The Effect of Artificial Intelligence on Service Operations and Service Personnel

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Abstract. Artificial Intelligence (AI) can significantly change service operations. The timing of when service personnel are sent to lift installations and what those technicians do when on site will change. These changes are explored.

If the service tasks performed are different, one can conclude that the skill sets of the technicians will also need to be different. The skill sets and training requirements of service technicians and service supervisory personnel are also explored.

Global urbanization, post-pandemic workplace conditions, and AI will all affect the quantity of technicians required globally. These factors and their influence on staffing are reviewed.

1 INTRODUCTION

The proper functioning of lifts and the effectiveness of service operations are highly dependent on the service technician's capabilities. The technician must have the skills, tools, parts, materials, and support to properly perform service and repair functions.

Virtually all successful lift service companies, regardless of their size or location, have developed policies, practices, and procedures to deliver quality services. However, new technologies such as Machine Learning (ML), the Internet of Things (IoT), and Cloud computing will require significant changes in the service delivery system for these service providers to reap the benefits of these new technologies.

Three areas will be explored as follows:

1. The service tasks that will be performed and when they will be performed.
2. The skills and training that will be required for the next generation technician.
3. The quantity of service technicians that will be required for the post-pandemic data driven service world.

2 MACHINE LEARNING FOR LIFTS

Machine Learning involves gathering data, processing that data using algorithms and then recommending maintenance tasks and proactive actions to prevent breakdowns.

The following are some of the typical types of data used for ML [1]:

1. Static Data.
    a. Lift details such as capacity, speed, number of landings, travel, door type, drive type, and any other attribute that defines the lift.
    b. Building location.
        i. Latitude.
        ii. Longitude.
        iii. Altitude.
    c. Building type: office, residential, hotel, hospital, factory, etc.

2. Usage data.
    a. Trips made.
    b. Kilometres travelled.
    c. Door cycles per floor.
    d. Relevels.
3. Operational data
    a. Operating mode: automatic, independent service, fire service, emergency power, etc.
    b. Error codes generated.
4. Sensor data
    a. Vibration data.
    b. Ride quality.
    c. Temperature.
    d. Humidity.

The following are typical analytic tools used to evaluate data:

1. Classification And Regression Trees (CART).
2. Artificial Neural Networks (ANN).
3. Deep Learning.
4. Anomaly Detection.

3 SERVICE TASKS AND TIMING

3.1 Service Tasks

3.1.1 Present system, preventive maintenance

Most companies assign a technician a list of units to be serviced and the frequency of service for each unit. For example, units may be serviced weekly, twice monthly, monthly, or quarterly.

A specific number of hours to be spent for each visit is also included in the assignment.

A maintenance chart is commonly prepared that indicates what items should be inspected and what items should be serviced on each visit.

3.1.2 Inspecting vs. Servicing

It should be noted that inspecting, whilst it is important, leaves the lift in no better condition than it was in before the inspection.

Servicing, however, involves adjusting the component, replacing worn parts, lubricating parts, and cleaning the component. When the servicing is completed, the component should be in an as new condition.

3.2 Timing and Data Driven Maintenance

With Data Driven Maintenance, the technician is given a list of sites to visit on the next day. For each lift, a list of tasks to be performed during the visit is detailed. Most of these tasks will involve servicing a component rather than inspections.

Most inspections can be performed by using machine learning. For example, door tracks and door rollers will not be inspected if the door vibration signature is normal, and the controller has not issued any door related error codes.

If the door vibration signature indicates a contaminated landing door track at the Car Park level, which is open to the building exterior, then a service task for that door track will appear in the service task list [2].

Some maintenance tasks will be scheduled based on usage. However, usage data may be combined with environmental and building type data.

For example:

> Experience has indicated a particular type of door lock should be serviced after 15,000 cycles. Since door cycles can be counted, each floor potentially will require service at a different time. The lobby floor doors obviously need more frequent service than the doors of a partially occupied floor. Additionally, from job data it can be determined that this lift is located at a tropical seaside resort where the landing doors open to the building exterior. In such environments, doors need to be serviced every 5,000 cycles.

Breakdowns will be reduced because AI will create alerts that inform the service technician of impending failures sufficiently in advance of the failure that a visit can be scheduled to take preventive actions [3]. A scheduled repair or replacement can be performed at a lower cost than a repair that must be completed before the lift can be returned to service. All breakdowns inconvenience the client. Breakdowns that entrap passengers are especially inconvenient.

Data driven maintenance requires a far more complex maintenance scheduling system. However, such a system can deliver the proper amount of service at the proper time thereby improving both operational efficiency and customer satisfaction.

4 SKILLS AND TRAINING

Data Driven Service requires technicians and supervisory personnel that have the additional skills needed to perform this type of maintenance properly and safely. The skills required are as follows:

1. Basic mechanical, electrical, and electronic knowledge, and skills. These are the same skills currently required for lift maintenance. These basic skills are required because the lift is still performing the same functions of moving goods and people as it did before the introduction of IoT. Additionally, machine learning will not eliminate the basic oiling, greasing, and cleaning of lift equipment.
2. Computer literacy. It is logical to assume that the current and future generations of service technicians are computer and smart phone literate. However, in some markets, training in this area might be necessary.
3. Probability and Statistics. Whilst most lift service technicians are familiar with descriptive statistics, few have an appreciation of inferential statistics. Artificial Intelligence is based on inferential statistics. A basic understanding of this subject is necessary if only to appreciate that predictive analytics will always be a work in progress.
4. Vibration. The fundamentals of vibration will need to be understood. Accelerometers are being used to measure ride quality, kinematics, and to identify defective or damaged components. Important topics are:
   a. Natural Frequencies.
   b. Resonance.
   c. Fast Fourier Transforms (FFT).
   d. Vibration signatures.
5. Sensor Technology. Various types of sensors will be used to gather information that will be used by machine learning algorithms. A basic knowledge of the following types of sensors is required:
   a. Accelerometers.

b. Barometric sensors.
c. Temperature sensors.
d. Humidity sensors.
e. Strain gauges.
f. Photo-electric sensors.
g. Hall effect sensors.

6. Radio Frequency fundamentals. Most IoT systems are using some form of wireless communication. In addition to cellular modems for cloud connections, other low power wireless methods are being used to communicate with remote sensors. Future technicians will need to have some knowledge of the following:
   a. Frequency and Wavelength.
   b. Antenna fundamentals.
   c. Ground planes.
   d. RF cabling.
7. Electro Magnetic Compatibility (EMC). EMC fundamentals, both emissions and immunity, need to be understood. Particular attention must be given to installation methods and earthing.

5 MANPOWER REQUIREMENTS

5.1 Urbanization

Future manpower requirements will be driven primarily by urbanization.

Urbanization is the migration of people from rural areas to cities [4]. Urbanization began with the appearance of the first true cities in Mesopotamia around 5,500 BCE [5]. The technological explosion that was the Industrial Revolution led to a significant increase in the process of urbanization.

The Industrial Revolution began in the UK in the 18th century [6]. Urbanization soon followed as can be seen in the following chart:

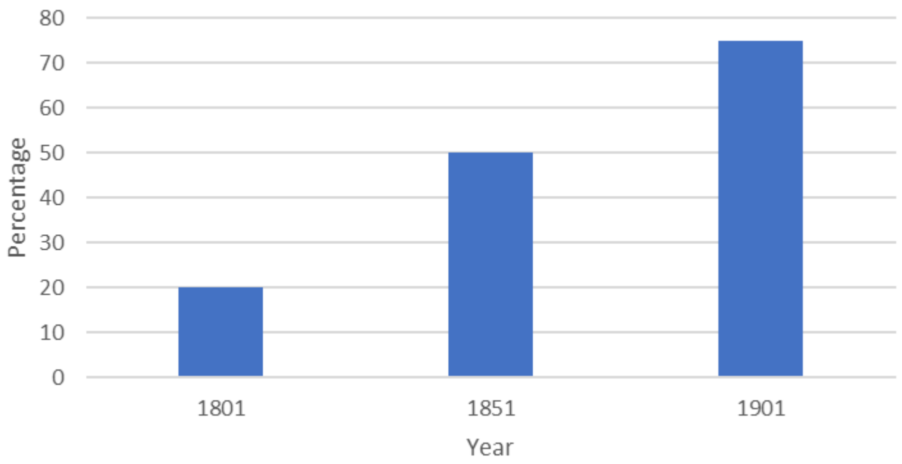

Figure 1 Urbanization Percentage

Note that the percentage of the UK population living in urban areas increased from 20% to 75% [7].

To accommodate urbanization, cities must grow upward rather than outward in order to reduce transportation time, transportation related carbon emissions, and the consumption of green spaces [8]. Upward growth implies taller buildings and more lifts.

When one thinks of urbanization one immediately thinks of China and India. In China the number of people living in cities will increase by 108 million in the next eight years [9]. In the next eight years, India will see 102 million more people living in cities [9].

Urbanization is continuing even in highly developed countries. In the next eight years, the USA will see 21.7 million more urban residents whilst urban areas in the UK will need to accommodate an additional 3.5 million people [9].

Urbanization will cause the number of lifts and the number of floors served by each lift to increase almost everywhere, even in highly developed countries.

The easy and inefficient way to deal with this additional demand for service technicians is to hire more people. The efficient way to cope with the demand is by using AI and by employing better trained technicians.

Economic data indicates that the increase in efficiency of service operations will also result in increased real wages for service technicians [10].

The number of labour hours worked for any given lift will decrease whilst the total number of hours worked in the lift industry will greatly increase due to the combined effects of increased efficiency and urbanization.

5.2 Post-pandemic working conditions

The COVID-19 pandemic will influence urbanization and office space requirements [11].

A portion of the office population will work remotely. Hybrid working, where workers work remotely a percentage of the time and work from their offices the balance of the time will be common. Remote working whether full time or hybrid will create an initial increase in office vacancy. Some of the surplus will be offset by workers requiring more individual space. Social distancing can reduce the transmission of disease whilst the additional work area improves productivity.

The effects of remote working and workers' requirement for more personal space will only slow the rate of urbanization until the surplus space is absorbed.

6 CONCLUSIONS

Artificial Intelligence will change the timing and frequency of service. This will result in improved customer satisfaction and operational efficiency.

Lift service technicians will need additional training to acquire the skills required for Data Driven maintenance.

Urbanization will cause more lifts to be placed into service. Additional lift technicians will be needed in the immediate future as the improved labour productivity made possible by AI will not keep up with the increased demand for technicians.

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BIOGRAPHICAL DETAILS

Rory Smith is Visiting Professor in Engineering/Lift Engineering at the University of Northampton and a Consultant at Peters Research Ltd. He has over 53 years of lift industry experience during which he held positions in research and development, manufacturing, installation, service, modernization, and sales. His areas of special interest are Machine Learning, Traffic Analysis, dispatching algorithms, and ride quality. Numerous patents have been awarded for his work.