CALL-BACKS

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ABSTRACT
The terms reliability, availability, and number of call-backs will be defined in this article; alongside the word definitions, the desired quantitative and qualitative definitions will also be given.

A review will be given here of the steps taken to try to define more clearly the criteria by which the maximum number of call-backs allowed per elevator for a year can be determined, and the exceptional cases that are not included in the general accounts are detailed here. I will also review in short the various types of service available and their effect on the reliability, availability, and quality of the elevators.

1 IN PLACE OF OPENING REMARKS

It is customary in the opening remarks to summarize the content of the article being presented.

Since some of the points that will be made here cannot be defined as pure science, I will permit myself to depart from the usual custom, and will relate to you an anecdote concerning this article.

In 1986, I approached several of my colleagues in various parts of the world, and requested them to send me any information they had that can enrich my knowledge on the subject of call-backs.
When I began receiving replies, I was surprised to discover that a large number of my colleagues were not at all familiar with the term 'call-back'.

For them, and for those who are now encountering the term, "call-back" for the first time, its definition in NEIEP - Elevator Terms (1980) is : "CALL-BACK : In contract service, a customer request which requires a check of an elevator other than the regularly scheduled examination".

2 QUALITY AND RELIABILITY

The elevator industry, undoubtedly, progresses alongside the electronics and computer industries, and elevators whose control is based on microprocessors are no longer a dream but rather a reality all over the world.

As the control becomes smart and more sophisticated, the expectations of the user from this system grows as well, and he wishes to receive a product of high quality and greater reliability than before the advent of microprocessors.

It is obvious that quality is the keyword for a product that claims to be the latest development, and without doubt, an inseparable part of quality is reliability and availability.

In elevators, as in every other product, there are various criteria that classify their quality, and accordingly, there are various levels of reliability for the single parts and for the entire system.

One of the main causes of many confrontations between the user and the service company, is the fact that usually solid facts of any kind that can show how good or how bad the reliability of the system is, do not exist.

The wish to change and improve the situation has been felt in recent years. This comes as a result of the development of sophisticated systems built around microprocessors that enable us to monitor the behavior of elevators, and to provide for both the user and the service company, the most comprehensive data on availability, quality, and reliability of the elevators.

This type of system, the data logger, was presented by the author at the Congress in Budapest, Hungary, (Lustig, 1985).

Beebe (1986) presented another type of system that enables us to monitor several elevators in different locations simultaneously.

Alongside the development of such systems by individuals, we know that elevator manufacturers provide their most advanced models, and even those models that are not built on microprocessors, are provided with monitoring and control systems as an integral part of the elevator installation.

In order to overcome the problem of confrontations as mentioned above, it is necessary, first of all, to define the required level of reliability of the system, and to define the different methods of achieving this level.

From the operational point of view, reliability is effected by two factors:

(i) Scheduling of preventive maintenance and reduction as far as possible of elevator's downtime with response time to a call-back having great importance as well.

(ii) Minimum System Response Time (**MSRT**) (the time is measured from the moment the user presses the button on any floor, and until the moment the door opens and the elevator is ready to serve him).

The MSRT is one of the most important parameters for classifying elevator systems (just as there are other characteristics, such as **RTT**, **HC**, **INT**, etc.). If while the system is operating and functioning normally, and the **MSRT** data will be as good as can be, if happens that at the same time the number of elevator downtimes is great, and the response time of the service company is long, the picture that emerges in the eye of the user will be very negative.

This is the reason that downtimes and response times seem just as important to this writer, as do the system response time (**SRT**).

Unfortunately, data on reliability which is very common for other technological systems that serve us daily, does not exist for elevator systems.

This data is **MTBF** (Mean Time Between Failures), **SR** (Serviceability Ratios) and **MTTR** (Mean Time To Repair) and was defined by Godwin in 1986 as follows:

$$MTBF = \frac{MP}{NF} \qquad \ldots (1)$$

$$SR = \frac{MP-MT-CUT-PMT-DT}{MP-MT-CUT} \times 100 \qquad \ldots (2)$$

$$MTTR = \frac{DT}{NF} \qquad \ldots (3)$$

where **MP** is monitoring period, **NF** is number of failures, **MT** is any modification time, **CUT** is customer usage time, **PMT** is preventive maintenance time and **DT** is downtime.

MTBF and **MTTR** are defined in hours while **SR** is in percentages.

Since in most cases, this kind of information cannot be determined, the decision whether a certain level of reliability has actually been achieved, is usually a decision based on instincts and feelings, and not so much on facts.

With the intent of improving the quality of elevators (to reduce the amount of downtime and improve availability), an unprecedented step was taken in 1981 which I believe is unique to Israel. This step was to give a seal of approval from the Standards Institution Of Israel to the elevator as a whole unit and not to the specific single parts of the system.

The purpose of this being the testing of its conformity to the detailed requirements in the Israeli standard for elevators and to the procedure of guaranteeing quality, that is prepared by the Institute. These conditions include general, mechanical, and electrical requirements.

It is important to note that among the general requirements there is a clause stating that "there should be follow-up on company service cards to strive to reach the point where there should not be more than one (1) call-back for 2 months. This monitoring follow-up will begin after the break-in period".

3 NUMBER OF CALL-BACKS FOR AN ELEVATOR PER YEAR

As mentioned already, data for reliability and availability of elevator systems are not present at this stage. This is true also for the number of call-backs per elevator per year.

When, for one of the conditions of a service contract between the user and the service company, we wish to define the reliability and the availability of the system, we have to define also at the same time the subject of call-backs allowed per elevator per year.

The definition of the number of call-backs allowed per elevator per year and the availability of the elevator are accepted by elevator consultants all over the world, and this is an integral part of the general conditions detailed by them in each and every job.

In these cases, usually, the maximum number of call-backs allowed for an elevator in one year are defined, and it is specifically noted that the cases that stem from and are related to vandalism are not included in the general account (Godwin).

Recently, an attempt was made to define in more detail, the cases that should not be included in the general account of call-backs permitted per year. These are as follows:

(i) **Incorrect use by one of the users.** - Every failure which is caused by incorrect use by the user (pushing the stop button, etc.)
(ii) **A failure caused by dirt.** - Dirt on the photoelectric cells, or an accumulation of dirt in the door grooves.
(iii) **A failure caused by irregular power supply.**
(iv) **A failure caused by deterioration.** - Failures caused by normal deterioration such as burnt-out light bulbs are not considered.
(v) **A failure caused by deliberate vandalism.**
(vi) **Repairs done during night shift.** - Since these are not always done by the permanent elevator technician nor by a skilled technician, these failures are not included in the general account.

Alongside the definitions of those cases where call-backs will not be considered in the general account, additional conditions defined are detailed here:

(i) Between the user and the service company, an all-in service contract should be signed or a clear commitment should be given by the user to exchange and/or repair parts when necessary.

(ii) The time when the number of call-backs will be counted will begin only 6 months after hand ing over the elevator to the user, and this, in order to enable the contractor to overcome any initial "childhood diseases" of the system.

Up until the writing of this article, an insufficient amount of data has accumulated on the success or failure of this attempt. The hope is that the definition of this subject in a contractual way beyond any detailed definition of the related conditions as explained above, will have the result of improving reliability and availability of the systems.

Figure 1 details data gathered by the author for the average number of call-backs in various places around the world. The data is based on information received from elevator manufacturers, consulting engineers, and government workers in various countries.

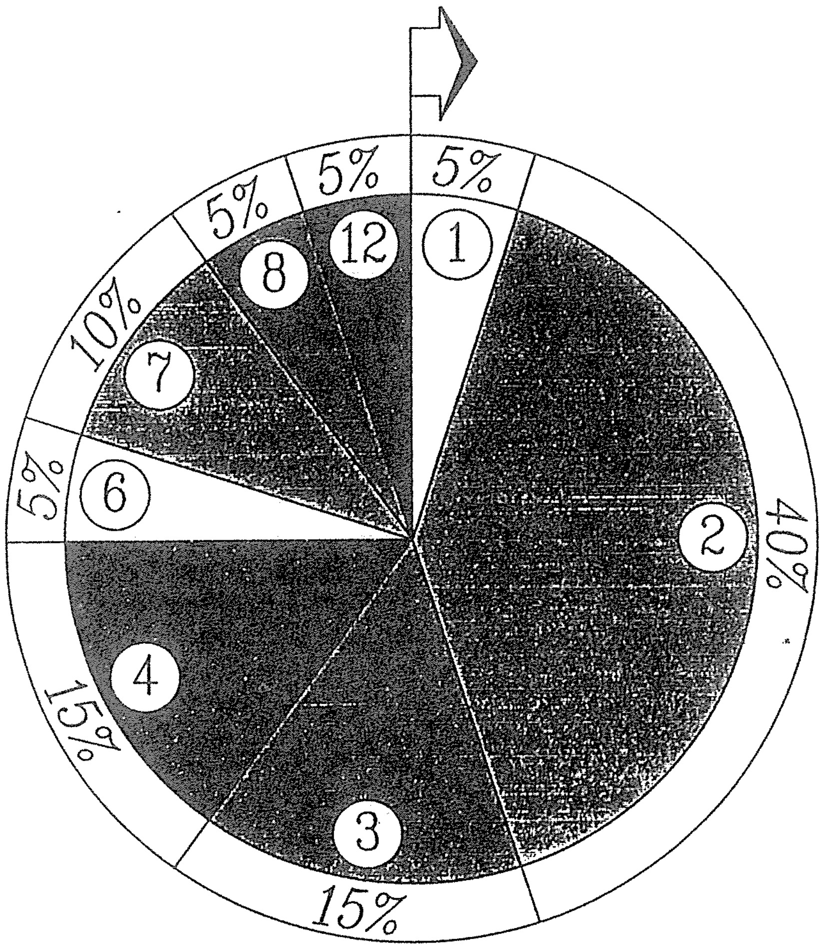

FIGURE 1: Average number of call-backs

The numbers marked 1, 2, 3, 4, 6, 7, 8, and 12 in the graph indicate the average number of call-backs per year for an elevator.

From the data detailed in the above graph, we see that in 40 % of the cases, the average number of call-backs per elevator for the year was 2.

For 80 % of the cases, the average number of call-backs was between 1 and 6.

For only 20 % of the cases, the number of call-backs was higher, between 7 and 12.

3.1 The Various Causes of Call-Backs

In principle, it is possible to classify call-backs into various main groups with sub-groups.

Below is data gathered throughout 1987, relating to a group of 1601 elevators. In total, that year there were 5735 call-backs which can be divided as shown in Table 1.

No.	Description	No. of C-B's	Percentage of total	Accumulated percentage
1	Doors	2065	36	36
2	Problem with Electric system	1692	29	65
3	Problem with Mechanical system	742	13	78
4	Cause of failure not determined	633	11	89
5	Push buttons	275	5	94
6	Problem with Safety devices	163	3	97
7	Miscellaneous	165	3	100
8	T O T A L	5735		

TABLE 1: Total number of call-backs

We see that the most common are problems related to the doors (36 %). 3 % of the cases were defined as miscellaneous, and here are included all the cases of call-backs caused by incorrect use, deliberate vandalism, removal of keys, etc.

The average number of call-backs per elevator per year according to the data detailed above is about 4 (3.59).

4 AVAILABILITY

Availability indicates the probability that the system or the component provides full functionality.

The availability of an elevator at any given time is expressed as the percentage of the total operational time during which the elevator was available.

It seems that the keyword by which the user can decide whether the system at his disposal is functioning well and satisfactorily is availability.

Let us take as an example, a very extreme case where a specific 2-elevator system had only 2 call-backs within one year. But the time that elapsed from the moment of the occurrence of the first breakdown and its repair and return to operation was 3 weeks, and for the repair of the second breakdown 5 hours were required, therefore it can be said that although the number of call-backs is very low (2), the availability of the system is very bad.

We can translate this into numbers by using concepts defined above, such as SR, MTBF, and MTTR. We have here a group of 2 elevators operating 24 hours a day, 7 days a week.

The number of hours that the system was down (3x7x24)+5 = 509 hours.

If we define the PMT (Preventive Maintenance Time) for the 2 elevators per year as 100 hours, i.e. 50 hours per elevator, we see that:

$$SR\ \% = \frac{(8760-50-254.5)}{8760} \times 100 = 96.52\ \%$$

$$MTBF = \frac{8760}{2} = 4380 \text{ hours}$$

The amount of time that the system was down as defined here is 509 hours.

$$\frac{509}{17520} = 2.90\ \% \text{ downtime}$$

$$MTTR = \frac{509}{2} = 254.5 \text{ hours}$$

From here we see that the average time required to handle a failure in the system brought in this example, was 254.5 hours. Clearly, this is too lengthy and is unacceptable.

If we relate to the 1 - 2 % of total operational time of the elevators as the maximum downtime permitted for a system having good availability, then obviously a downtime of almost 3 % characterizes a system whose availability is not good, and the expectations of its user have not been realized.

For the sake of comparison, let us take another example where the number of call-backs of the same 2 elevators for a year were 26.

The total amount of downtime for the year was 92 hours.

$$SR\ \% = \frac{8760-50-46}{8760} \times 100 = 98.9\ \%$$

$$MTBF = \frac{8760}{26} = 337 \text{ hours}$$

$$\frac{92}{17520} = 0.53\ \% \text{ downtime}$$

$$MTTR = \frac{92}{26} = 3.54 \text{ hours}$$

From this example, we see that the average time required to repair a failure in the system was 3.5 hours. We see as well that the maximum downtime was only 0.53 %. Since previously we defined that 1 - 2 % can be considered good, then downtime of 0.53 % meets these requirements. On the other hand, the system had 26 call-backs throughout the year, which is clearly unacceptable.

The two examples brought here prove that the two requirements (availability and number of call-backs) should both be considered as criteria for determining whether an elevator system is functioning well or not.

5 THE SERVICE

Several types of Elevator Service Contracts exist, the most common and accepted ones are :

(i) A service contract where the service company must give preventive maintenance, and in the event of breakdowns must repair them. In such a case, the user pays for work-hours and for parts. (For part of the work-hours and for the transit time to the building, the user does not pay any fee in addition to the agreed upon fee).

(ii) A comprehensive service contract (also called All-In Service) where for a certain agreed upon sum, the service company provides what is detailed in (i), and in addition all expenses related to the exchange or repair of parts falls on him and not on the user.

The desire to reduce the number of breakdowns and the time required to locate and repair each failure and the shortening of response time for every call should be the guidelines of the service company. To achieve this, he should take the following steps:

(i) Installation of only the best quality equipment.
(ii) Highest quality of installation.
(iii) Performance of quality control at the end of each stage of installation, at the end of the installation, before handing over the system to the user, and during regularly scheduled service visits.
(iv) Employment of superior skilled workers.
(v) In case of a failure, immediate repair of every part found faulty.
(vi) Exchanging every part requiring changing.
(vii) Exchanging entire components if necessary for smooth operation of the system.
(viii) Use of exchangeable equipment and/or temporary repair if necessary.

Preventive maintenance and quality control are executed as is known at certain set intervals scheduled ahead of time. The quality control performed parallel to preventive maintenance can and should diagnose failures before they occur and also allow for decision - making on the actions that should be taken in the future concerning preventive maintenance. It is true that these actions can somewhat shorten the time that the system is operative (during checking, the elevator cannot be used), but their contribution to reduction of time required to locate and repair failures is far greater.

Here I would like to state that in Israel there are now, in the final stages of preparation, standard contracts for elevator service for residents in apartments buildings as well as for institutions.

6 CONCLUSION

The keywords to characterize satisfaction of a user from his elevator system are availability and reliability, followed by the better known factors such as HC, RTT, INT, etc.

The increasing application in the elevator industry of the latest developments in the electronic and computer fields, and their passage to controlled computer systems have contributed greatly to the improvement of availability, reliability, and operation of elevator systems.

However, we should not forget by any means that beyond all the advanced technology, no matter how successful, the individual still exists, and it depends on him whether a system is available or not, and this person is the one who , by insisting on superior quality products, correct installation, and performance of preventive maintenance, can reduce to a minimum the number of failures and time intervals that the elevators are out of service.

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9 BIOGRAPHICAL NOTES

Ami Lustig, Consulting Engineer, was born in Israel. Graduate of Tel-Aviv University. In 1972 he joined Eng. S. Lustig elevator and electrical consulting firm. In addition to his work as a consulting engineer, he is responsible for the development of various computer programs, among them the LSP. He was also group leader for the team that designed the LDL 2000 data logger.