy efficiency of buildings and comfort of its occupants might be curvilinear (u-shaped). Moreover, perceived control is found to be an important factor influencing occupants' comfort in a building. Consequences of these findings for energy efficient building are discussed.

***Keywords*—**building automation, comfort parameters, energy-efficiency, perceived control, user satisfaction

I. Introduction

ALL over the world, preservation of resources and sustainable building materials and methods that meet today's needs without compromising the needs of future generations increasingly gain in importance [1]. The research towards "Green Buildings" calls for the "Three Zeros": Zero Energy, Zero Emission, Zero waste. We have to build sustainable buildings that in terms of their total annual consumption require no energy to operate them, that do not produce any harmful emissions and that are completely recyclable [2]. Against the background of global warming, green building issues take on an existential urgency for humanity. Therefore, appropriate certification systems are reflecting the above formulations. For example the US Green Building Council issues the LEED certificate. LEED stands for "Leadership in Energy and Environmental Design". [3]

In this context, office buildings play a special role, as energy consumption per square meter is considerably higher than that of residential houses [2].

The importance of green buildings is reflected in a surge of theoretical and empirical work in this field. Many studies [e.g. 4, 5] concentrate on 1) evaluating the cost of sustainable building and comparing it to traditional building costs, thereby embracing short-term and long-term approaches, or 2) calculating the environmental impact of traditional buildings and comparing it to green buildings. Apart from financial and environmental aspects, energy efficient buildings as well have social implications [1]. The effect of energy efficient buildings on human well-being is a social implication that yet only starts to be considered [6], [7]. In order to investigate this impact further, human well-being respectively the quality of life is defined in the following. Furthermore, elements influencing the quality of life are extracted and their importance is empirically validated.

II. Quality of Life

In accordance with Arndt's satisfaction/dissatisfaction model [8], cognitive dissonance theory [9] and modern understanding of customer satisfaction [10], human well-being or quality of life can be defined as the subjective life satisfaction of an individual. In this sense, Cooper understands quality of life as "social constructs, which reflect the beliefs, values, expectations and aspirations of those who construct them" [11].

Quality of life may be regarded only for a certain section of life or for life as a whole [12]. In this article it is focused on working life, more specifically comfort in office buildings.

Adapted from the 1992 definition of thermal comfort in the ASHRAE standard of 1992 [13], comfort is understood as a condition of mind that expresses satisfaction with the environment.

Quality of life in office buildings is traditionally interlinked with the parameters warmth, light and air quality [14], nowadays complemented with ergonomics and ambience [15]. Furthermore safety might be an important element constituting comfort, as the need for safety is an essential human need that influences human actions and feelings [16]. For example, if people fear theft or personal assault they are likely to feel less comfortable in a building than otherwise.

Many studies examining the influence of certain parameters on comfort concentrate on the modification and analysis of individual parameters and their effects in artificial settings. A good overview over these studies is provided by Gossauer and Wagner [15]. The problem of theses studies is that they have

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high internal but low external validity [17]. Many field studies on comfort therefore analyze the interdependency and influence of various parameters on comfort in a real-life setting [e.g. 7, 15]. Other field studies analyze differences in comfort between different types of buildings. For example, thermal comfort between naturally ventilated and air-conditioned buildings is measured [18, 19] and comfort in energy efficient homes is compared to comfort in conventional houses finding differences in noise exposure and health of residents [20]. Despite these research efforts, parameters constituting quality of life in office building are still not fully understood. Nevertheless, it seems evident that comfort is a multidimensional construct consisting of different comfort parameters. Thus, the following hypothesis can be stipulated:

H1: Satisfaction with individual parameters of comfort positively influences perceived overall comfort in a building.

As indicated above, the discussion of energy efficiency of buildings does not yet incorporate a discussion of social impacts of technologies that improve energy efficiency of buildings. From a sustainability point of view, buildings however have to improve their ecological, economic and social performance [1, 2]. Whether this normative requirement can hold true, shall be analyzed in this article. For this end, we assume the following:

H2: Comfort is higher in energy efficient office buildings than in traditional buildings.

III. Influence of Building Automation on Quality of Life

Large office buildings do often have a high amount of energy consumption. Building design influences important factors like air quality and use of daylight. Good environmental design is often passive (low technology) and active (high technology). The target of passive design is to do as much as possible with as little as possible. Building orientation, external shading, use of natural daylight and ventilation, storage mass, recycled materials and water management are just a start towards responsible design. Active high technology systems include automated lighting controls as well as a fully integrated computer controlled energy management system. It is the mix of both active and passive design elements that leads to a truly exceptional performance [21].

In particular in office settings, an integrated service of the technical equipment in buildings may increase efficiency and save investment costs as well as operating costs. For example, in many refurbishment projects user-independent building automation systems saved up to 30% of operating cost [22]. Building services engineering focusing on energy savings hence tries to minimize personal influence on comfort parameters in order to optimize energy efficiency [23]. This reduction of perceived control may have a negative effect on acceptance of building automation by occupants.

Perceived control is “the belief that one can determine one’s own internal states and behavior, influence one’s environment and/or bring about desired outcomes” [24: p. 5]. Customer satisfaction literature suggests that a person’s sense of control is positively influenced by the perception of having a choice and contributes to the positive emotional experience of a situation [25, 26]. Choice puts individuals in control, as it provides them with the freedom to evaluate and select a certain alternative as opposed to being assigned one, while lack of change makes them feel put under tutelage [27].

Findings suggest that the option to change room temperature influences satisfaction with the thermal situation in a positive way [28, 29]. Moreover personal control of operable windows positively affects perceived comfort [30]. Generalizing these indications, quality of life is apparently influenced by the degree of building automation. We hence suppose:

H3: The smaller the perceived control of comfort parameters, the smaller is the perceived comfort in a building.

Individuals however seem to be prepared to surrender perceived control when they see the opportunity to seize a benefit that outweighs the loss of control [27]. In this sense, building automation may contribute to relieving the work burden and saving time for other things. Moreover, perceived energy savings may offset loss of control for ecology-minded consumers and derived cost savings for cost-sensitive individuals [23].

An individual thus is basically prepared to abandon perceived control, when building automation provides a clear benefit over personal adjustment of comfort parameters. According to the cost-benefit framework of judgment [31], this is more likely to occur for comfort parameters that are less important to the individual, than for parameters that are crucial for individual’s quality of life, because in the later case the loss of control will more likely be perceived bigger than the benefit. From this follows:

H4: The more important a specific comfort parameter for the individual, the less the individual is prepared to forego personal control of the parameter.

IV. Research Design

In order to prove the above hypotheses, a quantitative research was carried out. The research sample consisted of occupants of office buildings with differing degrees of energy efficiency. In order to increase validity, the same type of office building was used, namely four Austrian universities: one accounts for low energy efficiency, two for average energy efficiency and one for high energy efficiency. The study was part of a major government-funded research project on the sustainability of buildings. The basic idea is that buildings have a life, similar to a product-life cycle: they are planned, built, they are used, eventually re-used, renovated and finally demolished. Decisions made in the early stages of the life-cycle, influence the whole further life. The main target of the study was to evaluate quality problems of buildings during the phase of usage, to analyze perceived comfort parameters in office buildings and to increase consideration of occupants needs in order to use this knowledge 1) for optimizing economic, social and ecologic elements of a building in the early phases and 2) for reaching higher energy efficiency throughout the whole life-cycle of the building

We used the guidelines provided by Churchill/Iacobucci [32], Miller/Dickson [33] and Tourangeou/Rips/Rasinski [34] to ensure good design of the questionnaire and quick progress for the respondents. In order to safe time and cost we decided for an online questionnaire. For the construction of the online questionnaire, we performed 8 exploratory qualitative interviews and had the final questionnaire pre-tested by 10 members of the university. The link to the questionnaire was sent by email together with a short introduction to the theme. The mailing consisted of an initial email invitation and a later reminder. The questionnaire was sent out to the basic population of 4,217 students and 410 faculty staff. A total of 1,443 useable questionnaires was returned (31.2%). 43.7% female and 56.3% male, 90% students, 6.4% academic personnel (professors, lecturers, researchers), and 3.7% worked in administration responded. A comparison of the respondent profiles and the characteristics of given university population as well as between early and late responses revealed no significant differences at the $\alpha = .05$ level.

V. USED MEASURES

A. Comfort

In conformity with Gossauer [7], comfort was measured as individual satisfaction with thermal, acoustic, visual, aesthetic and ergonomic comfort as well as with air quality.

For thermal comfort and air quality, respondents were asked to quote in how far a set of statements (good indoor temperature in winter; good indoor temperature in summer; good, fresh air; displeasing air draft) applied to their situation (using a 6 item likert scale with 1= fully applies, 6= does not apply at all).

Acoustic comfort was measured with the same question design but different statements (good acoustics in rooms, noise through technical equipment, troublesome noise through technical equipment (copier, beamer, etc.), troublesome noise from persons inside the room, troublesome noise from other sources inside the building, troublesome noise from outside the building (e.g. traffic)).

Visual comfort was specified through the satisfaction (on a 6 item likert-scale from 1= very satisfied to 6= not satisfied at all) with natural and artificial lighting conditions.

Similarly, respondents stated their ergonomic and aesthetic comfort through the satisfaction with desk (e.g. size, position of computer) and chair (sitting comfort, legroom) room size, flooring, wall paint, storage space, plants.

Moreover, safety was integrated by asking how safe the respondent felt in and around university. Respondents indicated their feelings on a 6 item likert scale (ranging from 1 = very safe to 6= not safe at all). Finally, overall satisfaction with the office building was surveyed, again through a 6 item likert scale (1= very satisfied; 6 = not satisfied at all).

Confirmatory factor analyses of constructs showed satisfactory results (Cronbach's $\alpha > .70$).

B. Perceived Control

In order to measure perceived control, respondents were asked: "Generally speaking, in how far can you yourself influence the extent of air quality, warmth, and similar elements of the building that you consider important for your well-being." People could choose on a 6-point scale (1= to a very high extent", 6= "to no extent").

C. Importance of specific comfort parameters

Importance of specific comfort parameters is measured through a forced ranking of the parameters in order to eliminate the danger that respondents declare that all comfort parameters are very important. Respondents were asked which parameter of a given set of comfort parameters (i.e. noise control, lighting conditions, freshness and temperature of air, aesthetics of the room) was the most important for them. Furthermore, they were asked to rank the other parameters. In this way, respondents were forced to differ between the importance of the various parameters.

D. Building Automation Schemes

In order to test building automation schemes that allow for the highest energy savings, a round of experts were invited to discuss and evaluate possible schemes. The results were presented to two further experts who had to confirm the importance of these tools. In this way, the following schemes were selected and included in the questionnaire: fully automated air ventilation (no opening of windows through occupants); fully automated temperature regulation (no individual adjustments through occupant), lights turn off automatically if room is empty for more than 10 minutes; machinery and IT-systems turning off automatically if room is empty for more than 10 minutes, automated control of sun-blinds according to insolation. The sequence of these schemes in the survey was randomized to avoid primacy and recency effects [32].

VI. ANALYSIS OF RESULTS

In order to test H1, a regression analysis was executed with overall comfort as dependent variable and individual parameters of comfort (i.e. thermal, acoustic, visual, aesthetic and ergonomic comfort as well as air quality and safety) positively influences perceived overall comfort in a building. The hypothesis could be validated with R^2 0.56, F 28.83 and $\alpha < .001$. 12 out of 18 parameter aspects were found out to be significant (see α of t-tests in table 1). The degree in which the satisfaction with different aspects of the comfort parameters influenced overall comfort is displayed in the beta coefficients in table 1, where high absolute values signify high influence and low absolute values stand for low influence.

TABLE I
COEFFICIENTS OF H1

Model 1	B	STD. ERROR	BETA	T	Sig
(constant term)	0.43	0.22		1.96	0.05
acoustics in rooms (conference rooms, lecture halls)	0.10	0.03	0.08	3.04	0.00
noise from persons inside the room	0.01	0.02	0.02	0.62	0.54
noise through technical equipment (copier, beamer, etc.)	0.09	0.02	0.12	4.15	0.00
noise from other sources inside the building	-0.10	0.03	-0.12	-3.96	0.00
noise from outside the building (e.g. traffic)	-0.05	0.02	-0.06	-2.10	0.04
natural lighting conditions	0.10	0.04	0.08	2.44	0.02
artificial lighting conditions	0.06	0.03	0.06	2.02	0.04
desk (e.g. ergonomics, size, position of computer)	0.06	0.03	0.08	2.42	0.02
chair (sitting comfort, legroom)	0.03	0.02	0.04	1.19	0.23
room size and layout	0.09	0.03	0.10	3.24	0.00
coloring of flooring, walls and furniture	0.03	0.03	0.03	0.99	0.32
storage space	0.11	0.02	0.16	5.45	0.00
plants	0.04	0.02	0.05	1.82	0.07
feeling safe at university and in its basement garage	0.34	0.39	0.23	8.66	0.00
good indoor temperature in winter	0.07	0.03	0.08	2.33	0.02
good indoor temperature in summer	0.04	0.02	0.05	1.66	0.10
good, fresh air	0.08	0.03	0.08	2.27	0.02
displeasing air draft	0.00	0.02	0.00	-0.06	0.96

H2 was approached in two steps. First, ANOVA was carried out to measure whether overall comfort was different in buildings with different levels of energy efficiency.

TABLE II
TESTS OF BETWEEN-SUBJECTS EFFECTS OF H2

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Part. Eta²
Corrected model	184.039[a]	3	61.35	57.45	.000	.108
Constant Term	6925.34	1	6925.35	6485.20	.000	.820
Type of Univ.	184.04	3	61.35	57.45	.000	.108
Error	1518.51	1422	1.07			
Total	8969.00	1426				
Corrected total	1702.55	1425				

[a] R^2 = ,108 (corrected R^2 = ,106)

Differences turned out to be significant (see table 2), although more energy efficiency of buildings did not necessarily bring about higher degrees of individual comfort, but results indicate a u-shape of the relationship. Comfort was rated lowest in buildings showing a medium level of energy efficiency and comfort increased both with increasing as well as decreasing levels of energy efficiency (see table 3).

TABLE III
DESCRIPTIVE STATISTICS OF H2

Type of University	Mean of overall comfort	Std. Deviation	N
University A: university with lowest degree of energy efficiency	1.96	.957	401
University B: university with medium level of energy efficiency	2.87	1.283	351
University C: university with highest level of energy efficiency	2.08	.909	240
University D: university with medium level of energy efficiency	2.13	.935	434
Total	2.26	1,093	1,426

Second, a ONEWAY ANOVA was carried out to measure whether individual comfort parameters differed between buildings of high, medium and low energy efficiency. ANOVA showed significant results for 10 out of 17 comfort parameters. Discrepancies between universities of differing energy efficiency were significant ($\alpha < .05$) for the following parameters:

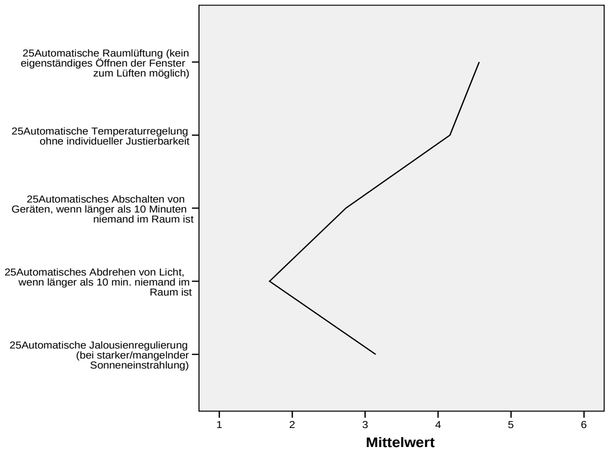
- Acoustics in rooms (conference rooms, lecture halls) are perceived worst in buildings of high energy efficiency (m=2.22) and best in buildings of middle energy efficiency (m=1.85).
- Noise from inside the building was more bothersome in buildings with medium (m=4.23) or high energy (m=4.43) than with low energy efficiency (m=4.66).
- Noise from outside the building (e.g. traffic) was more troublesome in buildings with high energy efficiency (m=4.24) than in buildings with medium (m= 4.79) or low energy efficiency (m=5.16)
- Artificial lighting conditions were better in buildings of high energy efficiency (m=2.09) than average (m= 2.16).
- Satisfaction with furniture such as desks (e.g. ergonomics, size, position of computer) was higher in buildings with high (m=2.47) or low energy efficiency (m=2.59) than in buildings with middle energy efficiency (m=2.62).
- The same held true for room size and layout (m_{low}=2.25; m_{medium}=2.64; m_{high}=2.27).
- Coloring of flooring, walls and furniture was more satisfying in buildings of low (m=2.26) and high (m=2.24 energy efficiency than in those of medium energy efficiency (m=2.66).
- Storage space was a problem in all buildings (m=3.50), but it was worst in buildings with middle energy efficiency (m=4.04)
- Indoor temperature in winter was perceived better in

buildings with low energy efficiency (m=2.47) than in buildings with middle (2.67) or high (m=2.84) energy efficiency

- Air quality was perceived better in buildings of low (m=2.42) or middle (m=2.41) energy efficiency than in those of high energy efficiency (m= 2.61).

H3 was tested via regression analyses with overall comfort as dependent variable and perceived control as independent variable. Results were highly significant with R^2 0.28, F

GRAPH I
OVERALL LEVEL OF ACCEPTANCE OF DIFFERENT BUILDING AUTOMATION SCHEMES



[a] 1= high level of acceptance; 6 = no acceptance

112.49 and $\alpha < .001$ and showed that overall comfort was higher, when people felt higher perceived control. Statistical details are provided in table 4.

TABLE IV
TESTS OF BETWEEN-SUBJECTS EFFECTS

Model 1	B	STD. ERROR	BETA	T	Sig
(constant term)	1.69	0.06		28.00	0.00
Perceived control	0.26	0,02	0.28	10.61	0.00

H4 was analyzed by a series of ANOVAs with the ranking of importance of individual comfort parameters as independent variables and the degree in which respondents are prepared to accept the appropriate building automation scheme as dependent variable. No significant correlation could be found between the variables. This hypothesis could thus not be statistically confirmed.

This lack of significance could however lie in the fact that respondents where relatively united anent comfort parameters they considered important (1. freshness and temperature of air (ranked number one by 63.9% of all respondents), 2. lighting conditions (ranked number 2 by 53.7% of all respondents), 3. noise control (number 3 for 47,2%) and 4. aesthetics of the room (55,5%)). Graph 1 shows that respondents are least prepared to accept building automation schemes (i.e. “fully automated air ventilation (no opening of windows through occupants)” and “fully automated temperature regulation (no individual adjustments through occupant)”) relating to the point most important for them (freshness and temperature of air). It is supposed that these two schemes have a high impact on the individual sensation of comfort, whereas “lights turning off automatically as soon as nobody is in the room” may be perceived as an important measure that helps to save energy, increases comfort as individuals do not have to remember to switch off the light themselves, and do not constrain perceived comfort.

VII. DISCUSSION AND LIMITATIONS

Results of the study could not unequivocally show that people working in energy efficient office buildings enjoy a higher level of comfort than staff in traditional buildings. This study rather alludes to a u-shaped relationship. A possible explanation for this run of the curve may be that many buildings with low energy efficiency, such as the one university under investigation that showed the lowest level of energy efficiency, are historic buildings that are a class in its own. On the other end of the line are high-tech buildings that captivate trough their innovative and modern design. Between these two superior positions is a vast spectrum of more or less meaningless and inexpressive buildings that fail to involve and inspire their occupants. This presumption is strengthened through the finding that people in buildings with middle energy efficiency were inter alia less satisfied with aesthetics, ergonomics of furniture, and room size. This might be a consequence of focusing on cost efficiency and not on needs and comfort perception of occupants in the planning phase.

Moreover, the results allude to noise and temperature control as potential weak points of energy efficient buildings.

However, as this study focuses on four university buildings only, results could be biased through cluster effect (i.e. clusters differ strongly among each other with respect to a factor that is not monitored and are very homogeneous within each cluster) [17]. For example, differing working atmosphere in the four universities - a factor not accounted for in this study - could entail this effect. As this study consists of few clusters with a high number of respondents interrogated in each cluster, this danger is - as a matter of principle – higher than in research designs with many clusters and few elements. Therefore more studies investigating this relationship are needed in order to confirm the found relationship and to scrutinize outlined reasons for the relationship.

This study finds that perceived control of comfort parameters has a positive influence on comfort. Due to the importance of perceived control, fully automated systems setting comfort parameters within a building and optimizing energy efficiency might fail to gain the necessary acceptance in society. Therefore, strategies for integrating tools of user-empowerment and human interaction with building automation seem necessary.

A limitation of this study is that personalities of occupants are not registered. Integrating such information in future studies may provide useful insights into the different aspects of perceived control and its interaction with technological innovations. For example, control seems to be perceived quite differently from the respondents of this study, although external conditions for the occupants are quite similar. In order to better understand this phenomenon, studies on the internal aspect of perceived control [24] may be fruitful. Factors such as sophistication, environmental awareness and experience may play a central role in these internal processes.

The analyses of the impact of the perceived importance of specific comfort parameters on the extent to which individuals are prepared to forego personal control of these parameters delivered mixed results. Exploratory research (e.g. laddering technique [35]) in the motives that drive people to object respectively accept a certain building automation scheme should help to bring more clarity into this field.

REFERENCES

[1] O. A. B. Hassan: "An integrated Management Approach to Designing Sustainable Buildings," *Journal of Environmental Assessment Policy and Management*, June 2006, Vol. 8, No. 2, pp. 223–251.

[2] W. Sobek: "Building – with sustainability in mind," *profile. Architecture Magazine,* June 2008, pp. 4-11.

[3] https://leedonline.usgbc.org/Login.aspx, 17.12. 2008.

[4] Ch. Stoy, S. Kytzia: "Benchmarking electricity consumption," *Construction Management & Economics*, Oct 2006, Vol. 24, Issue 10, pp. 1083-1089.

[5] A. Horsley, Ch. France, B. Quatermass: "Delivering energy efficient buildings: a design procedure to demonstrate environmental and economic benefits," *Construction Management & Economics*, Vol. 21 Issue 4, Jun2003, pp 345-356.

[6] W. Bischof, M. Bullinger, B. Kruppa, B.H. Müller, R. Schwab: *Expositionen und gesundheitliche Beeinträchtigungen in Bürogebäuden, Ergebnisse des ProklimA-Projektes*, Karlsruhe: Fraunhofer IRB Verlag, 2003.

[7] E. Gossauer: *Nutzerzufriedenheit in Bürogebäuden – Eine Feldstudie, Analyse von Zusammenhängen zwischen verschiedenen Komfort-parametern am Arbeitsplatz*, Karlsruhe: Frauenhofer IRB Verlag, 2006.

[8] J. Arndt: "The Quality of Life Challenge to Marketing", in: *Reynolds, F. D.; Barksdale, H. C. (eds): Marketing and the Quality of Life*, Chicago: American Marketing Association, 1978, pp. 1-10.

[9] L. A. Festinger: *Theory of Cognitive Dissonance*, Stanford: Stanford University Press, 1957.

[10] Ch. Homburg, R. Stock-Homburg: „Theoretische Perspektiven zur Kundenzufriedenheit", in: *Homburg, Ch. (ed.): Kundenzufriedenheit: Konzepte-Methoden-Erfahrungen*, 6., überarbeitete und erweiterte Auflage, Gabler Verlag: Wiesbaden, 2006, pp.. 17-51.

[11] I. Cooper: "Comfort theory and practice: Barriers to the conservation of energy by building occupants"; *Applied Energy*, Vol. 11, Issue 4, August 1982, pp. 243-288.

[12] M. Sirgy, A. Michalos, A. Ferriss, R. Easterlin, D. Patrick, W. Pavot: "The Quality-of-Life (QOL) Research Movement: Past, Present, and Future," *Social Indicators Research*, Vol. 76, Issue 3, May2006, pp. 343-466.

[13] ASHRAE (American Society of Heating, Refrigerating and Air-conditioning Engeneers): *ASHRAE 55 Standard 55 - Thermal environmental conditions for human occupacy*, Atlanta: ASHRAE Inc., 2004.

[14] G. S. Brager, R. de Dear: "Thermal adaptation in the built environment: a literature review," *Energy and Buildings*, 1998, Vol 27, Issue 1, pp. 83-96.

[15] E. Gossauer, A. Wagner: "Post-occupacy Evaluation and thermal comfort: State of the Art and new Approaches", *Advances in Building Energy Research,* 2007, Vol. 3, Issue 1, pp. 151–175.

[16] W. Kroeber-Riel, P. Weinberg, P. (2003): *Konsumentenverhalten*, 8. edition, München: Vahlen, , pp. 146f.

[17] L. Berekoven, W. Eckert, P. Ellenrieder: *Marktforschung – Methodische Grundlagen und praktische Anwendung*, 10. edition, Wiesbaden: Gabler, 2004.

[18] W. Bischof, R. T. Hellwig, S. Brasche: „Thermischer Komfort – die extraphysikalischen Aspekte," *Bauphysik* 2007, Vol. 29, Issue 3, pp. 208-212.

[19] B. Bordass, A. Leaman: "Making feedback and post-occupancy evaluation routine 1: A portfolio of feedback techniques," *Building Research & Information*, 2005, Vol. 33, Issue 4, pp. 347-352.

[20] A. G. Keul: *Energiesparprojekte und konventioneller Wohnbau – eine Evaluation NutzerInnen-Evaluation nach Bezug (Post Occupancy Evaluation) von sieben Energiesparprojekten und konventionellen Wohnbauten in der Stadt Salzburg - Grundlagenstudie*, Wien: Projektbericht Haus der Zukunft im Auftrag des Bundesministeriums für Verkehr, Innovation und Technologie, 2001, pp. 27-54.

[21] S. Kieran: "New urban relationships," *profile. Architecture Magazine,* June 2008. pp. 14-19.

[22] J. Milde: „Neue Europanorm EN 15 232," *Soll-Ist*, 2008, issue 4, pp. 14-15.

[23] A. B. Shepherd, W. J. Batty: "Fuzzy control strategies to provide cost and energy efficient high quality indoor environments in buildings with high occupant densities", *Building Services Engineering Research & Technology*, Feb 2003, Vol. 24, Issue 1, pp. 35-45.

[24] K. Wallston, B. Wallston, S. Smith, C. Dobbins: "Perceived control and health," *Current Psychological Research and Reviews*, 1987, Vol. 6, pp. 5-25; cited p. 5.

[25] M. K. Hui, J. E. G. Bateson: "Perceived control and the effects of crowding and consumer choice on the service experience," *Journal of Consumer Research*, 1991, vol. 18, pp. 174-184.

[26] M. L. Meuter, M. J. Bitner, A. L. Ostrom, S. W. Brown: "Choosing Among Alternative Service Delivery Modes: An Investigation of Customer Trial of Self-Service Technologies," *Journal of Marketing*, Apr 2005, vol. 69, issue 2, pp. 61-83.

[27] S. Botti, S. S. Iyengar: "The psychological pleasure and pain of choosing at the cost of subsequent outcome satisfaction," *Journal of Personality & Social Psychology*, 2004, vol. 87, pp. 312-326.

[28] R. de Dear: "Thermal comfort in practice," *Indoor Air*, 2004, vol. 14, issue 7, pp. 32-39.

[29] J. F. Nicol, S. Roaf: "Post occupancy evaluation and field studies of thermal comfort," *Building research and information*, 2005, vol. 33, issue 4, pp. 338-346.

[30] G. S.; Brager, G. Paliaga, R. J. de Dear: "Operable Windows, Personal Control and Occupant Comfort," *Ashrae Transactions*, 2004, vol. 110, part 2, pp. 17-35.

[31] E. J. Johnson, J. W. Payne: "Efforts and Accuracy in Choice," *Management Science*, April 1985, vol. 31, pp. 395-414.

[32] G. Churchill, D. Iacobucci: *Marketing Research: Methodological Foundations*, 9. edition, Thomson Learning, Mason, OH, 2005.

[33] T. W. Miller, P. R. Dickson: "On-line Market Research," *International Journal of Electronic Commerce*, 2001, Vol. 5, Issue 3, pp. 139-167.

[34] Tourangeou, R.; Rips, L.; Rasinski, K. (2000): The Psychology of Survey Response, Cambridge University Press, Cambridge 2000.

[35] T. J. Reynolds, J. Gutman: "Laddering Theory, Method, Analysis, and Interpretation," *Journal of Advertising Research*, 1984, Vol.. 24, Issue 1, pp. 27-37.