Maintenance and Safety Practices of Escalator in Commercial Buildings

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Abstract. The escalator is very crucial to transport a person from one place to another. Nevertheless, there are many cases recorded the accidents in relation to escalator. These may occur due to lack of maintenance which leads to systems breakdown, poor safety practices, wear and tear, users’ negligence and others. Thus, proper maintenance systems need to be improvised to prevent and reduce escalator accident in future. This research was aimed to determine the escalator maintenance activities and safety practices in a commercial building. Three case studies were selected within Selangor area. Semi-structured interviews were conducted for collecting data from these three case studies. To achieve the aim of this research, the study was carried out on the maintenance activities, safety practices and cost related to escalator maintenance. As one of the important means of access in building, it is very crucial to increase effectiveness of escalator particularly in commercial building. It is expected that readers will get clear information on the maintenance activities and safety practices of escalator in commercial building.

1. Introduction

The Buildings are constructed to provide shelter for human beings to carry out daily activities and for having their own space for privacy. The main criteria of a good shelter, it must be sufficient to provide comforts besides other facilities must be able to function well [4]. For example, services such as plumbing system, air-conditioning system, ventilation system, elevators and escalators must be provided especially for commercial buildings. Escalators or moving stairs are one of vertical transportation under the mechanical equipment, which is commonly used to transport people from one place to another, not only in commercial but also in residential buildings. In shopping complexes, it plays a vital role in transporting passengers to above and below floor levels. However, the system must be able to perform well to avoid problems particularly during peak hours. The installation in a building needs to consider certain major aspects such as the design and location. This is important to ensure the system equipped is comfortable to the users, safe and problem such as sick building syndrome can be avoided. Thus, the maintenance aspects must be done regularly and diligently to make sure the escalator can serve well and fit for its purpose.
Maintenance management is another aspect that is crucial to be taken care by the building owner. He or she must think on how the costs for unnecessary maintenance can be avoided and wrong maintenance practices can be avoided. The lifespan of escalator system can usually sustain without the need for major maintenance or replacement of new equipment if the maintenance management is carried out sufficiently. Besides, pre-requisite requirement must be complied according to what has been stated in the standard operating procedure. Since there are many escalator accidents have been recorded, both maintenance and its safety practices are the significant elements that should not be ignored by all parties involved.

2. Maintenance Activities And Safety Practices Of Escalator

Maintenance activities can be described as keeping structural components or fixtures in a proper schedule, programme or routine [7]. Maintenance is generally carried out based on recurring basis and it is normally done to ensure the equipment can achieve its fully functional state [3]. Maintenance can also be defined as a process to uphold the system in a good condition. Some of the affects due to proper maintenance management can be such as improving safety issues, energy efficiency, cost optimisation, and improve integrity, conducive environment and many more [6]. Maintenance of escalator is important to assure it is safe when it is operated. By having regular maintenance, it can increase the lifespan of an escalator.

Nowadays, maintenance plays a central role in bearing all aspects of physical, financial and sociological needs in an organisation. There are a few types of maintenance works such as Run to Failure Maintenance (RTF), Preventive Maintenance (PM), Corrective Maintenance (CM), Improvement Maintenance (IM), and Predictive Maintenance (PDM). Maintenance activities could either be repair or replacement activities, which are necessary for the system to reach its highest degree of productivity. The activity should be reasonable to be carried out at the optimal cost. The aspects of maintaining escalator include but not limited to the followings; all safety signages and escalator's directions are clearly displayed, the edges of each step must be marked with yellow lines, safety devices are equipped to prevent passenger’s feet from getting trap on or at the sides of step, switch for emergency breaks is well functioning and can stop when it is pressed and others.

There are a few safety practices that need to be precaution when using the escalator. These can be such as the safety features, traffic of escalator, location of escalator, and other physical considerations such as the surrounding nearby. Type of accident that is commonly happen when using the escalator is falling people or object. Therefore, safety features for escalator must be properly considered. The safety performance during normal operation depends on the number of safety features associated with the escalator. Safety features can be such as the speed on handrails and steps should be able to move concurrently to ensure the users are balance, width of the steps must be designed to prevent slipping, comb plates are placed at each of landing to avoid tripping when the escalator is moving and the balustrades are designed to prevent user’s cloth from getting stuck. Besides, the automatic service break is also installed so that the escalator will stop smoothly in situation if the drive chain or step chain is broken or if an object stuck into the handrail’s inlet. The emergency button must be functioning well in situation if a power failure happens [5].

Hence, safety is very important to be considered in the vertical transportation industry [1]. Even though escalator is very useful for transmitting users in the vertical way, lack of safety will cause dangerous to the users. Some people are reluctant to use vertical transportation due to those safety issues as been highlighted before. Without safety systems and reliable devices, building cannot be served at its supposed to be. Besides, the building owner might face some difficulties to obtain approval from the local authorities. Though the escalator can cause injurious to passenger in the state of dangerous, somehow it still has many advantages, which outweigh its flaws. Any system that deals with people must consider safety as priority.

The design criteria for an escalator include the traffic pattern when directing people to use the escalator [2]. Other than that, the maximum number of passengers per riding should be counted as well, for instance, a single width escalator travelling at about 450mm (1.5 feet) per second should be able to
move an approximate 170 persons for every five minutes ride. Certain escalators can travel up to 600mm (2 feet) per second, which can cater 450 passengers at a time. Hence, the capacity to carry the load has a direct relationship with the expected peak traffic demand. This is crucial at times where number of passenger increases during the prime hours. Escalator system must be safe and any breakdown or failure should be avoided.

Another crucial factor in determining the safety for escalator is the location to place the system. The most convenient place shall be located to areas where public users can see and move easily from one place to another. In shopping complex, it should be situated at the area where merchandise can display and attracted passengers to visit the stores [2]. The entrance and end step of escalator should not be placed at confined spaces because some safety issues may arise if it is located remote from the crowd. As a horizontal and vertical transporting system, it must be functioned at open spaces to maintain the line of traffic. This is different compared to lift system whereby it is normally situated at closed areas.

Safety on the floor openings can be done by installing the fire-resistant shutter as the exit door and installing fire sprinklers at the above area. Besides, hall that is constructed with fire-resistant walls must be provided. To avoid danger due to overheating at the floor opening, there must be an adequate ventilation system which allocating gears and motors. In compliance with the building by law, staircase must be adjacent to the escalator so that if any incident happens, the escalator can be functioned as the mean of escape to move passengers to the safer place. Another element that must be considered would be to allocate escalator for disable people i.e. for those who are using wheelchairs.

3. Research Methodology
The research process begins with the identification of research topic and follows the research methodology process to identify the aim of research. There are three objectives in this research which derived from the aim, to highlight the maintenance activities and safety practices for the escalator in a commercial building, to determine maintenance activities and safety practices for the escalator in Malaysia commercial building and to analyse the cost related to maintenance activities and safety practices for the escalator.

The data collected were based on the three objectives and they were gathered from primary and secondary sources. For the first objective, data collected from secondary sources like journals, proceeding papers and reliable articles. Secondary sources were information obtained from researchers who carried out similar areas but different aspects from this research. These sources aid to gain the clearer understanding of the topics covered. Data for the second and third objective were based on primary sources which were semi-structured interview and site visits.

Primary sources can be considered as the main data collection where it was composed from the interview session with the selected respondent and data which were gathered by attending site visits. The interview was based on semi-structured, which uses an interview schedule and flexibility in terms of the interviewee’s responses. Site visits can be considered as very helpful to understand the escalator components and the functions that are equipped in the selected shopping complexes. All data obtained from the primary and secondary sources were compiled and analysed using Microsoft Office Excel Worksheet 2013 and presented in tabular format.

Semi structured interview were done based on three case studies. A representative for each case study was interviewed based on their experiences as technical staff specific in controlling and monitoring the escalators’ operations and maintenance.

4. Analysis Of Findings
4.1. Maintenance Activities for Escalator
The maintenance activities vary depending on the company’s policy. Based on the information gather from the interviewees, it can be noted that all escalators have both daily and monthly maintenance. There are certain types of escalator, which executing regular maintenance in daily or in monthly basis. However, this is subjected to the policy and regulation provided by the supplier of this system.
Basically, the daily and monthly maintenance is very well recognised as the preventive maintenance and improving maintenance, respectively in the literature review. Based on the review, the maintenance activities were identified based on the theory on maintaining escalator. While from the case study, differences from the theory were found. Practical ways for escalator maintenance activities will depend on the certain set of rules that must be facilitated properly by the building operator.

Hence, the efficiency of escalator can depend on the maintenance activities executed. Maintenance of escalator will keep the system work sufficiently. Besides, the lifespan of escalator system can be enhanced. Based on the study conducted on maintenance activities of the escalator in shopping malls, this has achieved the first objective, which is to determine the maintenance activities of the escalator in a commercial building.

4.2. Safety Practices of Escalator

From the analysis, it can be proved that all case studies were fully equipped with safety features. Each escalator applied different approach for it safety practices. It cannot be neglected that escalator suppliers still considered and maintained safety cultures in their businesses. Table 1 shows the differentiation of safety equipment installed at for different case studies.

| Safety Equipment                  | Case Study 1 | Case Study 2 | Case Study 3 |
|----------------------------------|--------------|--------------|--------------|
| Emergency stop button & switch   | √            | √            | √            |
| Safety signage                   | √            | √            | √            |
| Handrail inlet switch            | √            | √            | √            |
| Yellow line/demarcation          | √            | √            | √            |
| Brush skirt guard                | √            | √            | √            |
| Audio message                    | √            |              |              |
| Auto start sensor                | √            |              |              |
| Bollard                          |              |              | √            |
| Green step                       |              |              | √            |
| Power saving features            |              |              | √            |

There are some common features from all cases studies that were equipped by the installer, they are emergency stop button, safety signage, handrail inlet switch, yellow line, and brush skirt guard. As shown in Table 1, those safety features are the crucial components. In another situation, there are five safety equipment installed at each case study that makes it vary from one to another. The audio message, auto start sensor, bollard, green step and power saving features are the equipment that makes the escalator deviated in terms of its safety characteristics. Based on this finding, the added value on the escalator will depend on their safety equipment where it will be more efficient and protective to be used.

From the research, different safety features in each case study were due to building requirement, marketing purpose, assurance of the safety to uses, budget for providing escalator in building, improvements from previous experience or lesson learnt gathered from existing buildings.

4.3. Cost Related To Escalator Maintenance Activities
Table 2. Overall estimated cost for escalator maintenance.

| Components                | Case Study 1      | Case Study 2      | Case Study 3      |
|---------------------------|-------------------|-------------------|-------------------|
| Escalator                 | RM380 000.00      | RM300 000.00      | RM400 000.00      |
| Set of motor and brake    | RM200 000.00      | RM200 000.00      | RM200 000.00      |
| Maintenance Charges       | RM450.00          | RM400.00          | RM450.00          |

The table 2 shows the estimated costs for the escalator maintenance. The cost components in relation to the maintenance works is influenced by the lifetime of equipment, travelling usage by the users, equipment breakdown and others. The installation cost of escalator in case study 1 is around RM 380 000.00 for one escalator. This case study has two number of the escalator which is for up and down. The technician had mentioned that if the motor break is broken, the motor should change the whole part of the motor. The cost for motor changes was quite expensive which is RM 200 000.00. The maintenance charge is RM450 for each escalator for every month. If any breakdown of the component will be no charge except for change of the component.

The installation cost of escalator in case study 2 is around RM 300 000.00 for one escalator. The maintenance cost depends on the type of maintenance activities. If it is for daily maintenance no charge required. If there is equipment breakdown, the charge depends on the equipment cost plus with a service charge. The maintenance charge estimated is RM400 for each escalator for every month. If any breakdown of the component will be no charge except for change of the component.

The overall cost of each escalator for case study 3 is around RM 400 000.00 for one escalator. There is a cost for servicing escalator, where the owner pays to the contractor. If there is any escalator breakdown, the owner will call a contractor in charge in servicing the escalator. Any replacement for the component will also be a charge. But, for daily inspection, it will not be charge any amount as the inspector is working under building supervision. The maintenance charge is RM450 for each escalator for every month. If any breakdown of the component will be no charge except for change of the component.

5. Discussion And Conclusion
There are various types of maintenance activities such as run to failure maintenance, preventive maintenance, corrective maintenance, improvement maintenance, and predictive maintenance. Safety practices for escalator are also important. Generally, safety practices can be achieved when these factors are considered in the system such as safety features, traffic, location and physical of escalator. All these factors contribute to conveniences and comfortable of the escalator to the users. For example, there are safety features installed in each escalator such as emergency stop button, yellow demarcation, brush skirt guard, auto start sensor and other safety component. All these safety features help to reduce accident during riding of escalator.

The maintenance activities for escalator are also important. From the three case studies, works are carried out as per scheduled. It can either be a daily and monthly maintenance activity. It can be concluded that all maintenance works based on the case studies undergo similar process. This shows that the maintenance activities are crucial, not only to escalator, but to other equipment. From the case studies, it can be said that the design criteria take into consideration the safety features. The safety aspects of these escalators are also sufficient on the safety of the users. The system is equipped complete with the basic and addition safety components to ensure the effectiveness of the escalator during riding. Usually, the safety sign attaches to the escalator as a guideline to the customer as the safety precaution.

It is important to include cost breakdown for the maintenance work and it should be planned from the beginning stage to avoid problems in the later stage. It is useful to prevent from delayed the maintenance activities of escalator. Based on the case studies, the average cost of escalator maintenance activities is around RM430/day. There might be some other additional costs, such as cost to replace
escalator equipment. Nevertheless, due to difficulty to obtain information, the exact data for that particular cost could not be analyzed.

There are a few recommendations that can be highlighted for improvement in future, for instance, a quality standard for escalator need to be standardized, further research on the maintenance activities and safety practices in Malaysia not only for shopping malls are needed to be expended. Road tour on the public awareness about the uses of escalator should also be conducted. Based on the case studies, there are difference maintenance activities of each case study. It is suggested that a Standard Maintenance Guideline should be proposed and suppliers need to follow and comply with the requirements. The escalator maintenance activities observed from the case studies are some of the good examples since the inspection is carried out daily and monthly basis, to make sure the escalator is in good condition and safe.

Since this research only focuses on the area of Selangor, it would be better if the research is expanded all over Malaysia. Therefore, we can know the broader aspects of maintenance activities and safety practices of escalator in Malaysia. The information for the escalator maintenance activities and safety practices will be more precise. All escalator system from the case studies taking the safety of the passenger as the main priority. Even though safety features are provided, as a passenger, we should aware and obey with Dos and Don’ts for our own protection.

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