Who's Behind The Call?

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ABSTRACT

The building occupants are waiting too long for the lifts, and large queues are forming at peak times. What can be done? Results from a traffic analyser study are provided, but provide insufficient information for analysis as the equipment counts "calls" and not "people". A manual lift study provides the necessary data to simulate the morning, lunchtime and evening peaks. The simulation provides confirmation that the current lift service could be improved with modernisation. Further options, including the installation of additional lifts, are assessed taking into account the client's changing needs for the building.

1. INTRODUCTION

This case study is based on a twenty-four storey office building in London. The building users are dissatisfied with the level of service provided by the existing single group of eight lifts. The current levels of service are expected to deteriorate further as the client intends to increase the number of people using the building.

The paper outlines an approach to assessing the existing installation by traffic analysis, survey and computer simulation. With a model of the current situation in place, it is then possible to investigate the benefits of modernisation.

2. TRAFFIC ANALYSIS FOR EQUIVALENT NEW BUILDING

Modern office building design criteria are based on sizing the lifts to cope with the morning incoming up peak. The up peak handling capacity is normally expressed as a percentage of the building population who get into the lifts at the main entrance floor during the busiest 5 minute period. It is assumed that if the lifts can cope with the up peak, they will operate satisfactorily for the rest of the day.

We know from experience that, more often than not, people have to wait longer for lifts at lunchtime. However, up peak design criteria are a valuable starting point for assessing a lift installation.

BS 5655 Part 6 (British Standards Institute, 1990) recommends designing to a five minute up peak handling capacity of:

- 12% for speculative buildings, or building where there will be staggered starting times
- 17% for buildings with unified starting times

The *Specification for urban offices* (British Council for Offices, 1997) recommends:

- 15% for office buildings

The other key criteria is Interval, which is the average time between lifts departing from the main terminal floor. *BS 5655 Part 6* suggests an interval of 30 seconds or less is excellent. The *Specification for urban offices* recommends a maximum Interval of 30 seconds.

Interval is not the same as Passenger Waiting Time. The relationship is complex, but as a guide it is reasonable to assume that an Interval of 30 seconds corresponds to an average Passenger Waiting Time of about 18 seconds (Strakosch G R, 1983).

Assuming 1 person per 10 m² population density, a handing capacity of 15%, and a maximum Interval of 30 s, traffic analysis software implementing round trip time calculations (Peters Research, 1999) demonstrates that this building requires a minimum of eleven lifts in two zones. Advice from the client suggests that the population density may increase above 1 person per 10 m². With this increase, the calculations suggest a total of twelve lifts in two zones are required.

Given that only 8 lifts in a single zone are installed, it is unsurprising that there is a problem with the existing installation.

3. TRAFFIC ANALYSER STUDY

Results from traffic analyser studies for the existing buildings were provided by the client. The traffic analyser had been used to count the number of up and down landing calls registered by the passengers, and to measure the time taken to answer each call.

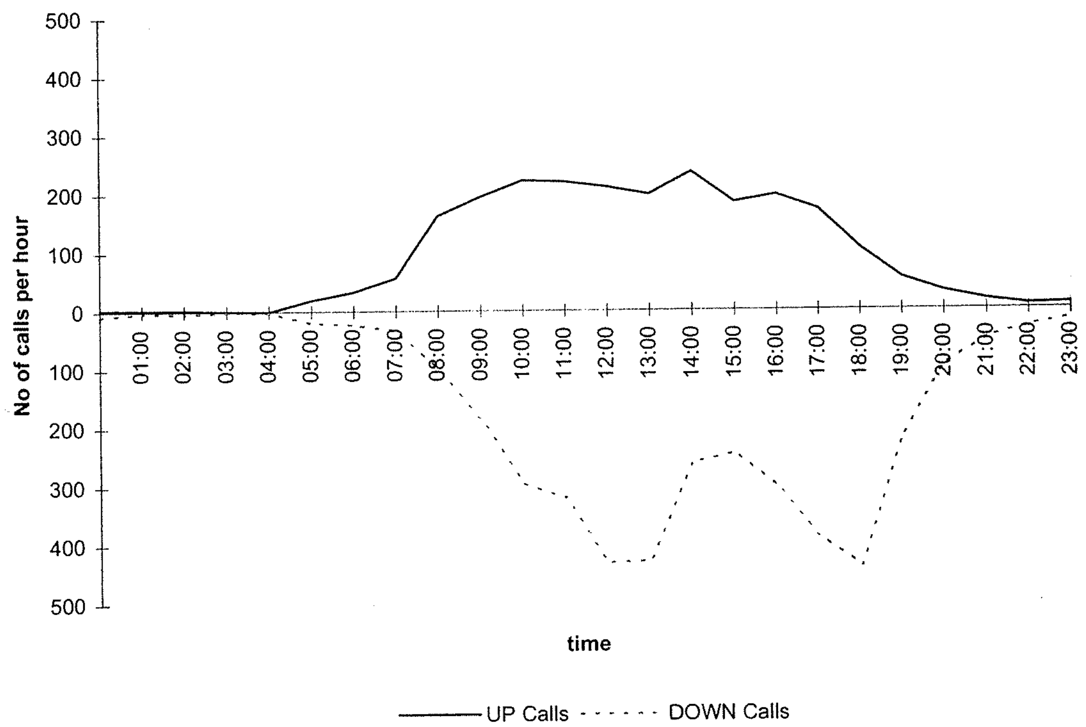

Figure 1. Up and Down calls (averaged over 1 working week Monday to Friday)

The results were processed to produce the graph in Figure 1. The upper section of the graph shows the Up calls placed on the system starting and ending at midnight. The lower part shows the Down calls.

Clearly the lifts are busy throughout the working day, with major down peaks at lunchtime and in the evening.

The graph does not highlight the up peak at the beginning of the working day. This is because the analyser is counting up and down calls rather be than the number of people using the lifts. In the morning there could be long queues in the lobby, but the up landing button would only be pressed once for each car load. At other times of the day, and on other floors, a landing button could be pressed for just one passenger.

For this reason, it would have been unreliable to use these results to assess the demand on the existing system, and possible improvements. Consequently we carried out our own survey, counting people as opposed to calls.

4. LIFT TRAFFIC SURVEY

We carried out a manual lift traffic survey on a Monday. At the peak periods we counted people getting in and out of the lifts at the main entrance floor, and at the restaurant floor at lunchtime. We also sampled traffic between other floors (inter-floor traffic) by surveying from within the lift cars.

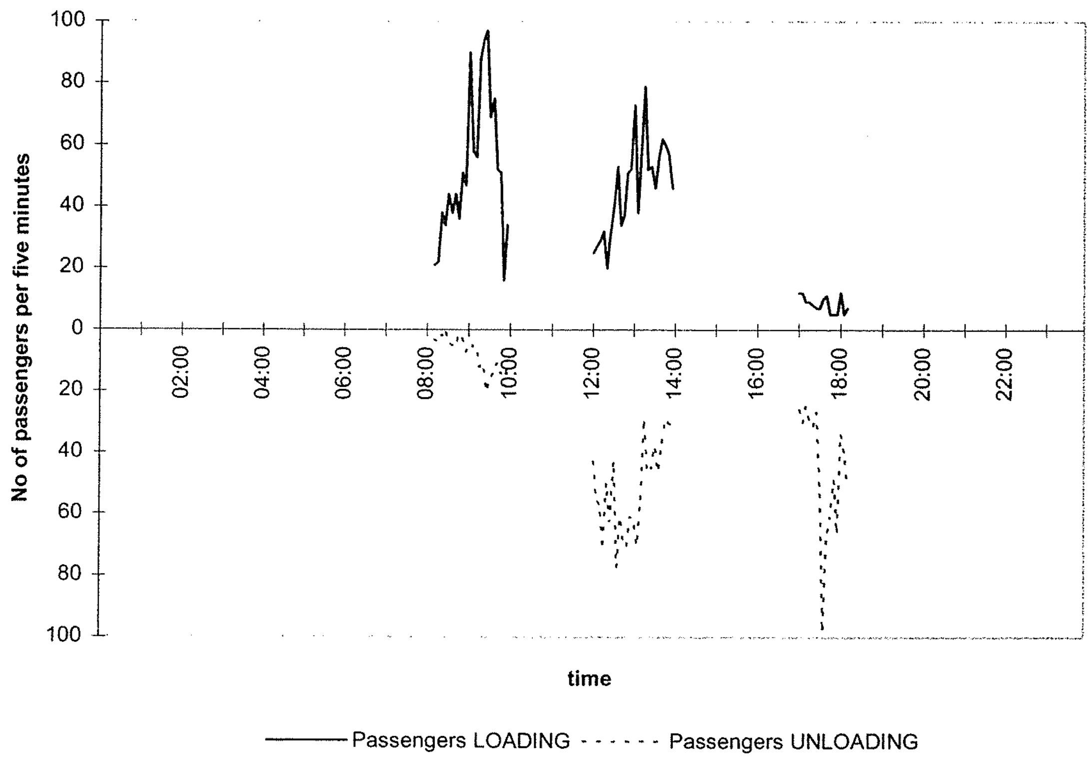

Figure 2. Traffic to and from main terminal floors measured morning, lunch and evening

Figure 2 shows the traffic to and from the main terminal floor(s) during the morning, lunch and evening peaks (intermediate off-peak times were not measured). The top half of the graph shows the number of people getting into the lifts, travelling up the building. The bottom half shows people unloading, having travelled down the building.

The survey results demonstrated predominately up traffic in the morning, a combination of heavy up and down traffic at lunchtime, and predominately down traffic in the evening. This is as we would expect in an office building.

According to reception staff, the survey day was not particularly busy. Occasionally there had been days when the queue had filled the reception area, and extended outside the main entrance. This needed to be taken into account when assessing possible levels of peak traffic.

5. SIMULATION OF EXISTING INSTALLATION

Based on our survey data, we used computer simulation software (Peters Research, 1999) to analyse the busiest fifteen minutes in the morning, lunch and evening periods. We have allowed for traffic to and from the main terminals, and for inter-floor traffic.

The resulting average passenger waiting and average transit time (time in lift car) results were as follows:

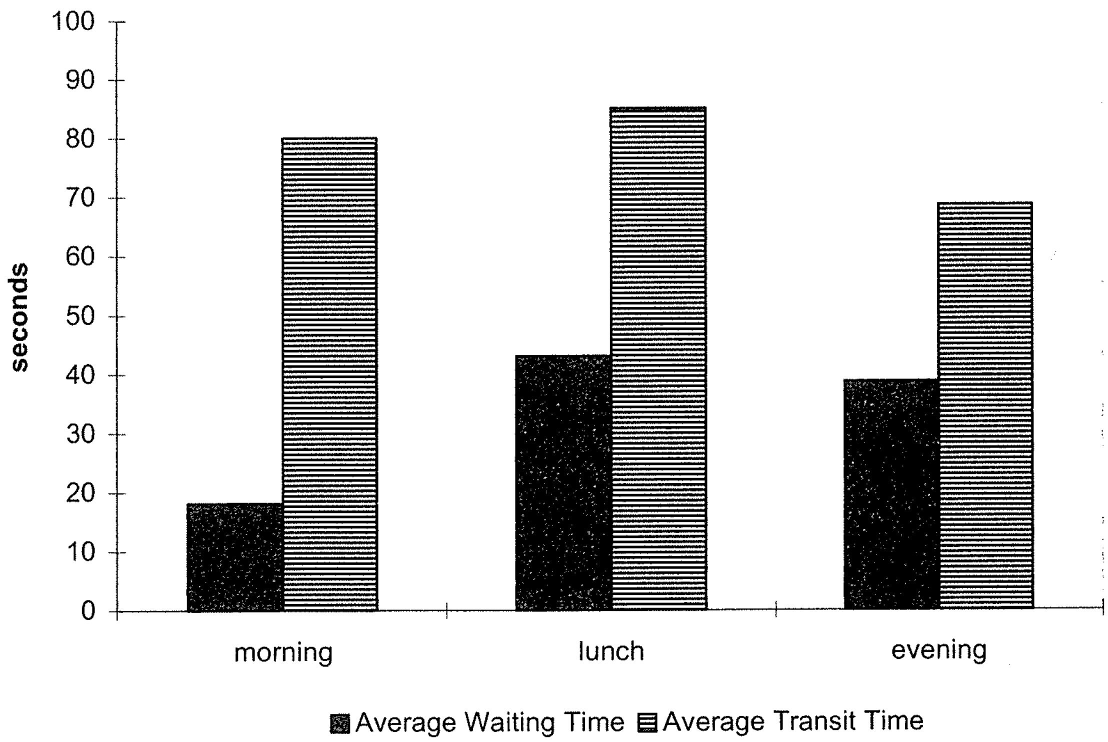

Figure 3. Waiting and transit times based for surveyed passenger traffic

The simulation demonstrates long passenger waiting at lunchtime and in the evening. The transit times are also high as a result of full lifts having to make a lot of stops.

To establish the impact of increasing the number of people in the building, we also ran simulations increasing the traffic by 10%, 20% and 30%. Results for Average Waiting Time are given in Figure 4.

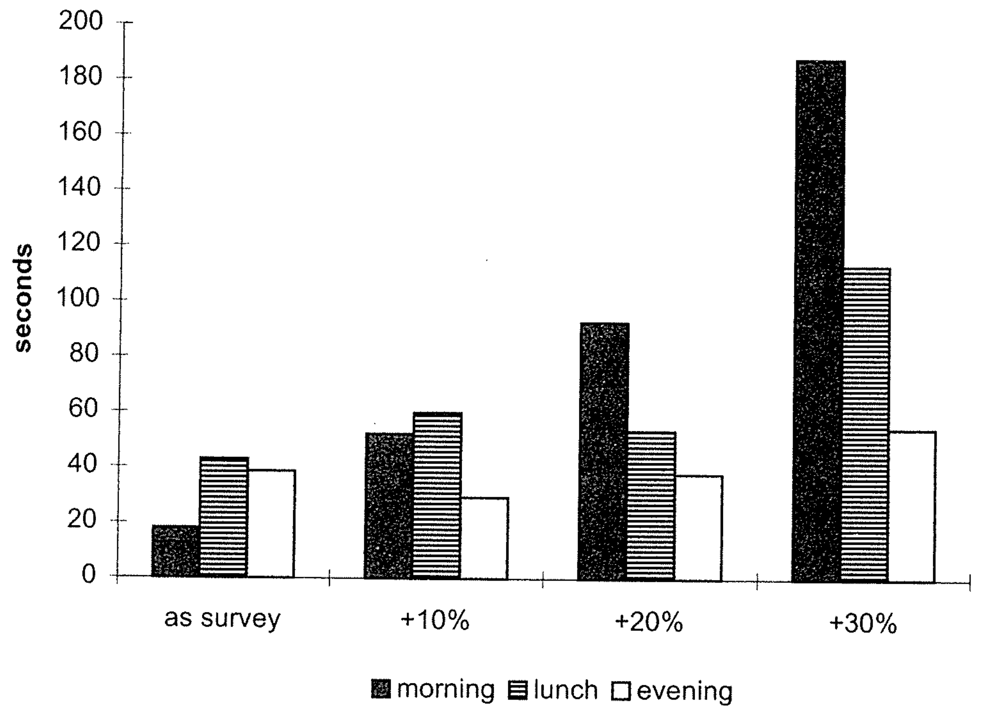

Figure 4. Average Waiting Time results for increasing traffic

With +30% additional traffic, the queue at the main lobby rose to over 170 people during the morning up peak. Given the queuing previously discussed, it is reasonable to assume that the passenger traffic has risen close to this level in the past.

6. BENEFITS OF MODERNISATION

To test the benefits of modernisation we have ran simulations with:

- Faster lifts within the limitations of the shaft structure
- Faster doors with pre-opening
- Enhancements to the basic up peak algorithm

Results for Average Waiting Time are given in Figure 5.

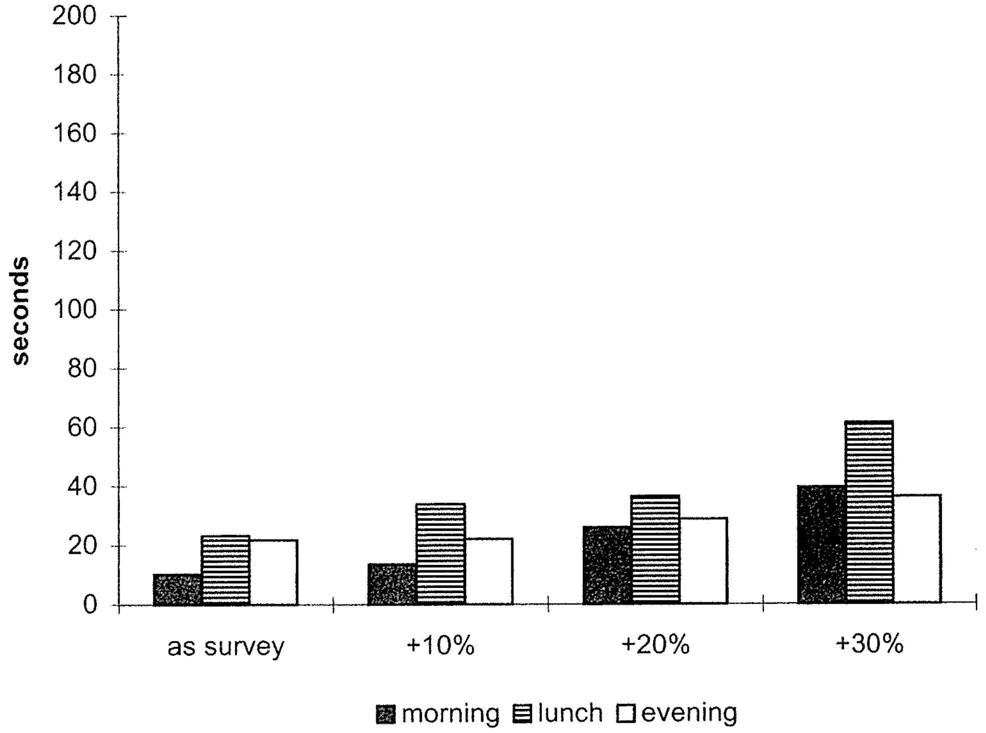

Figure 5. Average Waiting Time results for increasing traffic after modernisation

The results show that modernisation of the lifts will significantly improve performance. User dissatisfaction with the service will be less, but waiting times will still be high at peak times on busy days.

7. BENEFITS OF ADDING ADDITIONAL LIFTS DURING OR AFTER MODERNISATION

By modern standards, the building is under-lifted. The ultimate solution to this is to increase the number of lifts. To demonstrate the benefit of additional lifts, we have run a simulation adding two lifts to the modernised installation. The results are given in Figure 6.

These results demonstrate a significant improvement in performance, and that the installation now copes with busy days at peak times without excessive waiting times, although this only allows for an increase in population of 30% over the levels currently experienced.

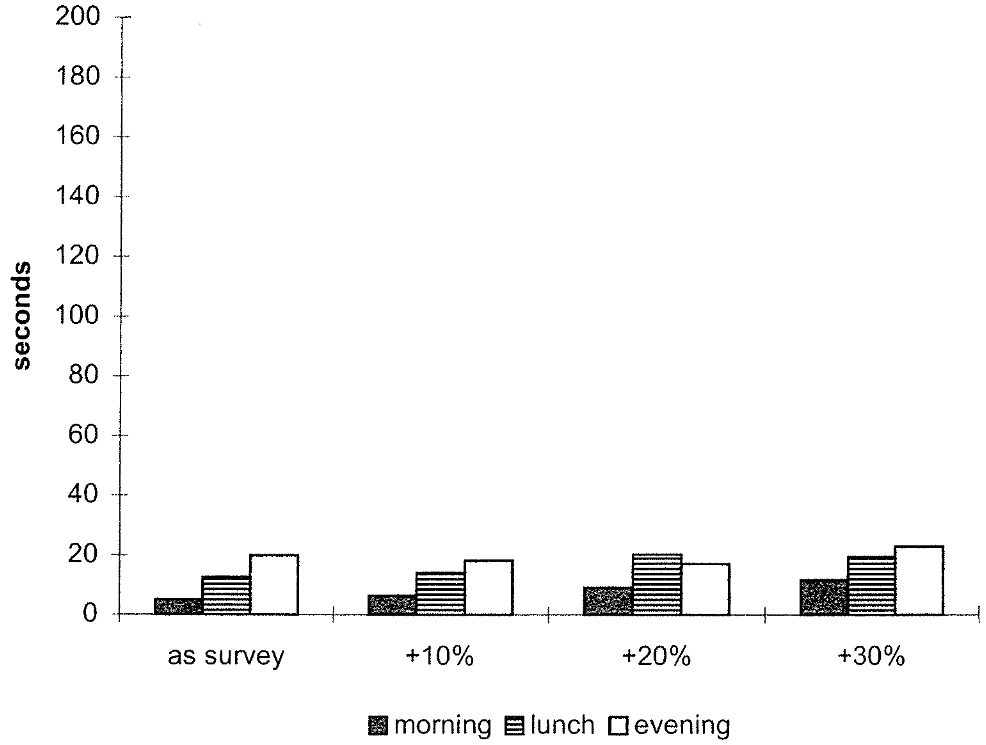

Figure 6. Average Waiting Time results for increasing traffic after addition of two lifts

8. CONCLUSIONS

The building under review is under-lifted. Given the information now available, a "modern" design would have a minimum of eleven lifts, or twelve lifts to allow for the anticipated population increase.

The existing eight lifts are overloaded. This results in passengers having long waiting times at peak periods. On busy days there are excessively long queues.

Allowing for the population increase and fluctuations in demand, our best estimate is that the system will now need to cope with at least 30% more traffic than measured on the day of our survey. (Further traffic studies have been recommended to improve our estimate of day to day fluctuations in demand.) Simulation demonstrates that with these levels of traffic, the existing system will regularly overload completely.

A major modernisation of the installation would improve performance significantly. A dynamic zoning system or call allocation system is likely to make best use of the available capacity. However the lifts could still overload, and would not meet current design standards.

To raise the performance to an acceptable level, we have recommended the modernisation of the existing lifts together with the installation of additional lifts. Options include:

- Increasing the number of passenger lifts from eight to ten. This would cope with the traffic experienced on the day of our survey, plus 30%.
- Increasing the number of lifts from eight to twelve. This would raise the standard of lift service to the level expected of a modern office building.