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Towards Machine Learning Maintenance in Airport Infrastructure

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ABSTRACT

The total operating costs of airport infrastructures include substantial upkeep expenses. Maintenance management methods are becoming increasingly important because any damage can lead to important consequences at the airport. Many classic maintenance methods, like "run to failure" or preventive methods, are lacking in different fields because they're expensive and show a non-maintenance management approach. Many methods related to BIM will detect all possible failures and resolve them before they occur, a type of management known as "predictive maintenance." Predictive maintenance enables you to maximize the availability of engineering systems, prevent downtime, reduce downtime, and increase safety.

Keywords: Maintenance, Airport infrastructure, Artificial Intelligence, BIM

I. INTRODUCTION

Maintenance in airport infrastructures (MAI) has attracted a lot of **interest** from both practitioners and academics, knowing the increase **in** the total number of deterioration over the next years because of different reasons including climate change. **The** Burbidge 2016 **report**. **There are** diverse and severe disasters that are creating enormous economic effects and human impacts in many countries across the world **due to the Covid 19 crisis**. Therefore, **it** implies a financial crisis and a lack **of** repair when there are any failures in airport **infrastructure**. Coibion **and co.,** 2020) **Industries have used** both traditional management techniques**,** which are **run** to failure and **preventive** maintenance**, for many decades**. **Running** to failure management is a reactive **approach** that waits for machine or equipment failure before **taking** any maintenance **steps** (Koenig et al**.,** 2019)

Concerning preventative upkeep, they are described as being driven by time. As a result, proactive upkeep management assumes that devices will deteriorate within a timeframe typical of their particular classification. The mode of operation and system affect the normal operating life of machinery, which is a problem. The authors of Luan et al. Predictive maintenance (PdM) is a spreading alternative to traditional methods such as breakdown corrective maintenance or scheduled predictive maintenance for several industries, used in aerospace and many other fields (Burnaev, 2019) It can improve the operational availability of engineering by increasing its availability. After the COVID-19 crisis, collaborative intelligent manufacturing will be prioritized. Reduce the costs and increase safety by preventing downtime due to unscheduled maintenance.

II. LITERATURE REVIEW

In this section, an overview of the relevant concept of the study will be examined. This will allow the identification of knowledge gaps and an understanding of the research domain. To facilitate an understanding the chapter is divided into 6 sections.

A. AIRPORT BUILDING

Airport buildings are defined as all infrastructures that are related to the aerospace domain. These buildings are:

- Passenger terminals
- Control towers
- Cargo terminals
- Sheds
- Maintenance, Repair and Overhaul (MRO) Facilities
- Fire safety stations
- Administrative buildings
- Covered parking lots
- Common facilities for car rental agencies
- Warehouses
- Hotels

These important buildings should stay operational to guarantee excellent executions 24 hours by 24 hours. In fact, the presence of any damage can create disorders inside airports. That is why, researchers are interested in different approaches related to artificial intelligence in order to predict all negative events or accidents that can create the closure of airports or implies other significant consequences.

B. Facility Management (FM)

Three-dimensional (3D) modelling of aerospace buildings plays an important role in different applications. One of these applications is maintenance planning. The purpose is to develop strategies in operational situations, revamping purposes (Kawashima, et al., 2014), retrofitting of old sites and preparation for dismantling (Veldhuis et all., 1998) during the lifecycle of industrial facilities (Son, et al., 2013). The most

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important Facility Management tasks are summarised in Figure 1.

Figure 1: Major Facility Management

C. MAINTENANCE AND OPERATIONS

Maintenance is defined as a set of operations that permit to keep equipment or an object in good condition by making repairs and upgrading or correcting problems or improving any parts ofan equipment (Pukite et al, 2017). Figure 1 shows that maintenance has a only with renovation and rehabilitation. Therefore, maintenance strategy is based on actions of rehabilitation and renovation to keep its object or equipment in service. Contrary to maintenance, restoration is a process of bringing back an object to its original state. Reconstruction highlights non-surviving portions of a building for interpretive purposes (Trisco systems, 2014). Building expansion is the main reason for reconstruction. It extends the buildings. Figure 2 shows the level of intervention depending on the level of degradation (Teo and Lin, 2011). In fact, there are different types of intervention:

- Preservation
- Conservation
- Refurbishment
- Rehabilitation
- Renovation
- Remodelling
- Restoration
- Demolition and rebuilding

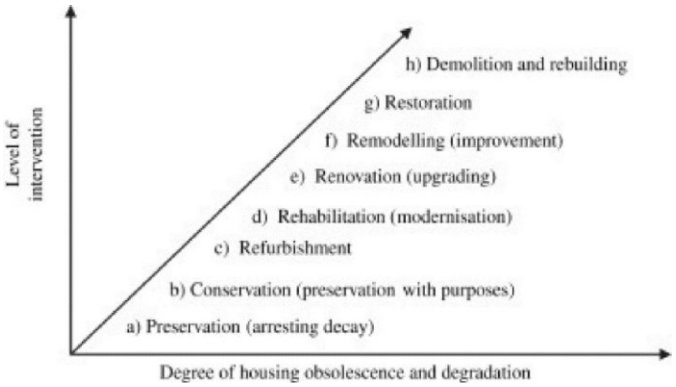

Fig. 2: Level of intervention

These types of intervention depend on which strategy of maintenance is needed.

In order to make the right action for maintenance in airport infrastructures, five important components are required to define the right strategy: These five major components (Lee et al.2009) are as follows:

The length of time for maintaining for their present use.

The life requirements of the buildings and their fittings and services. The standard to which the building and its services are to be maintained. The reaction time needed between a defect occurring and a repair being carried out.

The legal and statutory requirements shall also be considered

The figure 3 summarizes the cycle of the maintenance strategy (Lee et al. 2009)

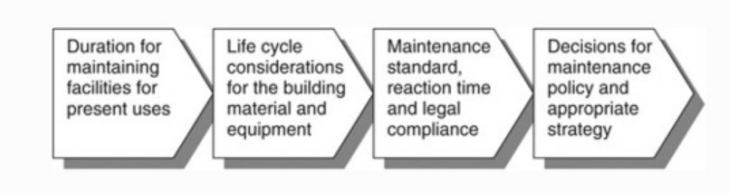

Fig. 3. Sequences for formulating building maintenance policy and strategy

There are 3 major types of maintenance that will be described in the next paragraphs:

- Corrective maintenance
- Preventive maintenance
- Predictive maintenance

i- Corrective maintenance and its application

Corrective maintenance is defined as a maintenance that is performed to rectify and repair the equipment. The objective of corrective maintenance is to restore equipments that have broken down. Corrective maintenance is similar to with breakdown or reactive maintenance. As regardsthe nature of tasks, it is always unplanned. (Mobley, 2002)

Corrective maintenance is illustrated thanks many applications such as restoring services that aredown and repairing things that are broken and urgent repairs in different industries such as in Unmanned aerial vehicle. (Petritoli et al, 2018)

ii- Preventive maintenance and its applications

Preventive maintenance (PM) is maintenance that is performed on an asset with the goal of reducingthe likelihood of failure, decreasing unexpected downtime, and extending its useful life. “Maintenance tasks are based on elapsed time” (Mobley, 2002). All preventive maintenance made. hypothesis that machines will be broken within a specific time. Figure 4 shows the statistical life of a machine. (Mobley, 2002). To illustrate this type of maintenance, there are different types of examples in industry such as a machine that will not need to be rebuilt after a specific period.

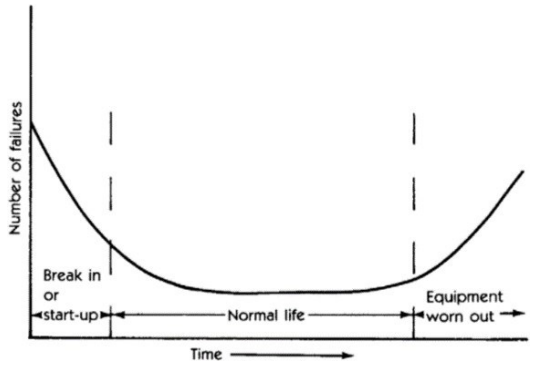

Fig. 4: Typical bathtub curve

iii- Predictive maintenance and its applications

Predictive maintenance (Pdm) is defined as a new habit and a philosophy that has a purpose to improveproductivity and to increase the efficiency of a random industry. Predictive maintenance approaches use tools to get the actual condition of the industry in order to avoid any failures and thus to reduce dowtime due to deffects. This approach of maintenance enables also to reduce costs compared to othertraditionnal methods.

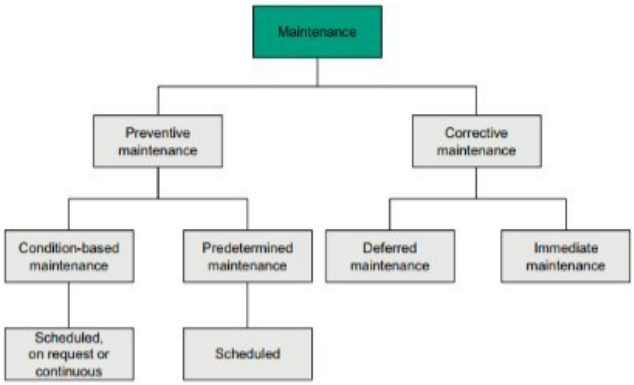

Fig. 5 : Types of maintenance

To sum up, Figure 5 summarizes the types of maintenance and it confirms that predictive maintenance is a part of preventive maintenance since maintenance tasks are planned compared to corrective maintenance

D. ARTIFICIAL INTELLIGENCE

i- BIM

Building Information Modelling (BIM) is a process that generates the 3D digital representation of a facility and understands geometric definitions at many levels of aggregation and parametric rules (Eastman, 2008). BIM enables sharing, exchanging and managing information among all parts involved in the construction and Facility Management (FM) throughout the entire lifecycle of a building.

Maintenance, safety management and retrofitting of existing industrial facilities are vital operations in their lifecycle as well (BIFM, 2012; Gorse & Highfield, 2009). Poor maintenance implies to equipment failure, which can have negative impacts that are related to environmental and economic domains.

ii- Machine learning and deep learning

Machine learning is a part of artificial intelligence (AI) with a concept that an algorithm can learnand adapt itself to new data without any intervention.

Machine learning is useful in parsing an important amount of data that is permanently available in the world to assist in decision making and to predict what will happen in the future.

For instance, the methods using machine learning enable to detect objects in the point cloud presentin a airport building. These detected objects will permit to predict the presence of possible failures and thus act before.

Deep learning is the core technique for learning-based image processing tasks. It is attracting the interest of researchers and engineers in point cloud processing (Shu, et al., 2016). Also, it is capable of learning unsupervised from data that is unstructured or unlabeled as described in Figure 6.

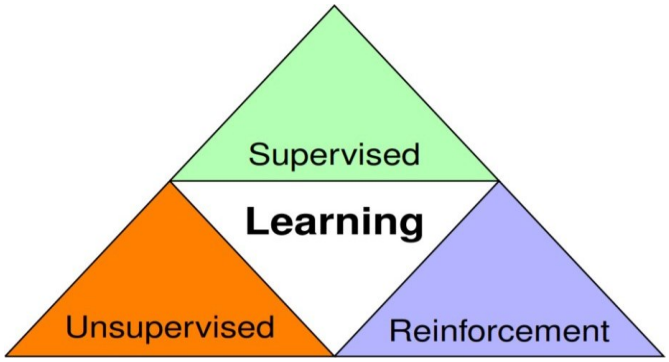

Figure 6: Categories of learning algorithms

III. CONCLUSION

There are also important contributions to the existingpractice and more specifically in 4D/5D construction (time and cost respectively) and analysis and design, safety, renovation, operation and maintenance and subsequently demolition of existing industrial plants.Overall, a system of different object types that are critical for airport facility operations and frequent in aerospace environments should be established for all the reasons explained above. Its adoption will have positive economic and societal impacts

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