USING AI-BASED WEATHER FORECASTS TO OPTIMISE CAFM SYSTEMS

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Abstract: The management and administration of complex building structures requires a comprehensive information system to control and manage them efficiently. This requires powerful information technology. Computer-aided facility management (CAFM) systems have revolutionised the management and maintenance of facilities in various industries. One important aspect that affects the effectiveness of CAFM systems is the weather. Traditional weather forecasting cannot provide the required accuracy and speed. However, by integrating artificial intelligence (AI) into the analysis of weather data, CAFM systems can now benefit from accurate and timely weather information, which has a significant impact on their performance and effectiveness.

Keywords: AI, CAFM, facility management; weather data, building management

Introduction

“Sunshine is delicious, rain is refreshing, wind is challenging, snow is cheerful; basically, there is no such thing as bad weather, only different kinds of “good weather”[1]. This view can also be applied to modern industrial buildings. The challenge for the technology contained within them is to keep the boundary conditions within the required parameters at all times, to support operations and not to jeopardise them at any time. In terms of weather, it is understandable that buildings need to be cooled on hot days and heated on cold days. Energy is therefore used to regulate the indoor temperature. But what if we used the weather to adapt to climatic conditions rather than fight them? To do this, weather data must be analysed early and accurately. Traditional weather forecasting methods often lack precision and real-time updates, leading to inefficiencies and unexpected disruptions.

Research methodology

There is a lot of information in the existing literature on the topic of ethics in the workplace. Many ethical questions on digitalisation have been elaborated on the boundary conditions of ethical principles in a modern world of work. Topics on psychosocial health from an ethical perspective have also been published. As few publications have been published to date on a comprehensive presentation of these principles in the context of remote working, this paper looks at their specific features in the literature and summarises them in a common context. Therefore, the research method is based on a literature review.

The ethical principles of AI-based data

The advent of digitalisation has precipitated a radical transformation of the contemporary working environment. One significant technology that has facilitated this transformation is artificial intelligence, which is being increasingly integrated into computer-aided facility management (CAFM) systems. These systems are employed for the administration and enhancement of real estate and infrastructural services. While the utilisation of AI in CAFM systems offers a plethora of advantages, it also gives rise to a multitude of substantial ethical concerns that necessitate meticulous deliberation. The ethical principles that are of paramount importance in the digitalisation of the world of work include fairness, transparency, data protection and accountability. In terms of fairness, it is of the utmost importance that AI systems are designed in such a way that discriminatory decisions can be ruled out. It is therefore imperative that the algorithms utilised in CAFM systems are subject to periodic review and testing to ensure the absence of any inherent biases. Such treatment could otherwise result in the unfair treatment of employees or service providers, which has both legal and moral implications[2]. It is of paramount importance that employees can comprehend and accept the functioning of AI systems. In the case of CAFM systems, this entails that the decisions reached by the AI must be explicitly conveyed and the underlying data sources must be made transparent[3]. The protection of personal data represents a significant concern, particularly in view of the General Data Protection Regulation (GDPR) in Europe. CAFM systems amass and process vast quantities of data, including potentially sensitive information pertaining to employees. It is imperative that this data is stored and processed in a secure manner to maintain user trust[4]. Ultimately, it is imperative to determine who is accountable for the decisions and actions of AI systems. In CAFM systems, malfunctions or erroneous decisions have the potential to significantly impact the operational and safety-related aspects of building management. It is therefore essential to establish a clear division of responsibilities[5]. The incorporation of AI into facility management systems (CAFM) has the potential to markedly enhance the efficiency and efficacy of building and asset management practices. Nevertheless, it is imperative that the emphasis on technical advantages does not result in the ethical implications being overlooked. While AI has the potential to enhance efficiency, there is a possibility that this may result in job losses. It is therefore essential to achieve a balance between the utilisation of technology and the safeguarding of job security[6]. AI-systems can make precise decisions based on large amounts of data. Nevertheless, it is imperative that the data sources are reliable and that the utilisation of said data is ethical. In the case of CAFM systems, this applies to both operational and personal employee data. In the implementation of AI systems, it is of paramount importance to consider the ethical principles previously outlined. This is the only means of ensuring that the technology is not only utilised efficiently, but also fairly and responsibly. The advent of digitalisation and the integration of AI in the contemporary working environment presents a plethora of opportunities, yet also gives rise to significant ethical challenges. In the case of CAFM systems, it is of particular importance to uphold ethical principles such as fairness, transparency, data protection and accountability. It is only through a meticulous examination of these boundary conditions that it is possible to guarantee that the advantages of the technology are fully exploited without endangering the rights and confidence of those involved.

CAFM building management systems

When even in ancient times, investment in property was mainly in land and buildings. In the last century, the focus of commercial property was on equipment[7]. One thing remains the same: it is still a major investment and commercial property is still an important asset for companies. This is true not only in terms of its physical value, but also in terms of its value-added function. Of the total lifecycle costs of a property, 20% are construction costs and the remaining 80% are operating costs[8]. This means that maintenance costs and related facility management are the much larger cost factor. Ongoing technical developments and the increasing use of technology in buildings have made the management of commercial property increasingly complex. Facility management or building management systems help companies to manage their buildings effectively. The focus is on increasing profitability and reducing costs through sustainable management. CAFM software supports the manager in all day-to-day processes and in complying with operator obligations. The operator is responsible for ensuring that the operation of the building does not create hazards. They must therefore take the necessary legal measures and document them accordingly. Software solutions are usually divided into three modules:

- Technical facility management:
  Maintenance, energy management, facility management and fault management.
- Commercial facility management:
  Contract, document, and order management. Rent and lease. Reports and key figures.
- Infrastructural facility management:
  Cleaning, relocation, inventory, space management, security and occupational health and safety.

The advantage of using CAFM software is that all data is collected in one tool and can be linked together. This means that routine processes, such as tracking maintenance contracts, can be automated. The documentation processes that result from the operator's obligations can be created within the system data and linked to all processes. These and other benefits of such support software led to a more efficient use of space, helping to increase the productivity of the operator's primary business[9].

Weather data and weather forecast

Weather forecasting models are complex systems that predict future weather conditions based on physical principles, historical data and numerical calculations. The calculations are supported by millions of sensors around the world and in space that are constantly collecting data. These models are crucial for forecasting short-term (up to 48 hours in advance), medium-term (up to seven days in advance) and long-term (more than seven days) weather events. In Europe, three global weather models are most used for forecasting. These are the American weather model (GFS), the European weather model (ECMWF) and the German weather model (ICON). What these models have in common is that data is collected and fed into the model to describe the current atmospheric conditions. The weather model uses mathematical equations to simulate the behaviour of the atmosphere over time. The application of AI is transforming the field of meteorology, facilitating the development of more precise and expedient weather forecasting methodologies. Conventional meteorological models are founded upon physical equations and necessitate substantial computational resources. AI models, in particular machine learning (ML), offer a rapid alternative, as they are capable of swiftly analysing vast quantities of data and identifying patterns that are not immediately apparent to humans. This capacity enables more precise forecasting of meteorological phenomena. One illustrative example is the AI-based weather model, “Using Machine Learning to Nowcast Precipitation in High Resolution”, developed by Google[10], which was designed to predict short-term weather events. It employs deep learning to analyze radar images and can deliver forecasts within minutes. In contrast to traditional weather models, it exclusively utilizes data from radar images. A study by Ayzel et al. (2019) demonstrates that deep learning models can predict the intricate nuances of short-term precipitation field development and can rival established nowcasting models based on optical flow techniques[11]. This perspective is corroborated by Agraval et al. (2019)[12]. A comparison was conducted between deep learning (DL) techniques and three commonly used models. The DL variant was observed to perform well in the domain of short-term forecasting, with a temporal resolution of greater than one hour and a spatial resolution of one kilometre[12].

Optimised use of resources

A considerable number of processes within the field of facility management remain largely static. To illustrate, there are fixed maintenance cycles, permanently programmed heating and ventilation controls, and inflexible room lighting and cleaning cycles. However, the necessity for a fixed number of permanently assigned workstations has been reduced as a consequence of the emergence of flexible workplace models. This implies that equipment and even offices are utilised less frequently, necessitating less frequent cleaning, heating and cooling[13]. The utilisation of contemporary meteorological data, such as outdoor temperature, for the purpose of regulating building heating, cooling and air conditioning systems based on weather conditions has now become a standard practice within the field of building technology. Nevertheless, systems utilising weather forecasts for control have only been accessible in a limited number of instances thus far. The incorporation of weather forecasts into existing systems could potentially result in energy savings in a straightforward and cost-effective manner, thereby reducing CO emissions[14]. The application of AI in facility management is already a well-established phenomenon. These platforms employ an optimisation algorithm that is continually evolving to intelligently combine the possibilities and requirements[8]. Seering et al[15] observe that the prevailing approach to meteorological forecasting in regulatory contexts relies heavily on the services of national meteorological agencies, which typically provide data as fee-based information on an hourly basis. In order to facilitate control of the building technology, it is recommended that data be provided at least every 15 minutes. The use of internet-based weather data, which is available free of charge, is therefore advised. Fluctuations in weather conditions frequently exert an influence on the utilisation of resources in facilities. The incorporation of AI-based weather forecasts into CAFM systems enables facilities to optimise resource allocation in real time. This encompasses the adjustment of energy consumption, the scheduling of maintenance tasks and the efficient deployment of personnel with a view to mitigating the impact of weather changes. The capture and analysis of AI-optimised data streams enables facility managers to gain real-time insights into the performance of the properties they manage[8]. The climatic conditions prevailing in each location are of great consequence regarding the patterns of energy consumption in buildings. The integration of AI-based weather data into CAFM systems enables the optimisation of energy consumption through the matching of energy usage with weather forecasts. For instance, lighting and other systems can be modified in accordance with anticipated meteorological shifts, thereby achieving energy savings without compromising comfort or operational requirements. The intelligent analysis of building sensor data and indoor climate control has the potential to save a considerable amount of energy. Intelligent lighting systems, for example, adjust the brightness fully automatically to the level of daylight. Improved knowledge of a building can results in savings of 10 to 15 percent of energy costs[8]. and optimise ongoing operating costs. Furthermore, long-term effects can also develop positively, as this proactive approach minimises downtimes, reduces repair costs and extends the service life of the systems. In addition to the technical optimisations, the data obtained in this way can also be used to gain considerable advantages in personnel scheduling. The performance of cleaning work is typically conducted in accordance with explicitly delineated service specifications. By optimising according to the data models, personnel can be developed from an activity-oriented process to a demand-oriented execution. The maintenance of roads during the winter season provides an illustrative example. The services are typically commissioned from November to April. The necessity for the winter service to be carried out varies depending on the geographical location. In some cases, there may only be a few days during the six-month period when the service is required. Consequently, personnel must be kept on standby for the remainder of the time. This results in the unnecessary utilisation of personnel resources and the generation of avoidable costs. Furthermore, the optimisation of cleaning processes can be achieved through the utilisation of AI-based data. In situations where precipitation is a persistent feature of the weather, it is more cost-effective to implement a programme of cleaning and maintenance of entrance areas to ensure they remain free from moisture, rather than maintaining a standby workforce for the purposes of undertaking a winter service that is not required. The availability of reliable weather data enables the implementation of such changes through the planning process.

Results

Despite the advantages they offer, AI-based weather models are not without their own set of challenges. The models require substantial quantities of high-quality training data and are frequently intricate and challenging to interpret. Furthermore, they must be continuously updated and adapted to remain aligned with evolving climatic conditions. The presence of rain is related to, but not perfectly correlated with, the presence of clouds, which presents a challenge in inferring precipitation from satellite imagery data alone. Weather services around the globe employ a vast array of monitoring equipment. For instance, Doppler radar enables the measurement of precipitation in real time, while weather satellites provide multispectral images and ground stations measure wind and precipitation directly. It is anticipated that future hybrid models, which integrate both physical and AI-based approaches, will further enhance the accuracy and efficiency of weather forecasting. The conjunction of physical laws with the capacity of AI to discern intricate patterns portends a new era in meteorological forecasting.

Conclusion

The implementation of a well-designed CAFM system is a prerequisite for the effective and efficient management of complex buildings. The incorporation of artificial intelligence (AI) into building management systems (CAFM) has the potential to revolutionise the way in which such systems operate. The utilisation of precise and contemporaneous meteorological forecasts enables the enhancement of predictive maintenance, the optimisation of resource allocation, the improvement of emergency preparedness, the promotion of energy efficiency, the optimisation of space utilisation and the facilitation of data-driven decision-making. As technology continues to evolve, the integration of artificial intelligence with traditional weather models will further enhance the capabilities of CAFM systems, enabling organisations to achieve greater operational efficiency, resilience and sustainability in the management of their facilities. Notwithstanding the existing challenges, the rapid development in this field demonstrates that AI will assume a pivotal role in facility management.

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