



SYSTEM EFFICIENCY RESEARCH REPORT

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1 Introduction

In this report the results of a system analysis and comparison will be presented and explained. This is done to prove the efficiency of the FireWatch system over other evacuation methods. To test the system the simulation software used to display the inner working of the FireWatch system was adjusted and applied to the different situations to result in the necessary data.

The three methods tested:

- *Random routes* = Occupants finding their own route to safety (mostly used in smaller buildings).
- *One chosen route* = Occupants being ushered to a predetermined escape route (mostly used by larger organizations).
- *FireWatch system* = Occupants using the routes allocated through use of the FireWatch system.

These systems were tested under the following conditions:

- A 2 story office building (10m x 24m).
- A walking speed of approximately 1.6m/s per person.
- Smoke spreading at approximately 2m/s.
- Fire spreading at approximately 0.4m/s.

Assumptions and measurements:

- The time to evacuate was taken to be the longest time it took for any one person to leave the building.
- The safety of a person was taken to be FALSE if said person either ran through a fire, or was exposed to smoke for more than 120 seconds (Linkedin.com, 2019).
- Time exposed to smoke for each person was determined using the spread rate of smoke, and the traveling of individual people through the building by monitoring the simulation.
- 20 runs were performed for each system (only one will be included as an examples per system).

2 Data collection example

RUN #5			
People	Time to escape (s)	Smoke exposure (s)	SAFE?
1	170.537436	85	TRUE
2	136.225806	68	TRUE
3	91.264788	46	TRUE
4	180.754698	90	TRUE
5	72.877242	36	TRUE
6	191.765376	96	TRUE
7	192.499938	96	TRUE
8	199.818162	100	TRUE
9	196.071126	98	TRUE
10	128.492526	64	TRUE
11	73.089	37	TRUE
12	170.197536	85	TRUE
13	178.13562	89	TRUE
14	52.929072	26	TRUE
15	202.328658	101	TRUE
16	233.296494	130	FALSE
17	159.710742	80	TRUE
18	209.261898	121	FALSE
19	201.823098	101	TRUE
20	200.80623	100	TRUE
Total	233.296494	1649	17
Average	162.0942723	82.45	0.85
Average	216.2375412	60.08577778	0.86

RUN #5			
People	Time to escape (s)	Smoke exposure (s)	SAFE?
1	158.58	79	TRUE
2	135.54	68	TRUE
3	153.54	77	TRUE
4	160.74	80	TRUE
5	109.2	55	TRUE
6	165.06	83	TRUE
7	147.12	74	TRUE
8	132.36	66	TRUE
9	118.44	59	TRUE
10	112.68	56	TRUE
11	129.12	65	TRUE
12	123.18	62	TRUE
13	138.24	69	TRUE
14	104.34	52	TRUE
15			FALSE
16	207.12	104	TRUE
17	209.28	105	TRUE
18	167.46	84	TRUE
19	177.6	89	TRUE
20	180.78	90	TRUE
Total	209.28	1417	18
Average	148.9673684	74.57894737	0.9
Average	221.4801696	68.28421053	0.84

RUN #5			
People	Time to escape (s)	Smoke exposure (s)	SAFE?
1	59.9328	30	TRUE
2	39.62925	20	TRUE
3	42.385314	21	TRUE
4	53.850942	27	TRUE
5	17.927352	9	TRUE
6	37.9938	19	TRUE
7	51.481434	26	TRUE
8	9.524136	5	TRUE
9	45.558912	23	TRUE
10	30.219372	15	TRUE
11	73.574736	37	TRUE
12	69.774444	35	TRUE
13	83.411028	42	TRUE
14	53.465388	27	TRUE
15	50.903796	25	TRUE
16	93.862494	47	TRUE
17	87.67617	44	TRUE
18	101.852934	51	TRUE
19	109.875384	55	TRUE
20	117.681654	59	TRUE
Total	117.681654	617	20
Average	61.529067	30.85	1
Average	119.5823574	20.09	1

3 Data Analysis

By inspecting the data the following results can be obtained.

By using the FireWatch system the evacuation rate was approximately 1.83 times faster than using the traditional methods. Dropping from an average of 220 seconds to an average of 119.6 seconds.

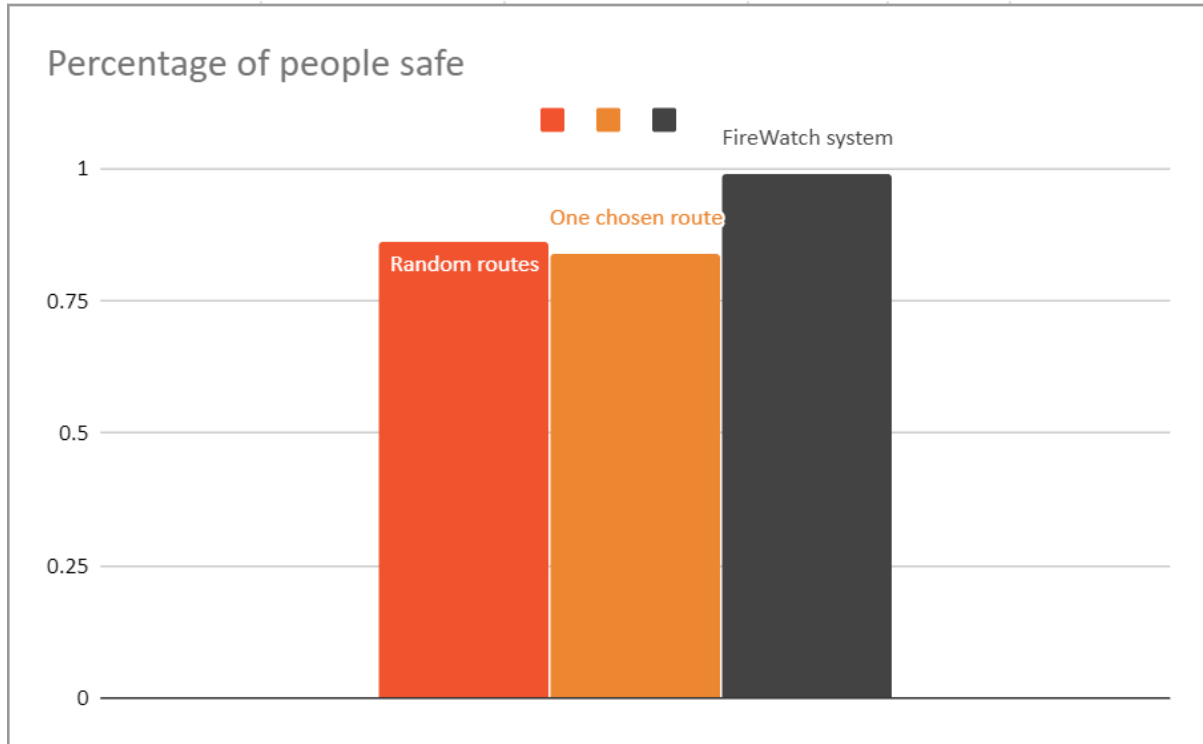
The safe escape rate is also increased 1.2 times, raised from an average of 85% to 99%.

This results in a large increase of safety across the whole system. The large decline in the danger is influenced most greatly by the avoidance of dangerous areas as soon as they are detected, and the avoidance of bottlenecks results in less time spent in the building, and therefore reduces the risk of smoke inhalation and therefore minimizes the health risks of the occupants. These results can be seen from the following graphs:

3.1 Percentage of safe evacuations

The value **0** represents 0% safe evacuations, and the value **1** indicates a 100% safe evacuation.

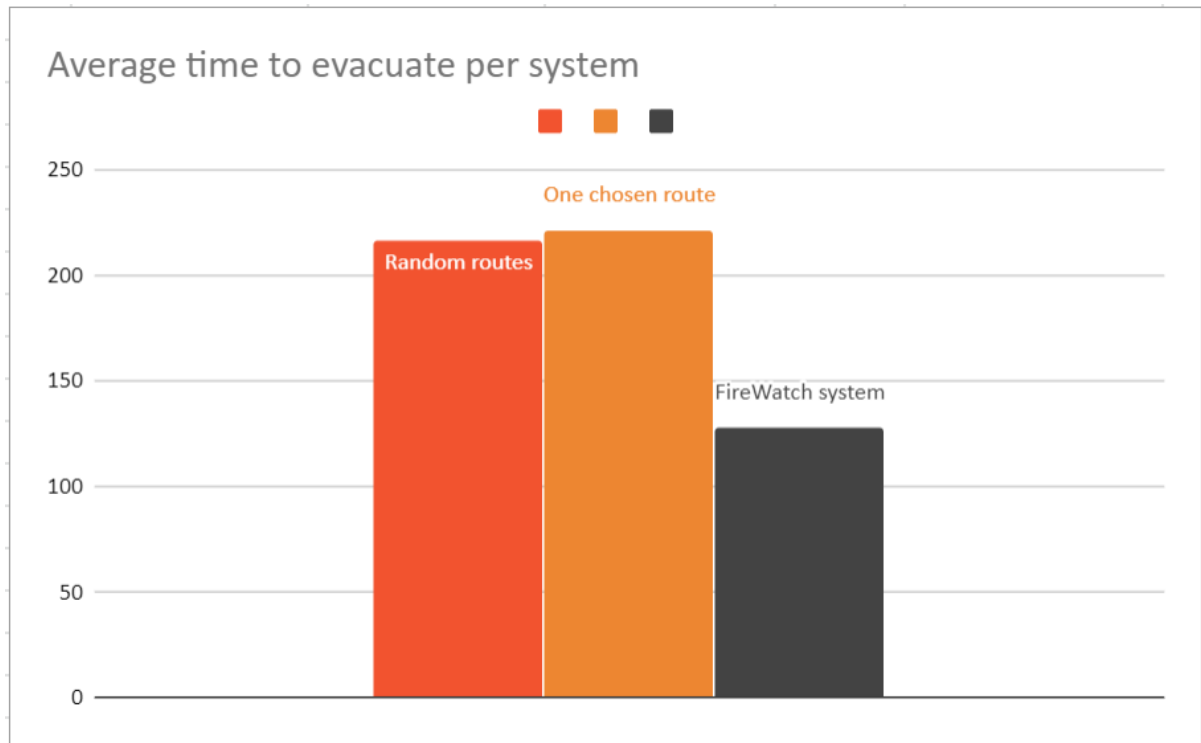
1. *Random routes* = Occupants finding their own route to safety (mostly used in smaller buildings).
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3. *FireWatch system* = Occupants using the routes allocated through use of the FireWatch system.



3.2 Average time to evacuate building

The **y-axis** represents time in **seconds**.

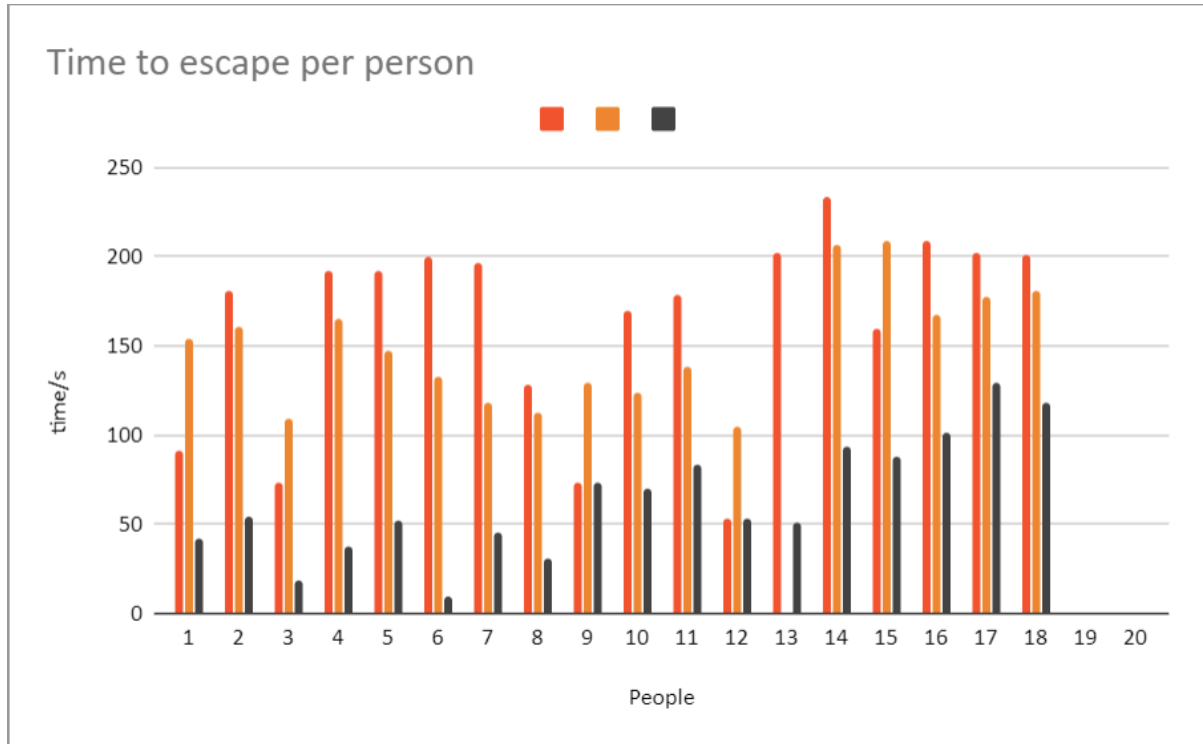
1. *Random routes* = Occupants finding their own route to safety (mostly used in smaller buildings).
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3.3 Time to escape per individual

The **y-axis** represents time in **seconds**. As can be seen there is a correlation between the times for each system, with the longest time to evacuate being related in most cases.

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4 Conclusion

The data gathered from system analysis proves that the application of the FireWatch system to the building evacuation process increases the overall efficiency of the process. This can be seen by the fact that the time taken to evacuate as well as the number of occupants harmed in the fire is minimized. This system can be extended to other types of emergencies, in theory the same optimization of the process should be obtained. Further research needs to be done on larger buildings with more people to extend the proof of system effectiveness. However for the purpose of this project as a proof of concept the collected data is sufficient to prove the validity of the concept of a Real-time fire escape system.

5 Bibliography

Linkedin.com. (2019). Fire smoke inhalation is dangerous and the number one cause of death in house fires!. [online] Available at: <https://www.linkedin.com/pulse/fire-smoke-inhalation-dangerous-number-one-cause-death-camy-thumwood> [Accessed 10 Oct. 2019].