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TYPES OF ENERGY CONSUMERS IN OFFICES

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1. INTRODUCTION

The building sector accounts for more than one-third of the total primary energy use and has significant potential for energy saving [1]. However, various physical and social factors affect the energy performance of dynamic systems, such as the indoor climate condition, the building envelope, maintenance, building equipment, operation, and occupant behaviour [2, 3]. Particularly human factors contribute to a high variance in energy consumption [4]. The occupant is a major leading factor for energy use in buildings, since building systems run to provide comfortable working environments for occupants. Many studies have used kWh/m^2 /year to compare energy use of buildings [5]. However, the energy use also needs to be measured by occupancy schedule and density of building users [6-8] how many people work in an office; how many hours do they stay inside. The objective of this study is to investigate how much the energy use per person is different before and after office renovation towards energy efficiency, and to identify user types according to occupancy schedule and whether energy use differs between users.

2. METHODOLOGY

This research is based on a case study approach, analysing the energy efficiency performance in Dutch offices after renovation. Renovated office buildings have been analysed to evaluate the measures taken and the improvement of energy efficiency after renovation. Following, a survey has been held and is statistically analysed to identify occupant types based on occupancy schedule. The questionnaire contained 10 questions, consisting of 5 categories: main personal information, information about the personal workplace, occupancy time, break time, and the type of space available for breaks (Fig2). Four renovated offices were selected as case studies. The case study offices have a high energy efficiency performance with energy label A (Energy Performance Certificate based on EPBD directive). The questionnaire was distributed to 615 employees from the four cases. 554 of people who started the survey completed the questionnaire, corresponding to a 90% respond rate.

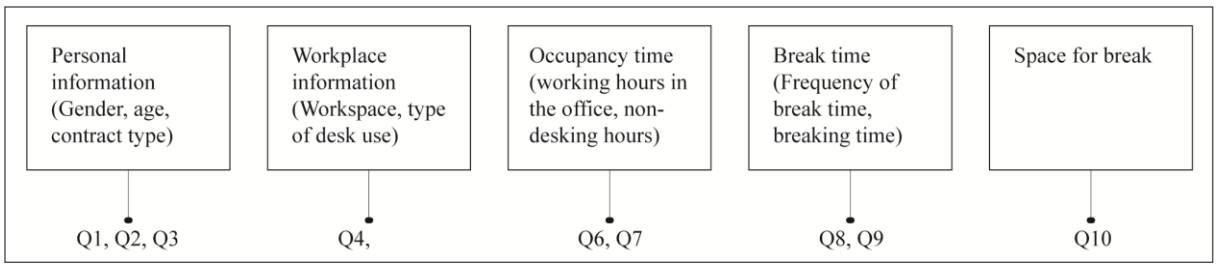

Figure 1 Schematic overview of questionnaires to identify occupancy pattern

3. RESULTS

Based on the outcome from the statistical analysis (using SPSS), occupant types of offices were defined. First of all, the data from the questionnaire were split into two groups of office occupants, depending on their employment contract type according to working hours, before conducting a two-step cluster analysis. This way, more precise occupant types can be generated than with merged contract groups. The results show that there are five occupant types in offices; three types of full-time occupants and two types with a part-time position. Type A and B are the people who work 31 – 40 hours in the office, and C works 20 – 30 hours per week. Of the full-time occupants, only type A spends the break time outside of the office whereas the other two types stay in the office (canteen). Type A and B have their own desks, but type C chooses their workspace randomly inside the office. Type D and E are the part-time contract employees who work 20 – 30 hours per week. Type D occupants do not have a fixed working desk, and they take a break outside of the office. Type E occupants have a fixed workspace (own desk), and they are likely to spend their break time in the canteen. Interestingly, all types take 30 minutes break time per day, next to their lunch break. Timewise, two groups were identified. Besides one-hour lunch time, one group tends to have three shorter breaks for 10 minutes each, and the other group has one break of 30 minutes.

Table 1 Energy consumption according to user types

User types	A	B	C	D	E
Energy use (kWh)	16.64	17.92	12.8	11.52	12.80

Based on the user types, distribution of energy use per person shows different figures. In average, people consume approximately 14.35 kWh per person in renovated offices and 22.92 kWh per person in non-renovated office. 8.57 kWh of energy use per person decreased after renovation. Table 1 show the energy use data applied the user types into energy consumption pattern in renovated cases. Thus, by using energy footprint of user types, we can predict the building energy consumption in an office renovation process.

4. CONCLUSIONS AND DISCUSSION

Occupants affect building energy use. Before we can understand occupant behaviour and energy using patterns, it is important to identify general occupant types. The occupant types which are clustered by survey explain occupancy patterns and occupancy hours of the office users. The outcomes of this research show the correlation between the energy use in renovated offices and the type of office user. The methodology used has proved to be useful to investigate occupant behaviour and user satisfaction alike studies.

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