Thermal environment as a management tool in high-rise building

Presentation Preference: Oral

1. INTRODUCTION

The current scientific and technological advances have enabled more efficient procedures in the development of several working activities, together with increasingly efficient equipment. The junction of these features allowed for a greater control of internal and external factors that influence the working activities. On the other hand, some sectors remain oblivious to environmental factors. An example is the construction industry and, more specifically the building branch. In this sense, thermal environment is an external factor for the conditioning of the development of any works and its field of influence embraces directly the way the workers perform their tasks. This line of work proceeds with productivity that may be increased or reduced according to the environment which the worker is subjected to. Furthermore, it is necessary to investigate whether the work performed at different height levels affects productivity, since this is one of the environmental variables. From this, there is a need to know the effects that thermal environment can cause in humans, seeking to minimize their reflections on their health and work, thus improving productivity and contributing to a more effective methods in the process of building.

Therefore, this paper seeks to reconcile the topic of thermal environment with the construction of buildings in height, and its productivity.

2. MATERIALS AND METHODS

Our research, covering at least two of the above mentioned areas, will focus on papers from journals and databases published over the last ten years. At the same time we also will keep in mind the state of the art (during the same period) about these themes. By doing so, we will able to find concepts, models, rules and cases in which the addressed topics - thermal environment, buildings and productivity – are included. For this purpose, more than 30 electronic sites of scientific papers with international scope disclosure were surveyed. The definition of portals to search was based on the list included in the Metalib Exlibris (Metalib, 2012). The portals surveyed are shown in Table 1.

Table 1 – Sites where the surveys were conducted.

Type	Name
Database	CiteSeerX, Compendex, Current Contents, Energy Citations Database, Inspec, PubMED, SCOPUS, Research and Innovate Technology Adminstration, Web of Science e Zentralblatt MATH
Scholarly journals	ACS Journals, Annual Reviews, ASME Digital Library, Cambridge Journals, ASCE, DOAJ, Emerald, Highwire Press, IEEE Xplore, Taylor and Francis, Ingenta, IOPscience, MetaPress, Oxford Journals, SAGE, SciELO, ScienceDirect, Scitation, Springerlink, Wiley Online Library

In order to find papers related to the topic under observation four key words and concepts were chosen, namely: "thermal environment", "building", "construction" and "model". For the accomplishment of additional screening for the work under way, combinations of keywords using the logical operator "AND" were made. When it was not possible to screen through the abstract, the job title was also used. The combinations performed are shown in Table 2.

Table 2– Procedures to the surveys realization.

Survey Number	Keyword	Number of publications founds
1	*"thermal environment" "building"*	1510
2	*"thermal environment" "construction"*	304
3	*"thermal environment" "construction" "model"*	135

Based on these findings, we started reading the publications to confirm which of them might be relevant for the research in progress. The method used for the acceptance/exclusion of the work was: the suitability for research purposes, theoretical framework demonstrating scientific reliability; explicit methodological procedures used; crisscrossing and development of the analysis of the results of the keywords used. The work selected for the preparation of this research contemplated all these parameters.

3. RESULTS AND DISCUSSION

The ever growing vertical integration of buildings is a worldwide trend, mainly in big cities due to the gradual increase in concentration of people in the same geographical space. According to Silva, Nascimento, & Bitoun (2009), for the cities to continue to grow, the availability of land is essential, although what happens in big cities is a decrease of free spaces for new housing construction, which drives the trend to vertical integration. In this context, thermal environment

emerges as a relevant factor in defining the housing project because it has a direct influence on the comfort of the people who may live or work there. In compliance with this reality, many papers have been published with the focus on the analysis of thermal environment inside the buildings, such as the study of thermal comfort in dwellings in general (Wang, 2006), the study of buildings without any air conditioning system (Ji, Lou, Dai, Wang, & Liu, 2006), the sensation of comfort in offices (Bluyssen, Aries, & Van Dommelen, 2011), thermal comfort inside the houses in hot, humid, cold or rainy seasons (Peng, 2010), among others. On the other hand, there are few studies that focus on the thermal environment during building construction as well as its relation to the workers` comfort and productivity, arising from changes in working conditions. Among these few examples, we can refer to the studies of Mohamed & Srinavin (2002), which relate the productivity of construction workers with thermal environment via thermal comfort, an index which aggregates a set of climatic conditions and parameters of clothing. Lopes (2007), in turn, sought to diagnose the conditions of thermal comfort the construction workers were exposed to over the following stages of construction: construction of foundations and concrete structure, execution of the masonry and installation of technical networks, and other facilities and finishing in general.

From the above mentioned scientific research, papers that measure the influence of the thermal environment on the workers` productivity in terms of high-rise building was not found. However, there are evidences that productivity changes with thermal environment and the latter varies with height. In this context, it is considered that the possibility of adding the variable "height" brings measurable benefits to the identification of the relevance of thermal environment and altitude in workers` productivity, allowing in parallel, the improvement of working conditions.

4. CONCLUSIONS

One of the factors with a direct effect on productivity is thermal environment. A possible cause for the decrease in productivity is high temperature, as demonstrated in many studies by Seppanen, Fisk, & Faulkner (2004), which showed a mean decrease of 2% in the performance of work for each degree Celsius when temperature exceeds 25°C. Furthermore, temperature and humidity also vary with altitude. When a high-rise building is under construction, the combination of these two factors may be crucial to optimize both working conditions and productivity. Consequently, there is a great influence both on the timeline of construction and the profitability of the enterprises, which is essential to any building. By studying the relationship between thermal comfort and productivity at different height levels in buildings, we can provide information that enables a more effective planning of activities in the work. This will lead to a rise of workers` productivity, contributing to their comfort and, at the same time, optimizing the construction process. This will help to achieve the stipulated timelines and to avoid additional costs by delays in the completion of the projects.

5. REFERENCES

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