Summary

As buildings become larger and larger the safety of occupants is becoming an important issue. After the 9/11 terrorist attack on the World Trade Centre (2001) the discussion about safety of occupants started and the ability to use lifts for evacuation was taken into account. The use of lifts can decrease the total evacuation time but also create the possibility for occupants to be self-reliant. The group with physically disabled people increases as the number of floor increases. Not only people in wheel chairs are considered being disabled, but also the increasing number of people with obesities or asthma, pregnant woman and very young children will have problems with the descend of a high number of stairs. To predict the influences of these physical (dis)abilities along with social human behaviour on escape times, simulation models are being made. The correctness of these simulations depends on their interpretation of human behaviour. This literature assignment reflects human escape behaviour from the literature on the behaviour simulated in computer models.

Human escape behaviour can be explained according to three categories: (Reynolds, 1987)

- ***Period of awareness:*** the period in which people react to an alarm. Smoke is the best consciousness raiser. It turns out that occupants hardly react on a slow-whoop alarm and that the period of awareness can be decreased if a spoken alarm is used. Occupants with disabilities or with previous experiences with fire tend to react faster to an alarm.
- ***Period of decision-making:*** occupants make decisions all the time during an evacuation. The occupant's best option is taken, even if that option leads through smoke or leads contra to the evacuation flow. These strange behaviours are named "panic behaviour" by observers but are logical to the occupant. The decision to fight the fire and warn others are the most popular ones and the decision to evacuate can be increased by communication with an agent.
- ***Period of escape:*** the actual evacuation. During the escape occupants group with familiars. They leave at a calm and easy pace, not causing stressful situations unless they are exposed to the actual fire. Walking speed is related to the density of occupants in the room and the willingness to use lifts depends mainly on the occupants' perception on the reliability of the lift, the floor number, how crowded the stairs are and their physical abilities. If occupants have to wait too long for a lift overcrowding can prevent the lift from departing.

Models describing escape behaviour in lifts also use the 3 periods of escape but can be further divided into 2 groups as there are 2 groups of simulation programs: those only evacuating with lifts (lift models) and those who combine stairs and lifts in the evacuation model (combined models).

- ***Lift models:*** are used for optimization of the number of lifts and the total evacuation time. Lift models use a coarse structure and global view which means that occupants are not simulated individually but only as a group. The period of awareness is not included but a stochastic distribution is used for the decision-making between lifts and stairs. The evacuation using stairs with possible obstructions is not further simulated. Behaviour in the period of escape is limited and based on stochastic distributions, mostly Poisson distributions. Lift models are validated according to 30 year old principles.

- ***Combined models:*** started as stair models but currently incorporate the use of lifts. They use a fine grid structure and individual perspective so physical abilities can be applied to occupants. Obstacles in rooms can also be simulated. The transition between group behaviour and individual behaviour is difficult to determine. The period of awareness and decision-making are incorporated in these models. Even inter-occupant communication is introduced in some models to simulate interaction between occupants but due to validation not all models include this agent based approach. Individual properties can be applied but the occupant's perception of risk is very hard to include. Combined models mainly use fire drills and movement experiments for validation.

The conclusion of these two groups of models, compared with the literature, is that lift models give a rough estimation of the total evacuation time. Models use averages and do not include individual limitations or obstacles. Combined models are more specified and could predict evacuation times for certain cases of occupants' preferences. The prediction of evacuation times is based on the individual capabilities and limitations of the occupants and will depend on reluctance or willingness for a specific escape route.

Although the use of combined evacuation models seems to be promising, normalisation is needed in order to prevent confusion. Current simulation models will not give the same outcome for a specific situation.

Many human behaviour aspects are included in both models but for example little is known about the behaviour of occupants waiting for a lift. More research is needed on the overlapping topic between lifts and stair evacuation because overcrowding can lead to significant longer evacuation times. Furthermore, research about evacuation times should include a more representation group. Both healthy people and people with disabilities should be represented aquire more significant reference data.