

How Schindler Undertakes Traffic Analyses

4.1 Introduction

A traffic analysis studies the performance of a group of elevators, based on assumptions about the expected traffic situation. The main performance measurements are handling capacity and waiting time. Reliable and comparable performance results are found by means of benchmark simulations which reflect the expected real behavior of a group of elevators under a wide range of traffic situations.

4.2 Measures and Definitions

The elevators' main task is to manage the traffic, i.e., the transportation needs of passengers and goods, in such a way that the highest possible density of arriving passengers and goods can be transported in the building at the highest possible perceived service quality.

4.2.1 Arrival Rate and Handling Capacity (P5, HC5)

For a specific elevator group, the arrival rate describes the density of arriving passengers in an observed time period. In contrast, the handling capacity is the number of passengers transported in an observed time period. As long as the elevator group is able to transport all the arriving passengers without building up waiting queues, the arrival rate and the handling capacity are equal.

Handling capacity is measured by P5 and HC5:

- P5 is the number of persons that is transported on average within 5 minutes.
- HC5 is the percentage of the population on the floors served by the elevator group that is transported on average within 5 minutes:

$$HC5 = P5 / (\text{population on floors served by elevator group}).$$

Example: Consider an elevator group which serves floors with a population of 1000 people. By observation, there are 600 passengers transported within 30 minutes, therefore:

- $P5 = 600 \text{ persons} * (5 \text{ minutes} / 30 \text{ minutes}) = 100 \text{ persons}$,
- $HC5 = 100 \text{ persons} / 1000 \text{ persons} = 10.0 \%$.

4.2.2 Waiting Time (WT) and Destination Time (DT)

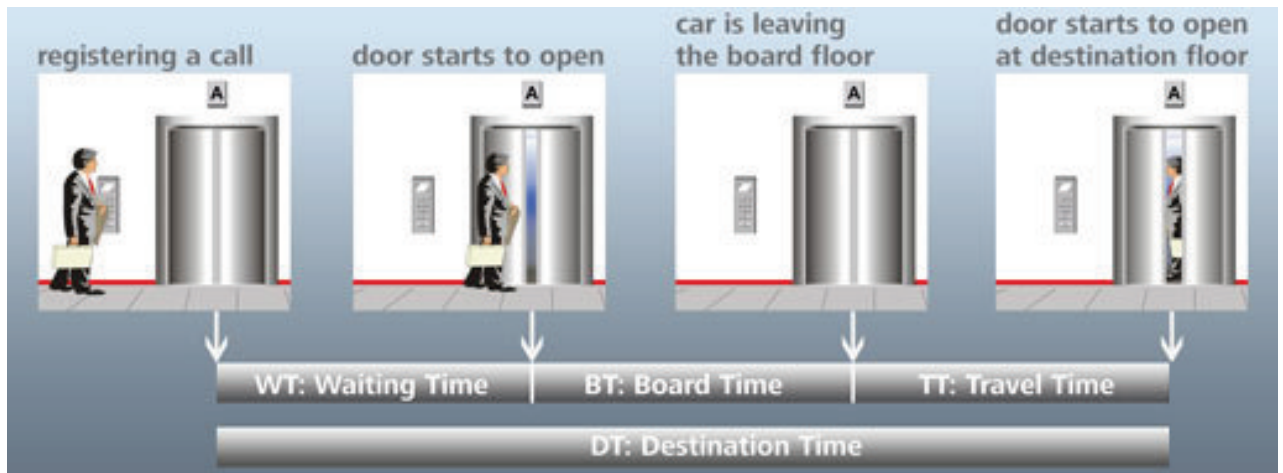
Waiting time and destination time for an individual passenger are defined as follows:

- waiting time: time from when the passenger registers a landing call (or joins a queue) until the door of the serving elevator begins to open on the boarding floor (zero if the door is not closed when the passenger arrives)
- destination time: time from when the passenger registers a landing call (or joins a queue) until the door of the serving elevator begins to open on the destination floor

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Measures and Definitions

Number of Intermediate Stops (IS)



For a number of served passengers in an observed period of time, the average waiting time WT and the average destination time DT are defined in the usual way as mean values of the passengers' individual waiting time and destination time, respectively.

4.2.3 Number of Intermediate Stops (IS)

The number of intermediate stops for an individual passenger is the number of times an elevator stops with the passenger between boarding floor and destination floor. For example, for a passenger with a direct (non-stop) trip from boarding floor to destination floor the number of intermediate stops is zero.

For a number of served passengers in an observed period of time, the average number of intermediate stops IS is defined in the usual way as mean value of the passengers' individual number of intermediate stops.

4.3 Methods of Traffic Analysis

A traffic analysis should cover a variety of important traffic situations, especially when planning new buildings. Reported values should be as reliable and comparable as possible. However, performance values depend on the methods of the traffic analysis and the basic traffic assumptions.

4.3.1 Simulation vs. calculation methods

In *simulation methods*, a real passenger flow is being replaced by a virtual one, which was created with the help of a random generator and loaded into the same control algorithm as used in a real elevator controller. Thus the results can be measured under different traffic conditions and reflect the expected reality to a very large extent.

In contrast, *calculation methods* are based on formulas which only cover a very limited range of traffic situations (usually, only up-peak traffic). The formulas reflect theoretical assumptions rather than a realistic behavior of elevator groups, and results are usually too optimistic. Therefore, calculation results should not

be compared with simulation results.

Schindler Traffic Analysis Reports are based on simulations in order that the reported results are the most reliable and realistic achievable.

4.3.2 Wide Range of Traffic Assumptions

The traffic flow in a building keeps changing all the time; no two days are the same. As a rule, traffic depends on many factors (such as location of building, tenant structure, etc.) and may vary considerably during operation of the building. A traffic analysis should take such factors into consideration and try as far as possible to cover future traffic situations.

In a complex building, a single traffic assumption is not sufficient. E.g., it is not sufficient to apply a traffic pattern measured in some other existing building for the design of a new building. In particular, the limits of the handling capacity of the elevators cannot be found by such "spot light" examinations.

Predictions about the range of handling capacity of an elevator group can only be made by actually simulating a wide range of traffic situations. A benchmark method applies a reference traffic situation from low to very high traffic intensity; by this, the limits of the elevators' handling capacity can be detected. Schindler uses a benchmark method which gives a neutral system assessment.

Schindler Traffic Analysis Reports are based on different traffic situations (see Section 2) tested by benchmark methods. This ensures that the traffic analysis covers a full range of applications and reports reliable and comparable performance predictions.