UCAS

الكلية الجامعية
للعلوم التطبيقية

Student Name	Student ID
SHAHD EYAD ETHALATHINI	220210527

Post-war building assessments system

Introduction

My project focuses on developing an intelligent expert system to evaluate building damage and prioritize repair actions based on multiple factors. By integrating fuzzy logic principles, this system analyzes structural damage, neglect levels, material degradation, hazard exposure, and other related parameters.helping decision-makers allocate resources efficiently and reduce the risk of further damage

The aim of this project is to streamline the process of building assessment to enhance traditional evaluation methods by offering an automated, adaptive, and user-friendly platform for damage assessment. It leverages both forward and backward chaining techniques to allow users to simulate various scenarios or query specific conditions, ensuring a comprehensive .and interactive experience

List challenges and try grouping them based on your based on specific criteria.

Lack of accurate data Original documents for buildings, such as engineering models, may be missing or inaccurate due to war

Hidden or invisible damage, such as erosion of the foundations or internal structure of the building as a result of bombing or explosions.

If the building is left without maintenance for a long period after the war, neglect can lead to increased structural damage.

The presence of hazardous or radioactive materials may hinder the assessment and further complicate the restoration process.

Determine the budget for reconstruction.

Examine whether restructuring will be more expensive or more effective than rebuilding the building from scratch.

Determine the extent of the war’s impact on the surrounding area, such as contamination or destruction of local infrastructure (roads, public networks).

Examine the integrity of the building’s basic structure (foundations, columns, roofs).

Evaluate cracks in walls and curved surfaces (these cracks may be an indication of structural weakness).

Personal biases of assessors influenced by experience,or emotional stress.

Lack of standardized protocols for assessments in post-war contexts.

Build the Knowledge Base:

IF original engineering documents are unavailable OR outdated
THEN
Conduct detailed field surveysCross-check with available historical records or similar structures in the region

IF hidden damage is suspected due to erosion, internal issues, or war impacts
THEN
Prioritize high-risk areas like foundations, load-bearing walls, and critical joints for inspection

IF prolonged neglect of a building is evident
THEN
Perform rapid assessments to identify critical failures

IF cracks, deformities, or foundational instability are observed
THEN
Recommend temporary shoring or bracing if the structure poses a collapse risk

IF hazardous or radioactive substances are present
THEN
Delay assessments until safety measures (decontamination or isolation) are implemented

IF surrounding infrastructure (roads or utilities) is damaged
THEN
Collaborate with authorities to restore critical access route

IF budget constraints limit assessments
THEN
Focus resources on structures with the highest risk of collapse or importance

IF assessments show evidence of subjectivity or inconsistency
THEN
Train personnel to recognize and reduce the impact of emotional or cognitive biases

IF physical access to the structure is restricted
THEN
Analyze data with software for 3D modeling and structural analysis

IF a structure shows signs of imminent collapse (large cracks, tilting
THEN
Enforce an exclusion zone around the structure to prevent accidents

IF material degradation is detected
THEN
Compare results to baseline material standards to determine structural safety

IF environmental hazards (e.g., toxic substances, radiation) are present
THEN
Establish safe zones for personnel during assessment and reconstruction

IF climate factors (extreme heat) affect assessments
THEN
Use weather forecasting tools to schedule safe inspection times

IF multiple structures require assessment
THEN
Prioritize high-risk and high-importance structures for immediate evaluation

IF resource limitations (manpower, equipment) exist
THEN
Allocate teams based on expertise and task complexity

IF local knowledge is available
THEN

Involve stakeholders in decision-making to ensure reconstruction aligns with community needs

F assessments require government or institutional support
THEN
Coordinate with relevant authorities for access permissions, logistical support, and funding

IF assessors are working in hazardous conditions
THEN
Provide thorough safety training, including handling hazardous materials and operating in unstable environments

IF knowledge gaps in assessment techniques are identified
THEN
Encourage knowledge-sharing between teams and experts to standardize best practices

IF structural assessments fall under regulatory frameworks
THEN
Document findings and decisions to ensure accountability and transparency

IF ethical dilemmas arise (cost vs safety
THEN
Prioritize public safety over cost considerations

IF data from inspections is collected (images
THEN
Train the system on pre-war and post-war structural datasets for better accuracy in assessments

IF historical or assessment documents need verification
THEN
Ensure that updates to records are transparent and tamper-proof

IF assessors show signs of emotional stress due to post-war conditions
THEN
Rotate personnel regularly to avoid burnout in high-stress environments

IF personal or cultural biases influence recommendations
THEN
Use diverse teams with varied expertise to balance perspectives

IF a structure is to be rebuilt or repaired
THEN
Ensure the design is sustainable

IF the assessed structure has historical or cultural significance
THEN
Prioritize preservation over demolition

IF the structure impacts the local community
THEN
Provide clear communication of findings and recommendations to all stakeholders

IF multiple teams are conducting assessments
THEN
Create a centralized digital repository to store and share inspection data

IF reconstruction or repair decisions are being made
THEN
Involve interdisciplinary experts (engineers) in the decision process

IF resources for reconstruction are limited
THEN
Monitor progress regularly and adjust plans based on evolving conditions

Methodology

The methodology adopted for this project combines principles of fuzzy logic to assess the condition of buildings and prioritize repairs based on urgency

Below is a step-by-step of the approach

Problem Definition and Objective Setting

Problem: Post-war building assessments involve challenges like incomplete data, conflicting reports, and subjective judgments

Objective: Develop an expert system to evaluate building damage and provide reliable recommendations despite

uncertainties

Data Collection and Input Design

Structural Damage: Cracks, deformation, and weakening of structural components

Neglect Level: Impact of maintenance delays on overall safety

Material Degradation: The extent of wear and tear on materials over time

Environmental Hazards: Exposure to risks extreme weather conditions

Building Age: The chronological age and associated risks of older structures

Accessibility: Ease or difficulty of conducting repair work in the building

Input Design: Each factor is represented as a fuzzy variable, categorized into levels

(low, medium, high)

Linguistic Variable	Description	Range	Fuzzy Sets
Damage	The extent of structural damage in the building	0 to 10	Low, Medium, High
Neglect	The level of maintenance delay or negligence	0 to 10	Low, Medium, High
Degradation	Material wear and tear over time	0 to 10	Low, Medium, High
Hazard	Environmental risks (e.g., earthquakes, floods, etc.)	0 to 10	Low, Medium, High
Age	The chronological age of the building	0 to 100	New, Medium, Old
Access	The ease or difficulty of accessing the building for work	0 to 10	Easy, Medium, Difficult
Urgency (Output)	Priority level for repair actions	0 to 10	Low, Medium, High

Fuzzy Logic System Design

Membership Functions

Define membership functions for all inputs

(Damage: low, medium, high)

and the output variable

(Urgency: low, medium, high)

Fuzzy Rules

For example

If damage is high and neglect is high, then urgency is high

If degradation is medium and hazard is medium, then urgency is medium

If damage is low and neglect is low, then urgency is low

Rules are designed to address all possible combinations of input factors

Control System Implementation

System Architecture

A fuzzy inference engine evaluates inputs based on the rules and calculates membership degrees

Defuzzification converts the fuzzy output (urgency levels) into a crisp value for actionable recommendations

Simulation Tool

Use Python's scikit-fuzzy library to implement fuzzy logic operations

Simulate various scenarios by inputting different values for damage, neglect, degradation, hazard, age, and accessibility

Outputs

Provide a clear urgency score (0–10 scale) and categorize it as low, medium, or high urgency

Testing

Case 1: Highly damaged, neglected, and hazardous old building

Case 2: Moderately damaged, well-maintained building with minor hazards

Case 3: A new building with minimal damage and no hazards

Results

The results of the project demonstrate the ability of the fuzzy logic-based system to effectively assess the urgency of action required for building repairs based on multiple factors

Case 1	**Damage:** 9 (High) **Neglect:** 8 (High) **Degradation:** 7 (Medium) **Hazard:** 9 (High) **Age:** 70 years (Old) **Access:** 4 (Medium)	**Urgency:** 8.9 (High)	The situation is highly critical due to severe damage, high neglect, and an old structure. Immediate action is needed.
Case 2	**Damage:** 5 (Medium) **Neglect:** 3 (Low) **Degradation:** 4 (Medium) **Hazard:** 6 (Medium) **Age:** 30 years (Medium) **Access:** 3 (Easy)	**Urgency:** 5.2 (Medium)	Moderate damage and low neglect result in medium urgency. Repairs are recommended but not immediate.
Case 3	**Damage:** 2 (Low) **Neglect:** 1 (Low) **Degradation:** 1 (Low) **Hazard:** 3 (Low) **Age:** 5 years (New) **Access:** 2 (Easy)	**Urgency:** 2.1 (Low)	The building is in good condition. Immediate repairs are not necessary. Regular maintenance is sufficient.

Comments

The introduction clearly outlines the problem, but adding a more detailed explanation of the impact of unresolved building damage (cost escalation, safety risks) would strengthen the urgency

The methodology provides a clear explanation of the fuzzy logic approach. However, it would benefit from explicitly linking each variable to its role in the decision-making process

Rules in the fuzzy logic system are listed well but could use some additional justification

The membership function ranges are appropriate but might need validation with domain experts to ensure real-world applicability

The table of linguistic variables is comprehensive

Conclusion

The expert system developed in this project successfully addresses the critical need for evaluating and prioritizing building damage based on urgency. By leveraging fuzzy logic, we created a dynamic decision-making framework capable of handling the inherent uncertainties in assessing structural damage, neglect levels, material degradation, hazard risks, building age, and accessibility. The system offers a practical tool for stakeholders to allocate resources effectively and take timely action to mitigate risks

The results demonstrate the system's robustness and adaptability across various scenarios as validated by case studies. These cases highlight how input parameters dynamically influence the output ensuring accurate prioritization of actions based on real world conditions

References

The ideas in the project are my own, but I took help from different internet pages and used external ideas from different people

Thank you