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ABSTRACT

This paper aims to analyze the impact of different strategies regarding the use of default model settings and embedded data-sets. Initially, the consequences of these different strategies on the results produced are discussed. This is followed by a detailed case-study focusing on the qualitative and quantitative impact that selecting different strategies may produce: whether the user provides their own data, uses a pre-defined library, or the default setting. The case-study focuses upon the relationship between the smoke level simulated and the occupant's walking speed. Currently, the relationship between smoke and visibility (and subsequently walking speed) is typically based on two different sets of experimental data: Jin and Frantzich/Nilsson. The two data-sets present different experimental conditions (i.e. gas irritancy, population characteristics, structural configuration, etc.), but they are often applied as if equivalent. Different evacuation models make different assumptions regarding evacuee performance in smoke, and employ different data-sets. To test the impact of this representation within evacuation tools, the authors have employed three evacuation models: 1) a model that by default uses the Jin data-set, buildingEXODUS 2) a model that by default uses the Frantzich/Nilsson's data-set, FDS+Evac and 3) a model that allows the data used to be modified, Gridflow. The case-study shows that 1) results appear to be consistent among models if they use the same data-sets 2) the same model can provide different results if applying different data-sets for configuring the inputs 3) models using embedded data-sets need user expertise and experience to configure the model and then to evaluate the results produced.

1 INTRODUCTION

The increasing use of evacuation models is leading to a development and expansion in their capabilities and usability [1,2,3,4]. Application areas are becoming more diverse, as are the uses of the models themselves [5]. In order to increase their usability, evacuation model developers are constantly working on improving their capabilities - making them more accessible and embedding more sophistication. This is achieved by focussing on more user-friendly interfaces and providing embedded default settings which allow users to rapidly obtain results. In fact, default settings often allow the models to be applied without prior configuration.

One of the consequences is an increasing number of users from different fields employing evacuation models as part of their work; i.e. applying the models as a peripheral activity that adds value to their role within an organisation. This may produce evacuation modellers that do not have a deep understanding of the model capabilities or the subject matter being addressed. Evacuation modelling is particularly susceptible to such issues, given the multi-disciplinary nature of the field (e.g. social and physical sciences) and that it represents a niche area within a much larger concern (fire safety in general) [6]. This can influence the accuracy of the results. This problem is compounded by the lack of specific academic or professional credentials relating to the use of evacuation models.

Some of the simulation packages currently available can be applied as part of a performance-based approach (i.e. the comparison between RSET - Required Safe Egress Time - and ASET - Available Safe Egress Time) by simulating fire and evacuation processes within the same environment. This kind of tool enables direct checking of smoke effects on human behaviours.

This paper presents the application of different data-sets for a specific aspect of evacuation modelling and the way this can affect the results. The case-study refers to the correlation between smoke densities and occupant walking speeds. Many other correlations and constructs are used within evacuation modelling; however, a single data use is investigated here to control for effect interactions. The study of this correlation is currently based on two main data-sets. The first is a set of experiments performed by Jin [7] more than 30 years ago. The experimental data collected has been used for providing the correlation between the extinction coefficient and walking speeds, visibility levels and cognitive abilities when exposed to smoke. The second correlation currently in use is based on the more recent studies conducted by Frantzich/Nilsson [8] who performed tunnel experiments for studying the influence of different visibility conditions on individual walking speeds. The two data-sets employed different experimental conditions (i.e. types of irritant gases, population characteristics, structural configuration, etc.), but are frequently used within evacuation models as if interchangeable. There are significant differences between the two data sets, and, although it is not suggested that the more recent data replace the older data, this does raise the general issue of how computer models, especially those with embedded default data sets, can be kept current and reflect newly published data.

The authors have selected three models to examine the impact of the default settings and embedded data-sets upon results produced. These models have been selected to address two different points: 1) the impact of default embedded data-sets on evacuation results, 2) the impact of user's input configuration in case of models with no-default settings (e.g. users apply a certain data-set).

A simple case-study is presented (i.e. a 100 m corridor) in which all the variables have been kept constant except the influence of smoke densities on walking speeds. The distance is somewhat longer than those used to generate the two experimental data sets, but chosen to more clearly demonstrate any differences between the performances of the different models. The following three models - applying different default settings/embedded data - have been used:

1) FDS+Evac [9] - the Frantzich/Nilsson's data-set is the default setting embedded in the model;
2) buildingEXODUS [10] - the Jin's data-set is the default setting embedded in the model;
3) Gridflow [11] - the model has no default settings and the user has to configure the input; i.e. the authors have applied both Frantzich/Nilsson and Jin data-sets in this case.

Conclusions are presented focussing on the impact of default settings/embedded data on evacuation results both in general and for the specific case of the correlation between visibility conditions and occupant walking speeds.

2. DEFAULT SETTINGS AND EMBEDDED DATA

2.1 General discussion

Default values or settings range in complexity according to the evacuation model in use. They can vary according to the transparency of the defaults being used, the range of model parameters, scenarios represented by default settings and the impact of default settings on the evacuation results, amongst other things. According to Gwynne and Kuligowski [6], models may broadly present three different categories of default settings:

A. No default settings. Users need to configure the input applying a full data-set(s) to run the model
B. Default. Models have a single "factory" setting that is embedded into the model. This allows the user to speed up the process of configuring the input.
C. Pre-defined. Models have an initial set of possible default settings or libraries. They are usually associated with different scenarios/conditions.

Transparency is a fundamental point for understanding the underlying default settings/embedded data behind each model. Oftentimes, the basic assumptions of a model are not immediately apparent. In contrast, open source models allow the user to fully control the model predictive capabilities by eventually modifying the default settings/embedded data in use. However, this can provide the user (especially the inexpert user) with too much control over the fundamental settings of the model. In addition, if the model has a single default setting (category B), it would mean that users could not modify the input, unless the source code is open, requiring additional effort and expertise.

The difficulty and complexity of the model interface (e.g. if it is based on a text-based or windows-based interface) can also impact upon the manipulation and understanding of the model settings. The more complex and less intuitive the interface, the more likely the user is to misunderstand the assumptions being made (and their impact).

The assumptions employed and the data-set assumed may only be appropriate for specific scenarios. If the model is then employed to different scenarios (beyond the original purpose of the model) or the data-set is extrapolated, this may influence the credibility of the results produced.

2.2. Visibility conditions vs occupant walking speeds

The presence of smoke may have a psychological, physiological and physical impact on performance. For instance, it may initiate evacuee response, may cause then to redirect their movement, crawl, or reduce the efficiency of their movement. An example of the impact of default settings/embedded data on the evacuation results is the correlation between derived visibility conditions and the walking speeds produced. The current state-of-the-art includes two main experimental data-sets based on Jin and Frantzich/Nilsson’s studies.

Jin [7] studied the effect of irritant and non-irritant smoke on walking speed. Experiments were performed in a 20m-long corridor that was filled with smoke corresponding to an early stage of fire. The experimental population consisted of 17 females and 14 males, ranging from 20 to 51 years in age. Irritancy was produced by burning wood cribs, while less irritant black smoke was produced by burning kerosene. Test participants were instructed to walk into the corridor. In case of irritant smoke both smoke density and irritation affect the walking speed.

The speed decreases rapidly for extinction coefficients included in the range of 0.1-0.5/m (see Figure 1) In case of irritant smoke, experiment participants were not able to keep their eyes open causing a zigzag movement or using the wall as an aid to guidance, with a range of speed of 0.3-1 m/s produced. The case of non-irritant smoke shows a slower decrease in the walking speed (see Figure 1), with a range of approximately 0.5-1 m/s.

The range of extinction coefficients investigated in these experiments was 0.2-1.0/m. In this case, if the smoke concentration is higher than 0.5/m (see Figure 1) the ability to walk was seriously affected by smoke, although to a lesser degree than with the irritant smoke. They would continue to walk with a minimum speed of approximately 0.3 m/s that is equivalent to the crawling speed, behaving as if in darkness and feeling their way along the walls.

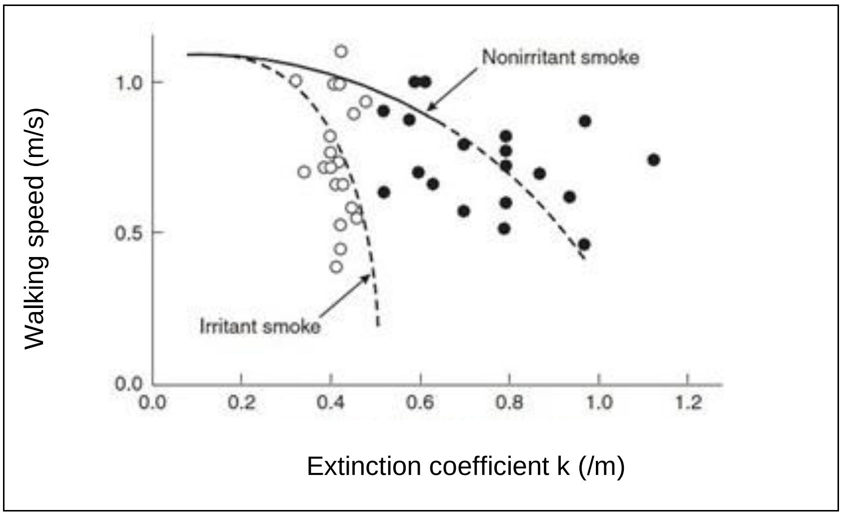

Figure 1. Jin's experimental correlation for walking speed vs extinction coefficients [7].

Frantzich/Nilsson performed tunnel experiments in which they analyzed the relationship between walking speed and smoke density [8]. The tunnel was approximately 37 metres long. It was filled with artificial smoke and acetic acid was used to simulate irritation. A total of 46 people took parts to the experiments. A broader range of extinction coefficients were examined than in the Jin experiments (see Figure 1). The range of extinction coefficients is approximately 2.0-8.0 /m. The walking speed range is approximately 0.2-0.8 m/s. The scatter of the collected data was wide and makes deriving a representative occupant walking speed for an assigned extinction coefficient difficult. This is a consequence of the different participant characteristics/capabilities. Another key aspect of the experiments is that occupants seem to walk faster when in close proximity to a wall. This finding reproduces observations made by Jin [7]. Also, while Jin's work involved a simple corridor, the Frantzich/Nilsson experimental rig was more complex, involving some wayfinding around obstacles. The comparison between the two data-sets can be made by comparing the decreasing speed trend.

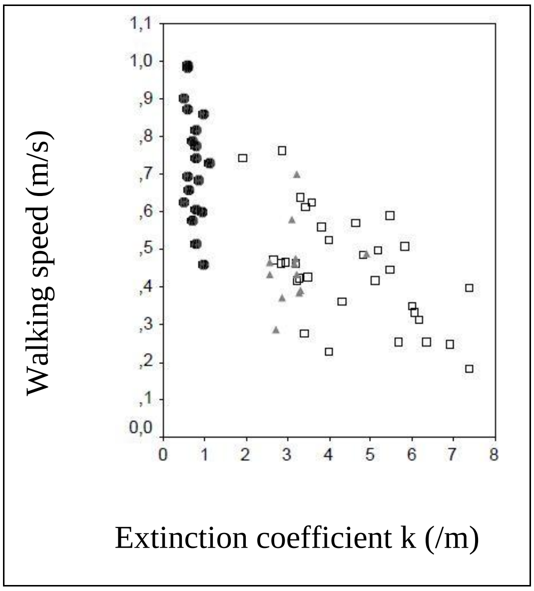

Figure 1. Extinction coefficient vs walking speed in Jin (black dots) and Frantzich/Nilsson's experiments (squares with external lights and triangles without lights) [8].

With regard to minimum walking speed there are two issues: physical ability to move through dense smoke and behavioural decision-making about whether to continue. For non-irritant smoke Jin found a minimum speed of about 0.3 m/s at high smoke densities when subjects moved as if in darkness, with similar findings in the Frantzich/Nilsson experiments, and in fire incidents some people are known to have moved through very dense smoke. However, studies by Wood and by Bryan have shown that the proportion of people turning back rather than entering smoke increases with the smoke density [12]. This depends somewhat on the situation, so that people in a relatively clear space may turn back rather than attempt moving through dense smoke, while those enveloped in dense smoke in the enclosure of origin may continue to move through very dense smoke. For tunnel fires some people have walked for several hundred metres in dense smoke [13]. For dense, irritant smoke the conditions may become so severe that people are unable to continue walking due to eye pain and breathing difficulties. Possible relationships between walking speed and effluent composition in terms of irritants have been proposed by Purser [14]. Another key aspect is the scatter of the data collected during the experiments. This shows that the susceptibility of each occupant to smoke is dependent on his/her personal characteristics and skills. The two different data-sets are currently interpreted by evacuation models as fractional values i.e. data-sets are employed for affecting any type of initial walking speeds in any type of smoke conditions.

3 CASE STUDY

3.1 EVACUATION MODELS

Three evacuation models are employed here 1) FDS+Evac [9], developed by VTT Technical Research Centre of Finland together with NIST, the National Institute of Standards and Technology, 2) buildingEXODUS [10] developed by the Fire Safety Engineering Group of the University of Greenwich and 3) Gridflow [11] developed by BRE. These models have been chosen because they use different methods for modelling the impact of smoke on occupant speeds.

VTT Research Centre of Finland has developed FDS+Evac - the evacuation module of the Fire Dynamics Simulator (FDS) developed by the NIST, the National Institute of Standards and Technology. The model allows fire and evacuation processes to be simulated within the same environment. It is a continuous model that applies the Social Force Model by Helbing [15] for simulating people’s movement. Agent movement and decisions are influenced by the conditions produced by the fire model (FDS). Smoke and speed correlation is based on experimental data-sets by Frantzich/Nilsson [8]. Despite the fact that Frantzich/Nilsson’s experiments provide the values of standard deviations in the occupants decreased speeds, FDS+Evac uses only the mean values. The incapacitation model is a simplified version of the FED concept introduced by Purser [14].

buildingEXODUS is an evacuation modelling package developed by the Fire Safety Engineering Group at the University of Greenwich. It is designed to simulate the evacuation of large numbers of people from complex structures. The model comprises five core interacting sub-models: the Occupant, Movement, Behaviour, Toxicity and Hazard sub-models. The software is rule-based, with the motion and behaviour determined by a set of heuristics or rules, interpreted on an individual basis. The Toxicity sub-model determines the physiological impact of the environment upon the occupant using an FED toxicity model [14]. The buildingEXODUS toxicity model considers the toxic and physical hazards associated with elevated temperature, thermal radiation, the narcotic and irritant smoke. When occupants move through a smoke filled environment their travel speed and behaviour is modified according to the experimental data of Jin [7]. The thermal and toxic environment is determined by the Hazard sub-model. This distributes hazards throughout the environment as a function of time and location. buildingEXODUS can accept experimental data or numerical data from other models. The fire hazards are specified at two arbitrary heights that are intended to represent a nominal head height and crawling height.

Gridflow is an object-oriented evacuation model, written in Visual Basic. It uses a continuous spatial representation. The movement algorithms employed are based on Nelson and MacLennan [16], who described a detailed method of estimating occupant movement and flows through various types of building spaces and elements. For Gridflow, unrestricted walking speeds are set as distributions or as specified by the user. Restricted walking speeds depend upon interpersonal distance with allowance for overtaking where appropriate. A default distribution is provided for modelling pre-evacuation time. This can be also modified by the user, permitting to apply log-normal, normal or uniform distributions. No default data-sets are embedded in the model with regards to smoke effects on people behaviours. Thus, the user needs to select the relevant data-set for the scenario being examined. Data about visibility and toxicity conditions can be implemented by the user through a spreadsheet. Users can specify the different speed factors and FED values, which are sensitive to the environmental conditions. The representation of the environmental conditions and the impact on the evacuees represented is therefore dynamic. The susceptibility of the evacuees to the implemented factors can be randomly assigned according to default or user-defined distribution laws.

3.2. Scenarios

A straight corridor (100 m of length and 3.5 m of width) with a single exit located at one end is modelled to test the impact of the different model assumptions on the results produced. The scenarios required a number of further assumptions to be made which were applied across all of the models employed:

- A single agent is simulated to remove agent interaction from influencing the results;
- Smoke is represented at a constant extinction coefficient during a simulation. Visibility conditions are therefore considered as constant in each scenario, although different extinction coefficients are examined between scenarios. No influence of external sources of lights are taken into account;
- The toxic effect of smoke is not considered in this scenarios (i.e. FED is always equal to 0);
- Free-flow conditions are assumed at the final exit and no influence of signage is taken into account;

- Two different environmental conditions are considered for each scenario, according to the Jin data [7]: irritant and non-irritant smoke;
- Initial unimpeded walking speeds are constant values (i.e. distributions are not used);
- Default values about agent's body dimensions are used.
- Agents are assumed to be upright during the scenarios (i.e. not to crawl).

Five different initial unimpeded walking speeds are considered (ranging from 0.25 m/s to 1.25 m/s). Agents with these initial travel speeds are exposed to five different visibility conditions (i.e. extinction coefficients ranging from 0.5 /m to 10 /m) for irritant and non-irritant smoke. This produces a total of 50 scenarios. A three place naming convention is used for the scenarios. The first place indicates the assumed initial speed of the agent (either 1.25, 1.0 0.75, 0.5 or 0.25). The second place indicates the extinction coefficient (10, 7.5, 3.0, 1.0, or 0.5/m). The final place indicates whether the smoke represented was irritant or non-irritant (either I or NI). Scenario [125_10_I] represents an agent with initial speed 1.25m/s, in irritant smoke with extinction coefficient 10/m.

3.2.1 Model input configuration

FDS+Evac

The general visibility conditions in FDS+Evac have been reproduced using its correspondent fire model FDS, the Fire Dynamic Simulator [17]. The corridor visibility conditions have been simulated defining the initial conditions of the environment. This method is based on the assumption of fixed visibility conditions in space and time and no external sources of light. Thus, the calculation of the ratio between the mass of soot and mass of air (Mass fraction – kg/kg) has been provided for obtaining the desired visibility conditions. In FDS, this parameter is the command line &INIT MASS_FRACTION(2) and the input value has been calculated for the 5 different extinction coefficients by simulating a fictitious fuel made of 100% soot. The variables generating toxic gases in FDS are set equal to 0 (i.e. the command line CO_YIELD=0). Initial walking speeds are inserted as a constant value in each scenario. The random fluctuations within the movement model have been set equal to 0.

buildingEXODUS

The geometry was constructed as indicated, with a free-flow exit. An agent was generated with the initial *Fast Walk Speed* set to the values indicated in scenarios. The agent was then positioned at the far end of the geometry. An environmental zone was set across the entire geometry and the extinction coefficient within the zone set to the values of the scenarios examined. The model allows the user to provide a detailed representation of the narcotic and irritant gases present. In this case, the toxic impact of the gases present is not of interest. Therefore, the model was configured to either use the embedded Jin irritant curve or the Jin non-irritant curve (with no narcotic or irritant gases explicitly modelled in either case). buildingEXODUS is able to represent the impact that smoke has on the initial response of the agent, the route adopted, the potential for crawling, the presence of agent staggering and boundary use for guidance. The first two behaviours were not relevant in this case study. Crawling was disabled to ensure consistency between the models employed. Tests were conducted to determine the impact of agents staggering within the smoke and wall adherence (both derived directly from the Jin data-set). However, in this instance the impact was minimal given the narrowness of the corridor, allowing the agents to use the corridor wall to overcome the staggering. The impact of these behaviours was between 1-5%, and has been excluded from the results presented below.

Gridflow

Default settings in Gridflow provide a minimum value of 0.3 m/s of walking speeds when using distribution laws. For this reason the modeller needs to insert initial walking speeds as a unique constant value in each scenario for modelling the desired walking speeds in case of values lower than 0.3 m/s. Inputs are provided by a spreadsheet from the user. FED values are set equal to 0 in this case (i.e. the toxic effect is not considered in these scenarios). Two different sets of speed factors have been used in Gridflow for simulating the considered scenarios. The first is derived from the FDS+Evac approximation of Frantzich/Nilsson's experimental data [9] while the second set of speed factors comes from the Exodus representation of Jin's data-sets [10]. Hand calculations have been done for calculating the speed factors according to these two different data-sets. The speed factors are then inserted into the input spreadsheet for each time step. The susceptibility set for each agent to speed factors was 1, so that every agent will have exactly the selected speed reduction (although it is possible to set varying levels of susceptibility for different individual agents).

3.2.2. Results

The results produced are shown in Table 1. The predicted evacuation times are in line with the correlations provided by Jin and Frantzich/Nilsson (Lund). Jin's curve is used only for its range of applicability (that is an extinction coefficient of 0.2-1.0/m for non-irritant smoke and 0.2-0-5/m for irritant smoke). Scenarios with extinction coefficients higher than 1.0/m for non irritant smoke and 0.5/m for irritant smoke would produce all the same results according to the Jin's minimum walking speed of 0.3 m/s.

Table 1 (part 1): Results from the three models.

Scenario	**Evac. time (s)**	**Evac. time (s)**	**Evac. time (s)**	**Evac. time (s)**	**Evac. time (s)**	**Evac. time (s)**
n°	F/N's *curve**	*FDS+Evac*	*Gridflow* (F/N)	*Jin's curve**	*Gridflow (Jin)*	*buildingEXODUS*
125.10.I	417	419	417	/	/	/
125.10.NI	417	419	417	/	/	/
125.75.I	204	203	205	/	/	/
125.75.NI	204	203	205	/	/	/
125.3.I	105	107	105	/	/	/
125.3.NI	105	107	105	/	/	/
125.1.I	87	87	87	/	/	/
125.1.NI	87	87	87	175	174	175
125.05.I	83	84	83	229	227	223
125.05.NI	83	84	83	97	96	97

*Hand calculations applying the formulas for Frantzich/Nilsson (F/N in the table) and Jin's correlation described in the FDS+Evac [9] and buildingEXODUS [10] manuals.

Table 1 (part 2): Results from the three models.

Scenario	**Evac. time (s)**	**Evac. time (s)**	**Evac. time (s)**	**Evac. time (s)**	**Evac. time (s)**	**Evac. time (s)**
n°	F/N's *curve**	*FDS+Evac*	*Gridflow* (F/N)	*Jin's curve**	*Gridflow (Jin)*	*buildingEXODUS*
100.10.I	526	526	527	/	/	/
100.10.NI	526	526	527	/	/	/
100.75.I	256	255	257	/	/	/
100.75.NI	256	255	257	/	/	/
100.3.I	132	133	132	/	/	/
100.3.NI	132	133	132	/	/	/
100.1.I	109	109	109	/	/	/
100.1.NI	109	109	109	219	217	218
100.05.I	104	105	104	286	283	279
100.05.NI	104	105	104	122	120	121
075.10.I	714	711	713	/	/	/
075.10.NI	714	711	713	/	/	/
075.75.I	333	339	332	/	/	/
075.75.NI	333	339	332	/	/	/
075.3.I	175	177	175	/	/	/
075.3.NI	175	177	175	/	/	/
075.1.I	145	146	145	/	/	/
075.1.NI	145	146	145	292	289	290
075.05.I	139	139	140	381	377	372
075.05.NI	139	139	140	162	160	162
05.10.I	1000	998	1000	/	/	/
05.10.NI	1000	998	1000	/	/	/
05.75.I	500	509	500	/	/	/
05.75.NI	500	509	500	/	/	/
05.3.I	263	266	263	/	/	/
05.3.NI	263	266	263	/	/	/
05.1.I	217	217	217	/	/	/
05.1.NI	217	217	217	439	435	436
05.05.1I	208	208	208	571	567	557
05.05.NI	208	208	208	244	241	242
025.10.I	2000	1998	2000	/	/	/
025.10.NI	2000	1998	2000	/	/	/
025.75.I	1000	1005	1000	/	/	/
025.75.NI	1000	1005	1000	/	/	/
025.3.I	526	529	527	/	/	/
025.3.NI	526	529	527	/	/	/
025.1.I	435	434	433	/	/	/
025.1.NI	435	434	433	877	877	872
025.05.I	417	415	417	1143	1143	1115
025.05.NI	417	415	417	487	487	484

*Hand calculations applying the formulas for Frantzich/Nilsson (F/N in the table) and Jin's correlation described in the FDS+Evac [9] and buildingEXODUS [10] manuals.

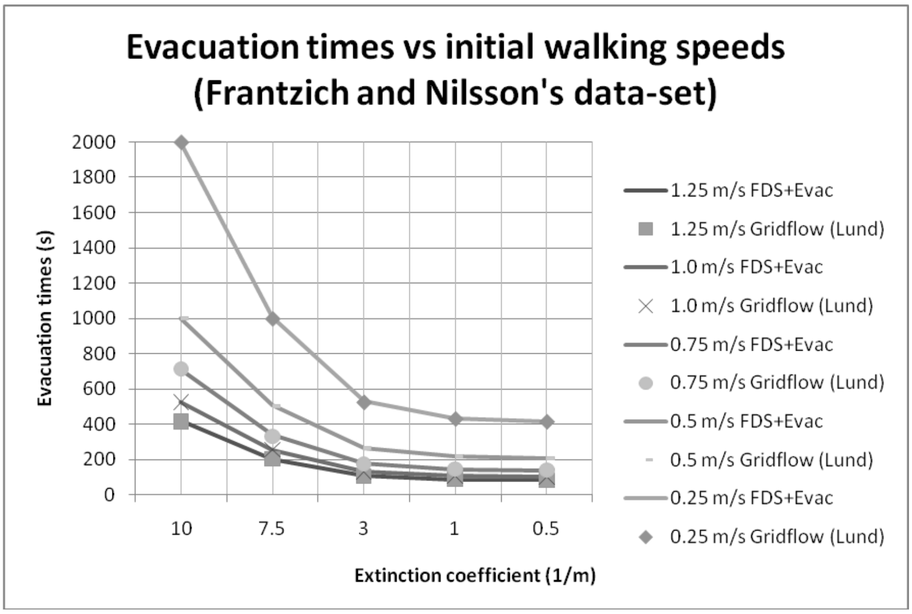

Figure 2: Evacuation time vs initial walking speeds applying Frantzich/Nilsson's data-set. Scenarios differ in relation to initial unimpeded walking speeds and visibility conditions (ie extinction coefficients).

Figure 2 shows the trend of the evacuation times in case of irritant and non-irritant smoke applying the Frantzich/Nilsson (Lund)'s data-set. The initial unimpeded walking speeds are related to the different extinction coefficients values. FDS+Evac and Gridflow produced reasonably consistent evacuation times when applying the same data-set (Frantzich/Nilsson). As expected, evacuation times increase with higher extinction coefficients and lower initial walking speeds. Frantzich/Nilsson's data-set is used as equivalent for the case of irritant and non irritant smoke. Thus, scenarios with irritant and non-irritant smoke do not produce differences in the evacuation times when applying this data-set.

The overall evacuation times produced by the models can also be compared against each other. In order to perform this comparison, scenarios included in the range of smoke concentrations of Jin's experiments should be considered; i.e. scenarios with extinction coefficients under 0.5/m for irritant smoke and extinction coefficients under 1.0/m for non-irritant smoke.

Results from the case of irritant smoke are resumed in Figure 3, in which evacuation times are presented. Significant differences in the evacuation times are evident in all the considered scenarios. The use of Jin's data-set provides higher evacuation times. In fact, Jin's data-set produces evacuation times that are approximately 170% greater than those produced in the scenarios where the Frantzich/Nilsson data-set is applied. This difference is exaggerated as the individual's initial speed is further reduced.

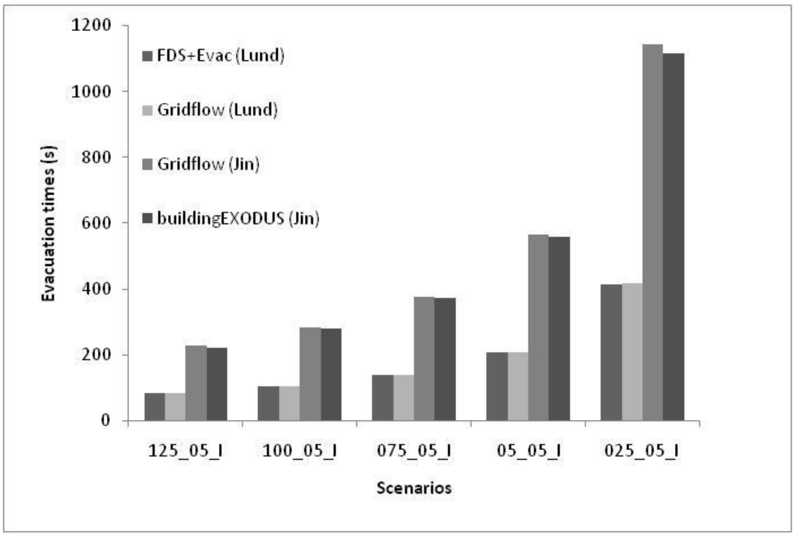

Figure 3: Evacuation times for scenarios with extinction coefficient = 0.5 /m and irritant smoke using FDS+Evac, Gridflow (both applying Frantzich/Nilsson and Jin's data-sets) and buildingEXODUS.

Two groups of scenarios are of particular interest when comparing the different model results for non-irritant smoke. These scenarios examine walking speeds when extinction coefficients of 1.0/m (see Figure 4) and 0.5/m are simulated (see Figure 5). Results shows that the use of Jin's correlation leads to an increase of evacuation times of approximately a 97-107% when the extinction coefficient is 1.0/m, and 14-19% when the extinction coefficient is 0.5 /m. As expected, the differences in the evacuation times are again higher in where lower walking speeds are initially assumed.

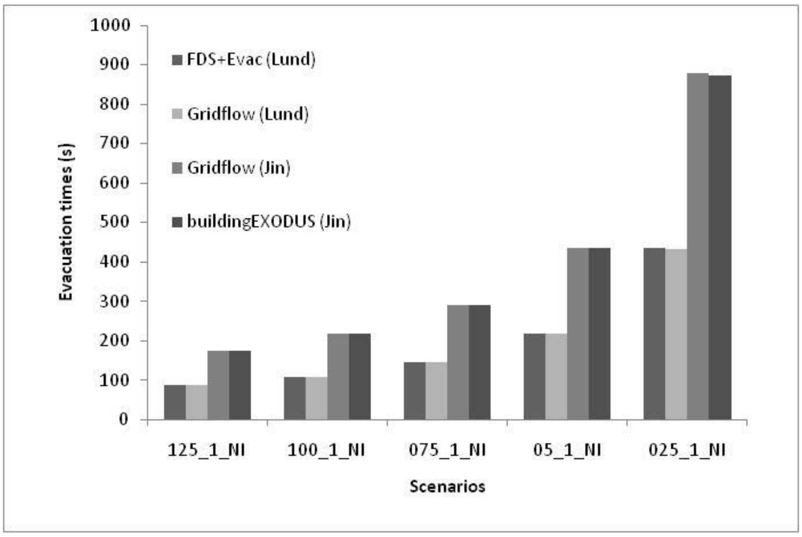

Figure 4: *Evacuation times for scenarios with extinction coefficient = 1 /m and non irritant smoke using FDS+Evac, Gridflow (both applying Frantzich/Nilsson and Jin's data-sets) and buildingEXODUS.*

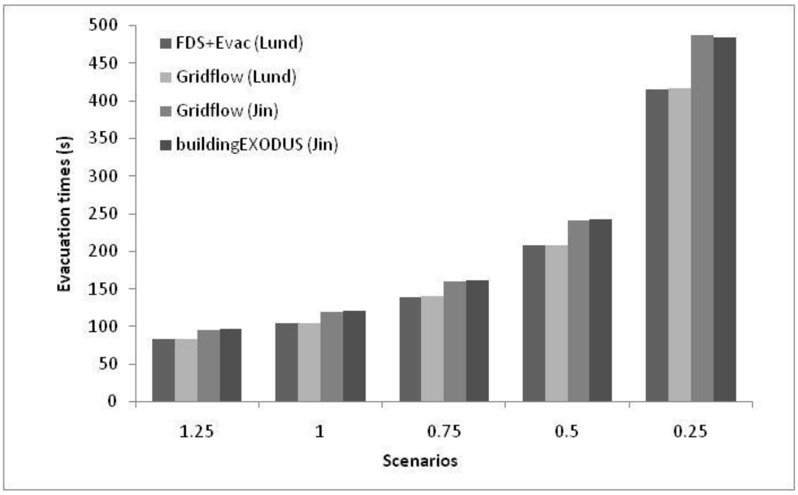

Figure 5 Evacuation times for scenarios with extinction coefficient = 0.5 /m and non irritant smoke using FDS+Evac, Gridflow (both applying Frantzich/Nilsson and Jin's data-sets) and buildingEXODUS.

4. CONCLUSIONS

This paper focuses on the impact of default settings/embedded data on evacuation modelling results. A case-study has been presented, showing the impact of different embedded data-sets on simulating the impact of smoke densities on occupant walking speeds. Two main data-sets have been analysed in detail for this purpose: the Jin and Frantzich/Nilsson's experimental data. Three models using different strategies for applying empirical data have been selected: 1) FDS+Evac, 2) buildingEXODUS and 3) Gridflow. A total of 50 scenarios have been examined to test the sensitivity of the results, given the embedded relationship between the smoke conditions (i.e. extinction coefficients) and the speed reduction.

The results presented show that (1) the application of different data-sets produced different results - when the same or different models are used, given the scenarios examined; (2) the numerical results produced are comparable when the same data-set is employed by different models (i.e. comparing Gridflow and FDS+Evac and Gridflow and buildingEXODUS).
Both of the original data-sets show considerable variation between the walking speeds of different individuals at different smoke densities. In contrast, the models tend to use a simple average correlation. A more realistic outcome might be obtained by varying both the unrestricted walking speeds and the sensitivity of speed to smoke density among an evacuating occupant population. Consideration should also be given to what proportion of occupants may stop moving completely at different smoke densities.

Both data-sets are often considered to be equivalent; instead, modellers should carefully evaluate the conditions of the scenario they are going to study before selecting the data-set and/or the associated behavioural assumptions. Different populations and smoke concentrations were involved in the scenarios that produced these data-sets. Modellers should be aware of these differences and their implications for the analysis at hand.

As has been shown for the case-study of the correlation between visibility conditions and walking speeds, it is critical for potential users to fully understand the model default settings, their embedded data-sets and the underlying assumptions on which they are based. If they do not, the models may be misunderstood and misapplied, potentially producing errors in the results, and the derivation of inappropriate conclusions.

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