

A Facility Management System with Complaint Processing using AR and BIM Integration

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M. Derviş Kopuz



- M. Derviş Kopuz received his Bachelor's Degree in Civil Engineering in 2020 and is scheduled to receive his Master's Degree in Computer Engineering, from Istanbul Technical University in 2024. He has been working as a Software Engineer in different fields such as E-commerce and SaaS since 2020.
- Interests
 - Distributed Systems, Game Development

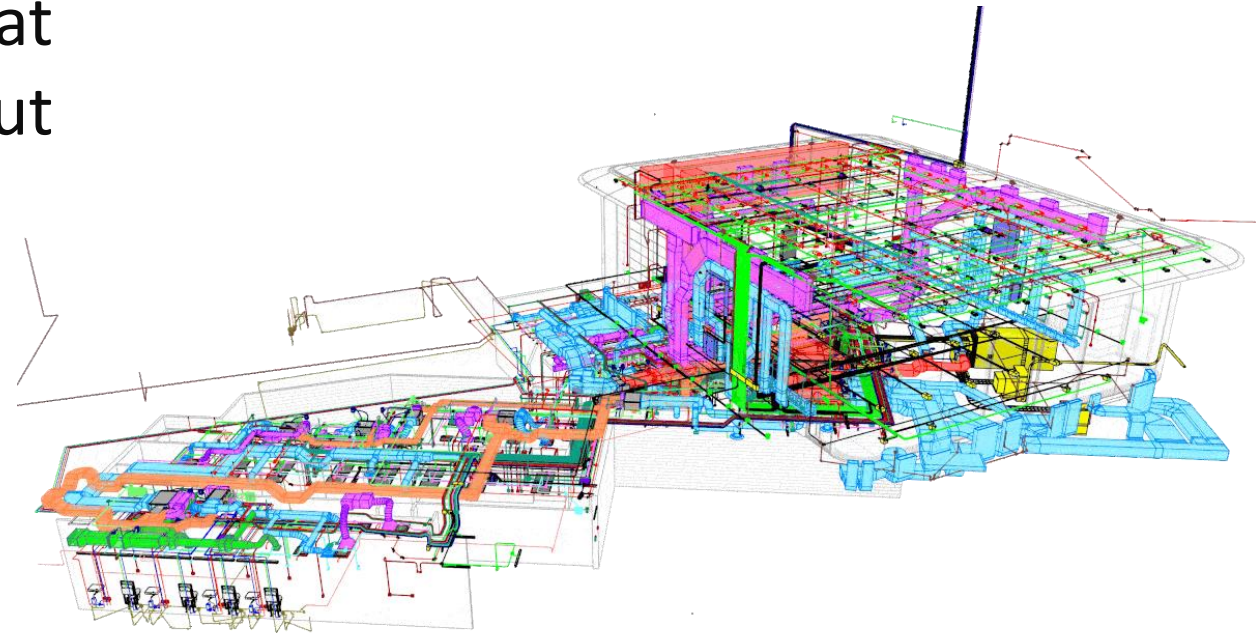
Facility Management

- Facility Management (FM) is the collection of services and processes which plays a vital role in enhancing the quality of life, productivity and efficiency within a facility.
 - Homes, Schools, Hospitals, Factories, etc..



Building Information Modeling

- Building Information Modeling (BIM) is a 3D model-based process that contains detailed information about the building.
 - geometry,
 - spatial relationships
 - geographic information
 - quantities
 - properties of building components.



- Used to project the BIM model on to the real world.
- Aim to provide interactivity with components.
- Image Recognition and Tracking
- Targeted Devices are mobile phones, tablets.



AR Foundation

Problem Definition



- Effective FM requires skilled professionals who are hard to train and replace without historical records which can be less than ideal in manual operations such as FM operations.
- It is estimated that 85% of a facility's lifecycle costs are incurred after the completion of the construction phase.*
- The integration of smart technologies into facility management systems presents a promising avenue for enhancing efficiency and realizing significant cost savings.
- Many existing FM systems struggle to effectively collect occupant feedback alongside contextual information, leading to suboptimal evaluations and decision-making.
- Accurate evaluation of occupant feedback holds the key to optimizing facility operations.

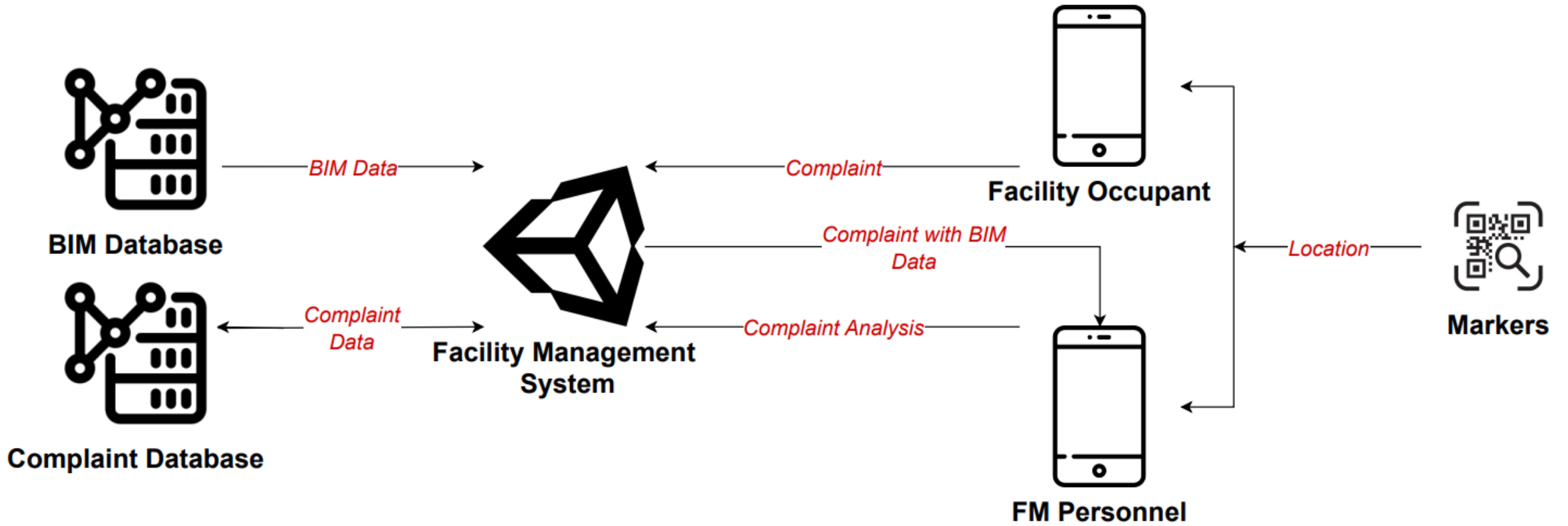
*A. Lewis, D. R. Riley and A. Elmualim, "Defining High Performance Buildings for Operations and Maintenance," 2010

Proposed System



- We advocate the integration of BIM with Augmented Reality (AR) frameworks, offering an interactive experience with BIM elements both for FM personnel and Facility occupants.
- **Facility Occupants** can use the system to report complaints/provide feedback directly linked to the relevant BIM elements, with precise spatial data.
- **FM personnel** can conduct a prompt and assured analysis strengthened by the BIM data and spatial information.
- The System can also help with incorporating a digital history log of the FM operations.

Proposed System



- BIM Model



blender



- AR Framework & Development



AR Foundation

- Database



- Target Platforms:



ANDROID



Component Information Panel Displaying Element Information



The screenshot displays a software interface with a central information panel for a door component. The panel is titled 'Door_2_[355149]' in red text. It lists the following information:

- 4. Location:
 - Building Level: [Ground Floor]
 - Room,Area: [Lobby]
- 5. Hardware:
 - Door Handle Type: [Pull Handle]
 - Locking Mechanism: [Card Access]
 - Hinges: [Continuous Hinge]
- 6. Fire Rating:
 - Fire Rating: [1-hour fire rating]
- 7. Accessibility Features:
 - Compliance with Accessibility Standards: [AD...]
- 8. Energy Efficiency:
 - U-Value: [measure of heat transfer through th...]
- 9. Manufacturer Information:

At the bottom of the panel, there are four buttons: 'Hide/Show', 'Create Complaint', 'Add-Ons', and 'Close'. To the right of the panel, there are two stacked buttons: 'Transparent' and 'Layers'. At the bottom right of the interface, there are two more stacked buttons: 'Draw' and 'Markers'. A small 'Development Build' watermark is visible at the bottom right corner of the screenshot.

Complaints Panel for an element in the application



- **Three** different tasks with **Two** different variations, totaling **Six tasks**, were constructed to be used in testing.
- Participant performed the tasks in both in the proposed AR system and in a traditional form-based 2D system.
- Participants completed the first three scenarios in **Facility Occupant perspective**.
- Participants completed the last three scenarios from the **perspective of a FM Personnel**.

Overview of Test Tasks



- **Occupant Perspective:**
 - **Task 1)** Create a complaint for a window letting cold air in.
 - **Task 2)** Create a complaint about an unpleasant odor in the workspace.
 - **Task 3)** Report a faulty light fixture among all the identical light fixtures.
- **FM Personnel Perspective:**
 - **Task 4)** Analyze the complaint about a window letting the cold air in.
 - **Task 5)** Analyze the complaint about an unpleasant odor in the workspace.
 - **Task 6)** Analyze the a faulty light fixture report.

Participant Demographics



Participant Demographics:

- 11 Participants
- Average Age (27 ± 2.69)
- Civil, Manufacturing, Computer, Support Engineering
- Some experience with AR
- 6 participants with prior BIM experience

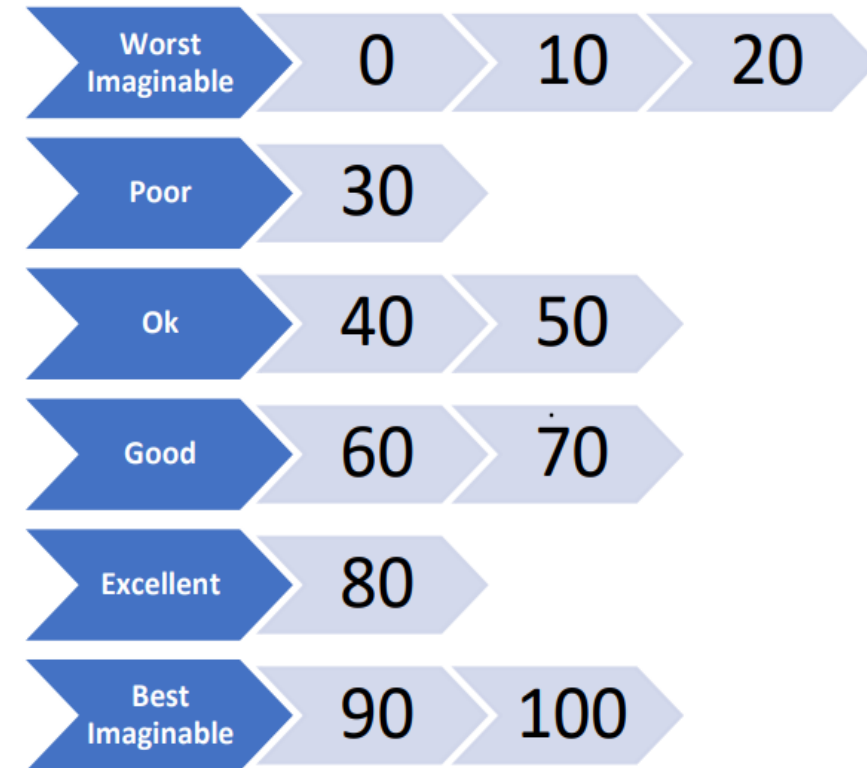
Metrics



Usability Dimension	Evaluation Metrics	Units	Investigation Techniques
<i>Efficiency</i>	Task Completion Time	Seconds	Direct Observation
<i>Satisfaction</i>	Post Evaluation Questionnaire	1 – 5 Scale	Questionnaire
	System Usability Scale		

- Task Completion Time in Seconds

Evaluation Metric	Tasks		
	Task 1	Task 2	Task 3
AR Application Avg. Task Completion Time (sec.)	72.10 (±14.46)	89.91 (±24.93)	67.82 (±16.97)
2D Application Avg. Task Completion Time (sec.)	88.73 (±18.71)	86.12 (±33.39)	75.46 (±22.82)



SUS Score	73.2 (± 6.8)
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- Acceptance Rate per different Environmental Factors for gathering feedback, with push notifications

Environmental Factor	Acceptance Rate
Safety and security	9/11
Air quality	7/11
Smell and odors	6/11
Accessibility	6/11
Humidity levels	5/11
Lighting conditions	5/11
Sensory stimuli	5/11
Temperature	4/11
Noise level	4/11

Participant Feedback



- Found the system **useful** from both perspectives.
- Felt **more confident** creating complaints.
- Expedites analysis of complaints.
- Multiple suggestions for improving the system.
- Requested a tutorial for first time users.
- Requested Analysis/Dashboard panel for reporting operations.

- Presented a system using AR-BIM integration for FM operations.
- The system offered an interactive approach to managing building data and collecting occupant feedback.
- Complaints/Feedback are enhanced with accurate spatial data.
- Proposed system is tested with Usability test scenarios.

- Refining the system and increasing SUS score.
- Updating the system according to participant suggestions.
- Conducting real world tests to assess system effects in real FM work flows.
- Analyzing improvements for different FM operation flows.

Thank you for your attention.

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