The Evacuation from Commercial Objects - The Case of DIS Object in Niš

RADOJE B. JEVTIĆ, Electrotechnical school „Nikola Tesla“, Niš

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Commercial objects present objects with lot of people inside in almost any time moment. The crowds and jams in these objects are very often. Although these objects have a lot of evacuation routes and exits, much of people and stuff in limited space can cause serious problem in evacuation sense, with presence of fear and panic. These and similar objects have clearly noted evacuation routes in the case of emergency, but experience proved that with the surprise effect almost no one pay attention on noted messages and warnings on object`s walls, but try to leave the object as soon as possible, very often not paying attention on injured, wounded or unconscious occupants. So, the best way for evacuation is prediction.

Optimal prediction can be realized by analyse of as much as possible potential evacuation scenarios. For precise, fast, safe and cheap analyse of evacuation scenarios, routes and calculation of evacuation times, evacuation software is used. One of the best evacuation software is Pathfinder. This paper was written to show the potential evacuation scenarios and calculation of evacuation times in Pathfinder for DIS commercial object in Niš.

Key Words: *commercial object, occupant, evacuation, simulation*

1. INTRODUCTION

Commercial objects were always present objects with lot of people and different stuff in one, limited space. Because of that, the crowds, jams and other problems are very often occurrences in those objects. Today, these objects are built as huge objects on several floors, where floors can be located above or below the ground, with stores, passages, ordinary stairs, elevators, slide stairs, toilets, garages and many other objects and contents. Very characteristic for these objects is the huge people flow and stuff, especially in some particular days. So, because of all noted, planed evacuation of one such object is from crucial importance for life safety, at the first place, and after that, for material properties safety.

The biggest commercial objects in the world are located in Asia. Related to many sources, the biggest commercial object-commercial centre is New South China Mall, in Dongguan, in China. This object, opened in 2005, has enormous 660.000 m^2 of space with more than 2.300 different stores and other commercial objects. The high place on the list of the biggest commercial objects has Golden Resources Mall in Peking, in China. This object has 557.400 m^2 and it was 1,5 times bigger than Mall of America. It was estimated that this object would have more than 50-000 visitors per day. The obvious proof that fire protection and evacuation prediction must be treated and realised at the highest level for these object`s types was Central World commercial object in Bangkok, in Thailand. This commercial centre with its 429.200 m^2 presented the biggest commercial object in Thailand. But, in April 2019, this commercial object was overtaken with fire that lasted two days. Enormous material damage was caused with three death people [1].

Related to the National Fire Protection Association (NFPA), the places in commercial objects where the fires are the most likely to occur, are restaurants. There are several reasons for fire in commercial objects. At the first place, it is cooking equipment. This type of equipment causes 61 % of all fires in restaurants. At the second place, there are electrical and lightning equipment. These types of equipment cause 9 % of all fires in restaurants. Next reasons are intentional fire setting, storage conditions etc [6].

Fires in commercial objects are often and in Serbia. Only in the past several months, several huge fires

Author’s address: Radoje Jevtić, Electrotechnical school „Nikola Tesla“, Niš, Aleksandra Medvedeva 18
e-mail: milan.jvtc@gmail.com
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in commercial objects have been occurred. Huge fire in hypermarket Tempo that occupies more than 7000 m^2 in Novi Sad occurred in the December 21, in 2021. The size of fire was such that 50 firefighters and 22 fire vehicles took part in fire extinguishing. Huge material damage was caused but there were no human victims [5]. Also, huge fire in hypermarket in Subotica, which present the part of the Russian commercial chain, occurred in March 7, in 2022. This fire caused huge material damage but no human victims [4].

Of course, fire is not the only reason for evacuation. Other causes include earthquake, waterflow, terrorism attack, bomb threat etc. Noted examples are showing that fire protection and evacuation of occupants in commercial objects should be always open task which must be constantly and permanently improved.

DIS commercial object in Niš was opened in 2013, in the Boulevard Medijana 15 street, at the same place where French hypermarket Mr. Bricolage was. The huge object has about 6.000 m^2, more than 12.000 articles and 90 employees. Soon, thanks to the good marketing, good leadership, diligent and pleasant staff, good location, many different articles with favourable prices, this object has become one of the most visited commercial objects in Niš. A large parking space in the front of the object enable the presence of lot of vehicles and people. Large entrance/exit door, large space between columns of stuff, big number of different entrance/exits, big number of payment places also enable unobstructed flow of people and stuff. DIS commercial object in Niš is presented on figures from 1 to 3 [3].

Figure 1 - DIS commercial object in Niš, the front and parking area.

Figure 2 - DIS object interior, payment places.

Figure 3 - DIS object interior, section for frozen food.

2. SIMULATION MODEL

Simulation model of DIS commercial object in Niš was realised in Pathfinder software related to the real dimensions of the object. This software presents special software for simulation of evacuation scenarios and calculation of evacuation times. The use of this software has very important reasons. The first reason, and of course the most important reason is safety, because the complete simulation is realised in „virtual" world.

Other important reasons are cheapness, in economic sense; precision and speed of calculations. It is possible to analyse different evacuation scenarios for different conditions and different speed of occupants and to calculate evacuation times for all those scenarios. Although software enables good graphical potentials for drawing and design objects and their elements, it is possible to import the objects drawn in some other programs, such as, the most frequently, AutoCAD. The version of this software used in this paper was 2021 [2].

The simulation of evacuation of DIS object was realised through three different scenarios.

The first scenario purported all potential doors/exits opened. The second scenario purported all potential front doors/exits closed. The third scenario purported all potential back doors/exits closed.

Every of three scenarios was realised for three cases. The first case purported 200 occupants in object, the second case purported 350 occupants in object while the third case purported 450 occupants in object.

The complete number of occupants in every case consisted employees and customers. Occupants were located randomly in the object, while employees were located at the same locations for every case. The speeds of occupants were 0.75 m/s, 0.95 m/s, 1.2 m/s, 1.5 m/s and 1.85 m/s.

The Pathfinder presentation of DIS object with noted evacuation directions, related to real dimensions and noted evacuation plan is presented on figure 4.

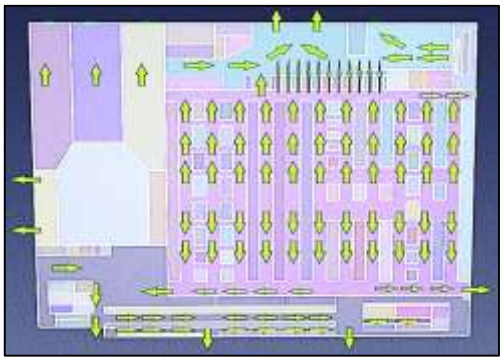

Figure 4 - DIS object in Niš with evacuation routes, Pathfinder 2021 presentation.

3. SIMULATION RESULTS

The computer used for simulations in this paper was laptop Dell Latitude, with Intel® Core™ i7-1185G7 (4 Core, 12M cache, base 3.0GHz, up to 4.8GHz, vPro) processor and 16 GB of RAM memory. There is general recommendation to use computers with „strong„ hardware configuration for realisation of simulations, because simulation duration can be from several minutes or hours to several days, in dependence of complexity and conditions.

Some of simulation moments are presented from figures 5 to 11, while the complete simulation results for all scenarios and cases are presented from figures 12 to 20.

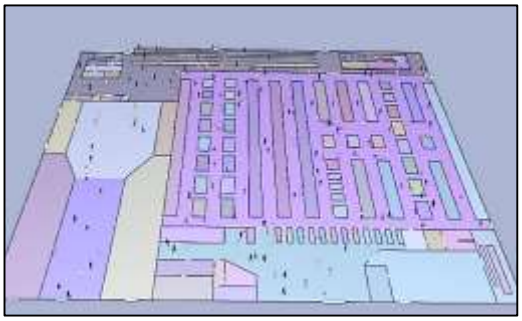

Figure 5 - Simulation moment for the first scenario, the first case, for occupant's speed of 0.75 m/s

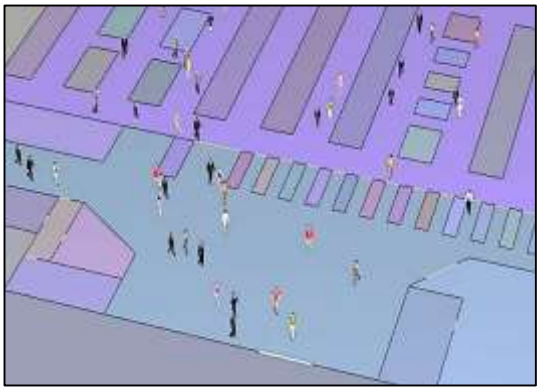

Figure 6 - Simulation moment for the first scenario, the first case, for occupant's speed of 0.95 m/s

Figure 7 - Simulation moment for the second scenario, the second case, for occupant's speed of 0.75 m/s

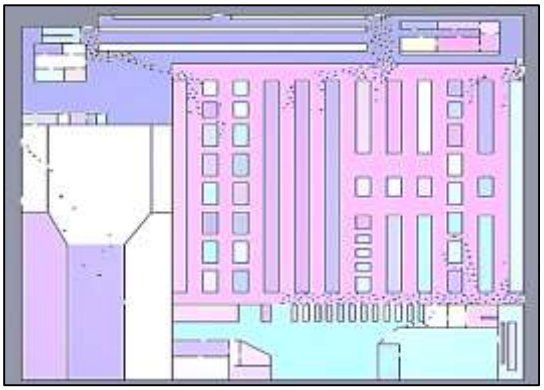

Figure 8 - Simulation moment for the second scenario, the third case, for occupant's speed of 0.95 m/s

Figure 9 - Simulation moment for the third scenario, the second case, for occupant's speed of 1.2 m/s

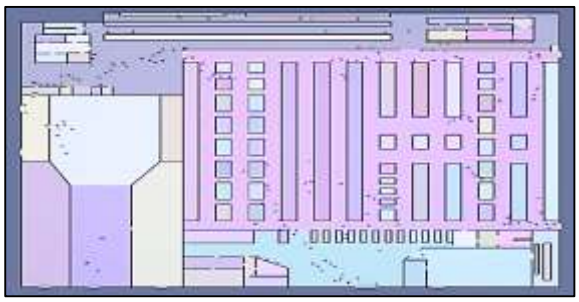

Figure 10 - Simulation moment for the third scenario, the second case, for occupant's speed of 1.2 m/s

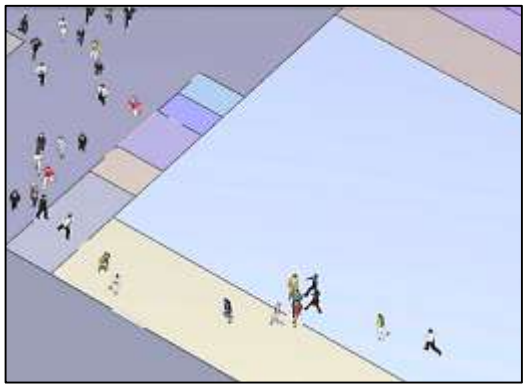

Figure 11 - Simulation moment for the third scenario, the second case, for occupant's speed of 1.5 m/s

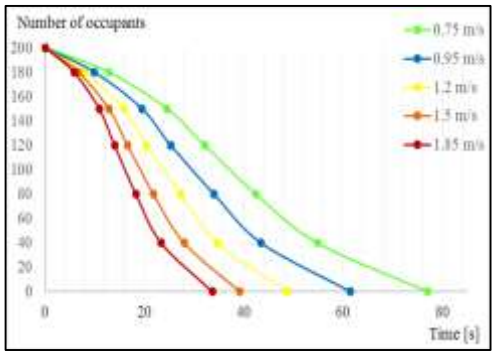

Figure 12 - Simulation results for the first scenario, the first case-200 occupants

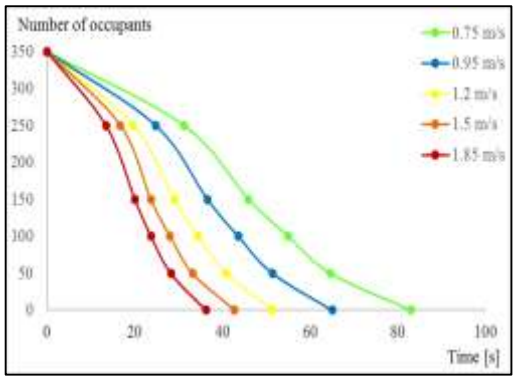

Figure 13 - Simulation results for the first scenario, the second case - 350 occupants

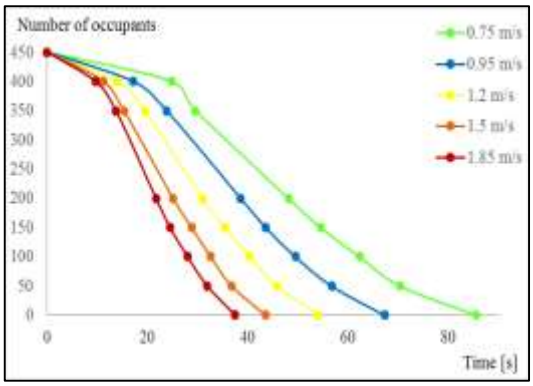

Figure 14 - Simulation results for the first scenario, the third case - 450 occupants

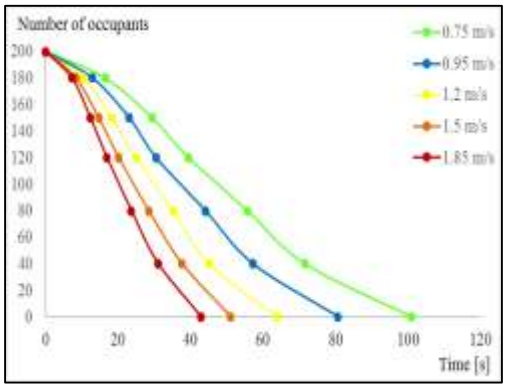

Figure 15 - Simulation results for the second scenario, the first case - 200 occupants

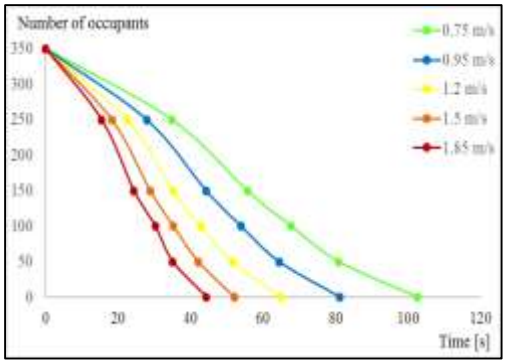

Figure 16 - Simulation results for the second scenario, the second case - 350 occupants

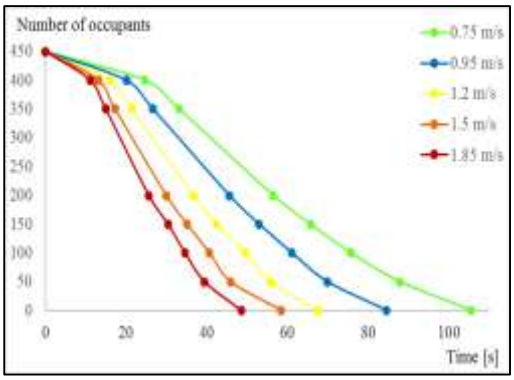

Figure 17 - Simulation results for the second scenario, the third case-450 occupants

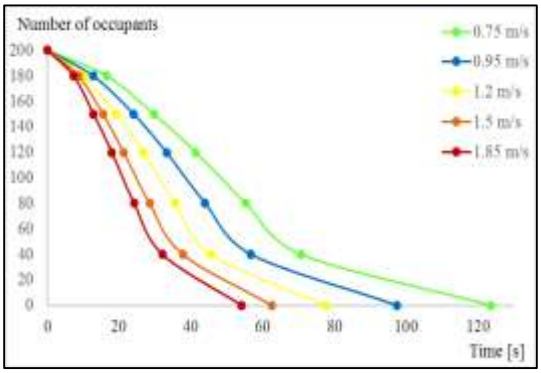

Figure 18 - Simulation results for the third scenario, the first case-200 occupants

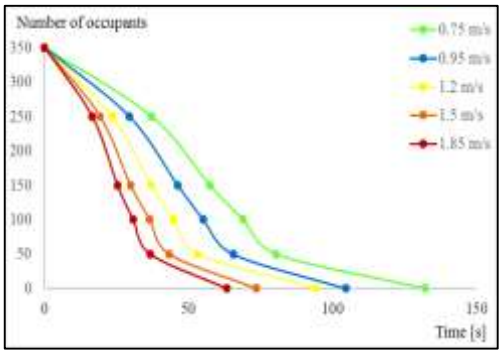

Figure 19 - Simulation results for the third scenario, the second case-350 occupants

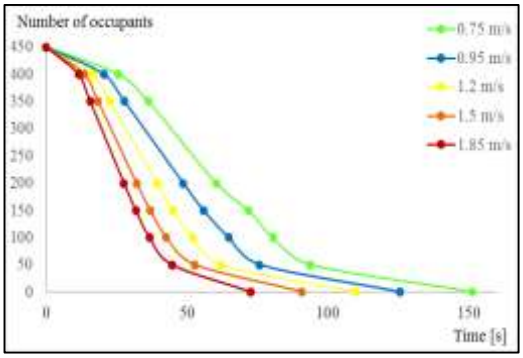

Figure 20 - Simulation results for the third scenario, the third case - 450 occupants

4. RESULTS ANALYSE

Realised simulation results for the first scenario presented on figures 12,13 and 14, where all potential doors/exits were opened, showed that the shortest evacuation time was 42.8 seconds, for the first case, for the occupant's speed of 1.85 m/s, while the longest evacuation time was 105.5 seconds, for the third case, for occupant's speed of 0.75 m/s.

Realised simulation results for the second scenario presented on figures 15,16 and 17 where all potential front doors/exits were closed, showed that the shortest evacuation time was 33.7 seconds, for the first case, for the occupant's speed of 1.85 m/s, while the longest evacuation time was 85.5 seconds, for the third case, for occupant's speed of 0.75 m/s.

Realised simulation results for the third scenario presented on figures 18,19 and 20, where all potential back doors/exits were closed, showed that the shortest evacuation time was 53.2 seconds, for the first case, for the occupant's speed of 1.85 m/s, while the longest evacuation time was 151.4 seconds, for the third case, for occupant's speed of 0.75 m/s.

Calculated evacuation times showed very good arrangement of doors and exits with very good arrangement of stuff inside the object. Wide passages as well as clearly defined evacuation routes also contribute to efficient evacuation. The proof for that was the fact that for calculated speeds of occupants there were no jams. Also, in the comparation with the similar objects, results showed that analyses evacuation scenarios related to the noted and planed evacuation routes enable acceptable evacuation times [7].

5. CONCLUSION

Prediction of potential evacuation routes and calculation of potential evacuation times have a crucial importance related to human lives and material properties safety.

Simulation software present great advantage and very important engineering tool in solutions of evacuation and fire problems. On the evacuation field, simulation software enables correct, fast, safe and cheap calculation of evacuation times, determination of evacuation routes and analyse of different evacuation scenarios. On the field of fire protection, simulation software enables determination of correct and optimal arrangement of fire and smoke detectors, prediction of fire and smoke movement etc. This and similar kinds of software must present obligatory tool for engineers and designers not only on science fields of fire protection and evacuation but on other science fields [8, 9].

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REFERENCES

[1] https://imovina.rs/lifestyle/10-najvecih-trznih-centara-u-svetu/114.

[2] https://support.thunderheadeng.com/docs/pathfinder/2021-3/user-manual/.

[3] https://www.rts.rs/page/stories/sr/story/57/srbija-danas/1308040/otvoren-dis-u-nisu.html.

[4] https://www.srbijadanas.com/vesti/hronika/detalji-stravicnog-pozara-u-subotici-izgoreo-supermarket-ruskog-trgovinskog-lanca-foto-2022-01-25.

[5] https://www.telegraf.rs/vesti/srbija/3434788-50-vatrogasaca-celu-noc-gasilo-pozar-u-novom-sadu-goreo-hipermarket-evo-kako-je-do-toga-doslo.

[6] https://www.unifourfire.com/blog/common-causes-commercial-fires.

[7] Jevtić BR. Simulation of the shopping centre Zona I evacuation, *Tehnika*, Vol. 3, pp. 537-541, ISSN 0040-2176, Beograd, Serbia, 2014.

[8] Jevtić BR. The significance and use of simulation software in fire protection, Path to a Knowledge Society-Managing Risks and Innovation PaKSoM

20121, *3rd International Virtual conference*, November 15 and 16, 2021.

[9] Jevtić B. R. The significance and use of simulation software in evacuation, Path to a Knowledge Society-Managing Risks and Innovation PaKSoM 20121, 3rd *International Virtual conference*, November 15 and 16, 2021.

REZIME

EVAKUACIJA IZ TRGOVINSKIH OBJEKATA - SLUČAJ OBJEKTA DIS U NIŠU

Trgovinski objekti predstavljaju objekte sa dosta ljudi unutar njih u skoro svakom momentu. Gužve i zakrčenja u ovakvim objektima su veoma česti. Iako ovakvi objekti imaju mnogo evakuacionih ruta i izlaza, mnoštvo ljudi i robe na ograničenom prostoru mogu prouzrokovati ozbiljne probleme u evakuacionom smislu, sa prisustvom straha i panike. Ovakvi i slični objekti imaju jasno naznačene evakuacione rute u hitnim slučajevima, ali je iskustvo dokazalo da sa efektima iznenađenja, skoro niko ne obraća pažnju na istaknute poruke i upozorenja na zidovima objekta već pokušava da napusti objekat što je moguće brže, veoma često ne obraćajući pažnju na povređene, ranjene i onesvešćene okupante. Zato, najbolji način evakuacije je predviđanje. Optimalno previđanje može biti realizovano analizama sa što je moguće više evakuacionih scenarija. Za preciznu, sigurnu i jeftinu analizu evakuacionih scenarija, ruta i izračunavanje evakuacionih vremena koristi se softver za evakuaciju. Jedan od najboljih evakuacionih softvera je Pathfinder. Ovaj rad je napisan da pokaže moguće evakuacione scenarije i izračunavanje evakuacionih vremena u softveru Pathfinder za trgovinski objekat DIS u Nišu.

Ključne reči: *trgovinski objekat, okupant, evakuacija, simulacija*