Abstract
In today’s data-driven environments, ensuring workflow efficiency and data security are crucial across various processes. The purpose of this study is to introduce a cloud framework based on Business Process Modeling Notation (BPMN) for assessing overheating risk in residential buildings. The framework provides a comprehensive approach, utilizing BPMN modeling to effectively evaluate and optimize risk assessment. By promoting clarity on shared processes and data, the framework enhances data sharing and assessment efficiency. This research significantly advances the field of overheating risk assessment and contributes to the development of cloud-based services for building assessment.

Introduction
Adaptation in service systems:
In recent years, the world has witnessed significant disruptions in day-to-day operations, leading to the adoption of alternative activities and solutions through various tools and platforms. This shift has underscored the importance of connecting proprietary systems to web-based infrastructures and adapting business processes with flexibility. However, traditional or service-oriented architectures used in common systems pose challenges for their adaptability to changes (Schäffer et al., 2021).

The rapid advancement of communication and information technologies has further highlighted the significance of adaptation in service-based systems. Existing standards and frameworks for Web services lack a comprehensive architecture that incorporates all aspects of monitoring and adaptation. Additionally, the emergence of new computing environments hosting diverse service types requires more efficient monitoring and adaptation systems for data sharing (Mezni, 2023).

Cloud computing plays a crucial role in different sectors, and data privacy and security are significant concerns in cloud computing, requiring attention from both providers and users. With sensitive data stored, transferred, and processed in the cloud, measures must be taken to ensure its protection (Ramachandran & Chang, 2016). Therefore, the focus of this research is to develop a BPMN framework within a cloud environment for the process of assessing the risk of overheating in buildings.

Systems Adaptation to climate change:
On the other hand, Climate change has resulted in widespread impacts globally, leading to more frequent and intense extreme weather events which adversely affecting people’s health and well-being giving an attention to what could be the outcomes in the future (IPCC, 2022), (Lawrance et al., 2022). Evaluating the risk of overheating in residential buildings through simulation models became a must to help in assessing buildings performance under different climate scenarios (Wadi et al., 2019). Some previous studies shed the light on evaluating overheating risks in residential buildings (Haj Hussein et al., 2022), nonetheless, further studies are needed across other zones and under additional different future scenarios (Monna et al., 2021), (Mitchell, 2021).

Based on the conducted literature review, significant emphasis has been placed on assessing and evaluating the risk of overheating. This phase is crucial within the overall overheating assessment process, which includes defining the risk, evaluation phase, design/redesig, reaching findings, implementing them, and monitoring the assessment process. Therefore, the objective of this research is to enhance the overall process of assessing the risk of overheating in existing residential buildings by leveraging BPMN flow and identifying efficient data sharing practices within a cloud-BIM environment.

This study combines different disciplines to provide an efficient assessment of overheating risk through effective data sharing in a cloud service. The study begins with a comprehensive literature review on the cloud service, highlighting its necessity, importance, and alternative approaches to adapt to current challenges. The report then presents the development of the overheating risk assessment process focusing on adaptation to climate change. The research methodology primarily revolves around the utilization of BPMN, showcasing the proposed framework and qualitative evaluation phase. The report concludes with discussions and conclusions. The main aims and research questions are outlined below.

The main aims of this study are as follows:
1. Develop a comprehensive BPMN framework within a cloud service for the assessment of overheating and evaluate its efficiency.
2. Facilitate effective data sharing among stakeholders to enhance the assessment process.

The research questions are as follows:
• How to develop and validate the holistic framework that effectively manages overheating, exchanges information, and automates processes?
What shared data is required for the assessment process, how can it be effectively shared? Where should data be stored in a cloud service?

Research methods & results
Assessment of Overheating risk
The assessment for the overheating risk is mainly based on a real case study for an existing residential building in different zones. Whole-building simulations conducted using the DesignBuilder tool under historical and future climate scenarios. Mitigation measures are tested and proposed to be used during extreme events.
In this study, the research conducted in a qualitative manner for the assessment process and BPMN that is proposed. Firstly, the identification of stakeholders responsible for the activities and the shared data is illustrated in the following paragraph.
The following figure (Figure 1) illustrates the process of the conducted overheating risk assessment, which involves defining events, the evaluating phase, design, testing/simulations, implementation, monitoring, and concludes with reviewing the client/occupant feedback.

![Communicate Data in a Cloud-Environment](Image)

**Figure 1: Overall phases of the assessment of overheating risk**
Each phase of the process involves specific stakeholders as: occupants, a designer, risk expert, and a contractor. The entire process is communicated in a cloud environment.

BPMN framework: Results
The Business Process Model and Notation (BPMN) is a widely used method for modeling business processes, including in cloud-based Building Information Modeling (BIM) environments. This study aims to develop a BPMN-based framework for assessing overheating in existing residential buildings, enhancing the effectiveness and efficiency of BIM management in the cloud. BPMN is not only effective for system design and security engineering but also enables resilient system design, helps define suitable business processes, identifies security risks, and proposes areas of improvement. Additionally, BPMN contributes to ensuring data security, further enhancing its effectiveness in system design and security engineering (Ramachandran & Chang, 2016).

A BPMN for the general overheating assessment is proposed as the following figure in (Figure 2).

The shared data in a cloud environment is proposed in (Figure 3), while (Figure 4) presents the evaluation process that is conducted by the risk expert.

Discussion
The proposed BPMN frameworks for assessing and evaluating the overheating risk in residential buildings aim to optimize data sharing and streamline the assessment process within a cloud-based environment. Stakeholders can effectively collaborate and ensure data security throughout the various stages. These frameworks are still in progress, aiming to further develop them in a cloud environment to enhance data sharing and optimize the process flow for a comprehensive risk assessment.
The assessment of overheating risk is crucial for occupant safety and comfort. The BPMN frameworks involve multiple stakeholders, including occupants, designers, risk experts, and contractors, enabling a comprehensive assessment process from event definition to client feedback review. Effective data sharing and collaboration enhance the accuracy and effectiveness of the assessment.

Cloud computing integration brings several advantages, such as efficient data storage, sharing, and real-time monitoring. The cloud environment accommodates the needs of stakeholders and ensures clarity and consistency in processes. However, challenges related to data security, privacy, and interoperability require attention for successful implementation.

Conclusion
In conclusion, this paper introduces a cloud-based BPMN framework for assessing overheating risk in residential buildings. The proposed frameworks enhance data sharing, streamline the assessment flow, and improve risk assessment effectiveness. Utilizing BPMN within a cloud environment enables stakeholders to collaborate efficiently, ensuring data security and providing a comprehensive assessment. The integration of cloud computing and BPMN offers improved data storage, sharing, and real-time monitoring capabilities. Further refinement is necessary to optimize data sharing and maximize the potential of cloud-based technologies. Future research should address data security, privacy concerns, interoperability, and explore advanced analytics and automation techniques. This study contributes to building assessment by proposing a comprehensive BPMN framework and showcasing the potential of cloud-based solutions. The frameworks provide a structured approach, promoting collaboration among stakeholders. Future work could be performed by integrating the work with the agile mindset with the proposed BPMN process.

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Figure 2: BPMN framework 1 - General assessment of overheating risk based on stakeholders’ activities organized in swim-lanes, vertical line shows the assessment phases.

Figure 3: BPMN framework 2 - Overheating assessment and shared data between stakeholders (in progress).
Figure 4: A BPMN sub-process developed for the evaluation phase of overheating risk in existing residential buildings.

References


