

AI Champions Bootcamp Agent-based Analyser for Technical and Regulatory Requirements Checks

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Adapted From **Data Literacy ePrimer – Module 5**





Agent-based Analyser for Technical and Regulatory Requirements Checks

prepared by PONG Woon Wei, SM/BCA (Lead)

Problem Statement: The Problem



The construction industry still relies heavily on manual checks to verify design intent and technical drawings against building specifications and regulatory requirements (e.g., BCA, SCDF, etc.).

Stakeholders with diverse backgrounds and expertise often struggle to navigate the complex tools and requirements needed for these checks.

With hundreds of projects initiated annually, these inefficiencies compound, leading to time-consuming processes and impacting manpower allocation.

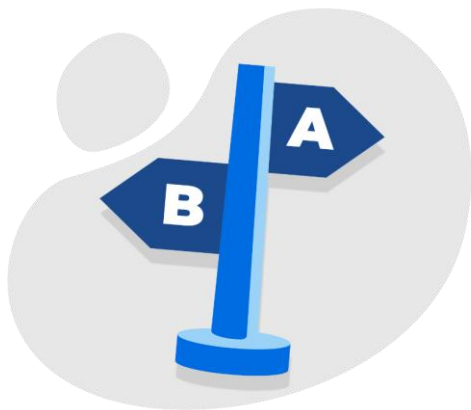
The key question is:

How can we simplify and automate repetitive checks, reduce non-compliance risks, and improve workflows to ease the work burden on project stakeholders?



<https://launchpad.gov.sg/ideathon/8adea89f-b8bd-4015-b9b8-4ed956b7a60a/ideas/58549471-d222-41a5-aef4-ba2cd0d837d5>

Proposed Solution



The proposed solution converts user-provided project data and requirements (e.g., technical drawings, building specifications, standards, and regulations) into an accessible tabulated structure, covering five key areas:

1. Intent: Extract measurable figures from technical drawings, documents, etc.
2. Requirements: Extract measurable figures from regulatory requirements
3. Checks: Compare design intent against requirements for non-compliances.
4. Recommend: Provide suggestions based on the most stringent requirements.
5. Validate: Cross-check online data for common practices and requirements.

This enables non-technical stakeholders to easily analyze and ensure project conformance. The system automates data processing and validation using Python packages, Google Gemini LLM models as AI agents assigned to tasks like extracting, parsing, comparing user-provided information, and cross-reference design intent with regulatory requirements, generate reports, validate using available online data resources, and respond to natural language queries to recommend the most stringent design criteria.

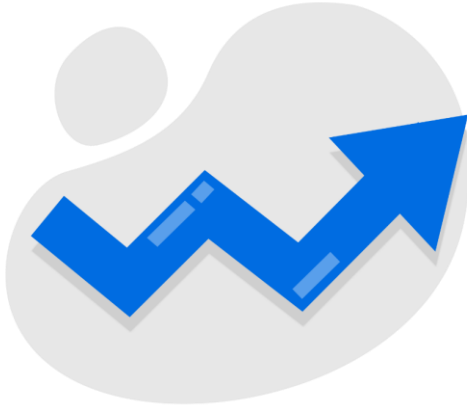
A Proof of Concept (PoC) will demonstrate the solution's feasibility using a common component, such as windows and/or doors, scalable to other components.

<https://launchpad.gov.sg/ideathon/8adea89f-b8bd-4015-b9b8-4ed956b7a60a/ideas/58549471-d222-41a5-aef4-ba2cd0d837d5>

Impact

This solution will streamline repetitive checks, reduce reliance on complex tools and manual processes, and mitigate non-compliance risks for project stakeholders.

With over 12,000 projects' submissions expected annually, automating design and regulatory compliance checks will significantly enhance efficiency and accuracy for regulatory bodies and industry practitioners.



<https://launchpad.gov.sg/ideathon/8adea89f-b8bd-4015-b9b8-4ed956b7a60a/ideas/58549471-d222-41a5-aef4-ba2cd0d837d5>

Stakeholders & Users

Industry practitioners, including Qualified Persons (QPs), main contractors, suppliers, specialists, and public agency officers, will benefit from automated analysis, checks, and increased productivity in ensuring design requirements and regulatory compliance.



<https://launchpad.gov.sg/ideathon/8adea89f-b8bd-4015-b9b8-4ed956b7a60a/ideas/58549471-d222-41a5-aef4-ba2cd0d837d5>

Available Data and Samples

The project is using publicly available regulatory requirements, such as BCA approved documents and the SCDF Fire Code 2023, specifically focusing on Chapter 4 fire safety requirements for access openings.

These standards are essential for ensuring compliance needs for all building projects.

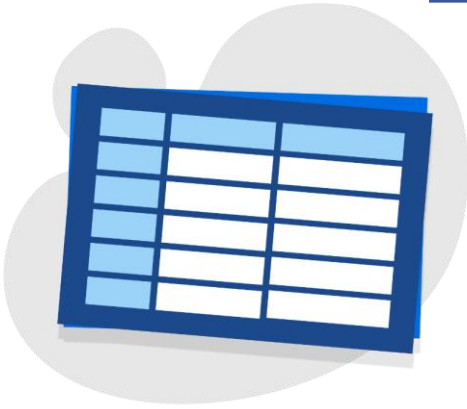
To better scope down the workload, the project is using a window schedule, captured as jpeg and used as practical data samples.

These sources provide a foundation for testing the automated parsing and compliance-checking capabilities of the system, helping users validate their building designs against recognized regulatory requirements efficiently.



<https://launchpad.gov.sg/ideathon/8adea89f-b8bd-4015-b9b8-4ed956b7a60a/ideas/58549471-d222-41a5-aef4-ba2cd0d837d5>

Data Classification



Officially (Open) / non-sensitive

<https://launchpad.gov.sg/ideathon/8adea89f-b8bd-4015-b9b8-4ed956b7a60a/ideas/58549471-d222-41a5-aef4-ba2cd0d837d5>

Lines Of Inquiry



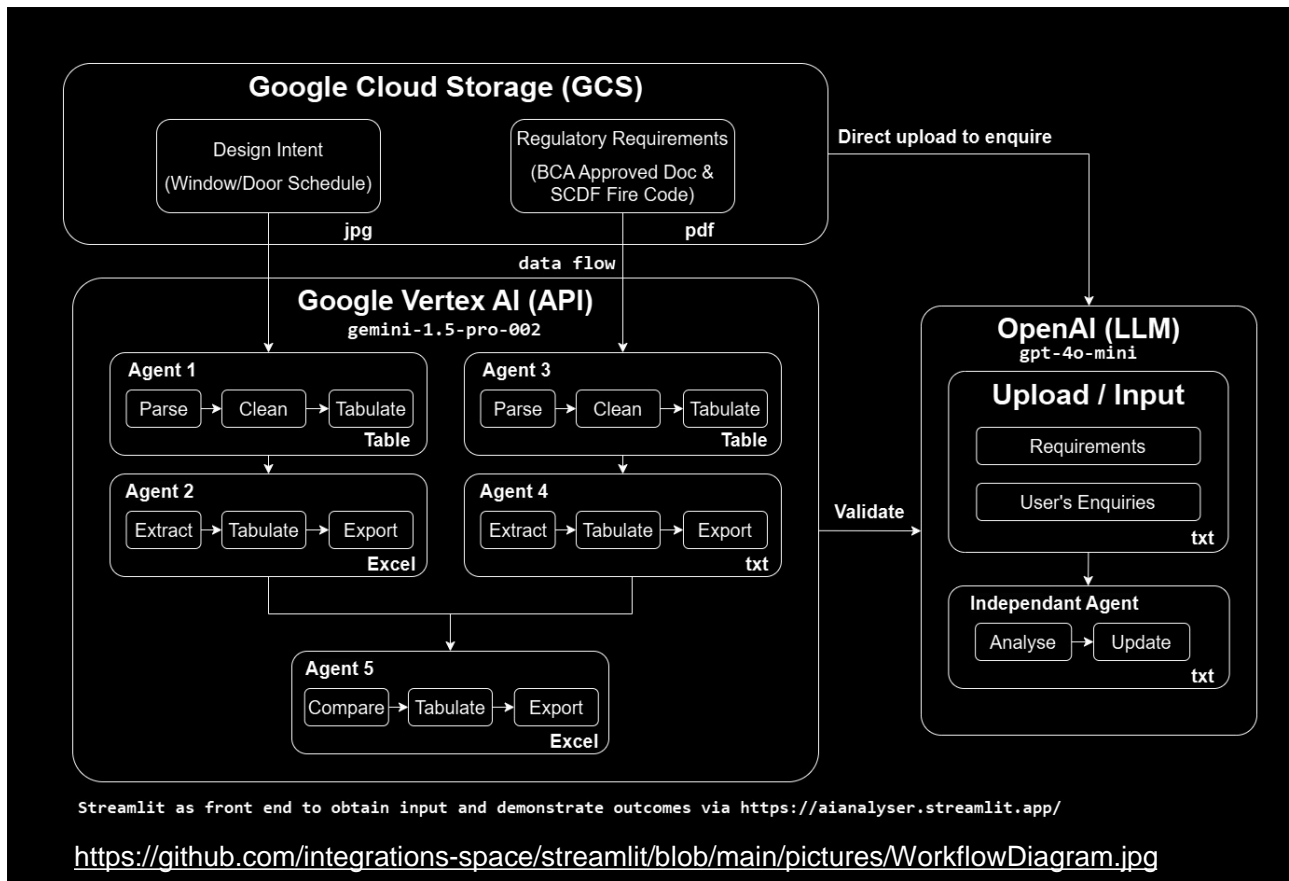
Hypotheses and Assumptions

1. **AI Feasibility:** The current AI models trained is able to extract, parse, clean and structure the data from PDF and image files.
2. **Compliance Automation:** With multi-AI agents' engagement, the process can be effectively streamlined on data processing for non-compliances checks.

Validation Approach

1. **Testing & Comparison:** Using a third party AI Agent of different model to compare AI-extracted data and recommendations, and having manual checks for accuracy.
2. **User Study & Scalability:** Through completed AI Hackathons with trade association chambers, and key vendors e.g. SIA/YAL and Google TrailBlazer programme, we have gained better understanding of the users' problem statements and needs for potential AI Agentic workflow and automated solutions to be scaled.

Methodology (Workflow Diagram)



Mock Up

<https://aianalyser.streamlit.app/>

Browser address bar: aianalyser.streamlit.app

Browser tabs: Imported From IE, Bookmarks, Gmail, YouTube, Maps, <https://blog.csdn.ne...>, Geniebook, Ready to Ship, Adobe Acrobat, All Bookma

Left Sidebar:

- <
- app
- about
- documentation
- methodology
- Authentication Required

Main Content Area:

Share ☆ ✎ ↻ ⋮

Username

Password

Login

Username: ants Password: abc2024

Mock Up

<https://aianalyser.streamlit.app/>

Agent-based Analyser for Technical and Regulatory Requirements Checks

Design Intent - Parse, Calculate & Tabulate

Click the button to allow:

1. AI Agent 1 to parse the provided window schedule drawing (in jpeg), and calculate the maximum room area using the predefined 10% ventilation requirement.
2. AI Agent 2 to clean, tabulate and save as Excel output for the next AI Agent to check.

Run Design Intent Parsing Script

Mock Up

<https://aianalyser.streamlit.app/>

Requirements - Parse & Compare

Click the button to allow:

1. Agent 3 to analyze compliance-related requirements with the provided PDF documents from Google Cloud Storage.
2. Agent 4 to extract and summarize key information from regulatory documents, providing structured analysis on specific requirements.

Run Requirements Parsing Script

Mock Up

<https://aianalyser.streamlit.app/>

Output - Checks and Recommend

Click the button to allow:

1. Agent 5 to use the provided window schedule as design requirements to check against regulatory requirements and provide recommendations for compliance.
2. BCA Approved Doc & SCDF Chapter 4 are provided as default requirements for the checks and recommendations.

Run Compliance Check Script

Mock Up

<https://aianalyser.streamlit.app/>

Validation - explore the use of GPT-4o-Mini Text File Parsing for topic-focused requirements

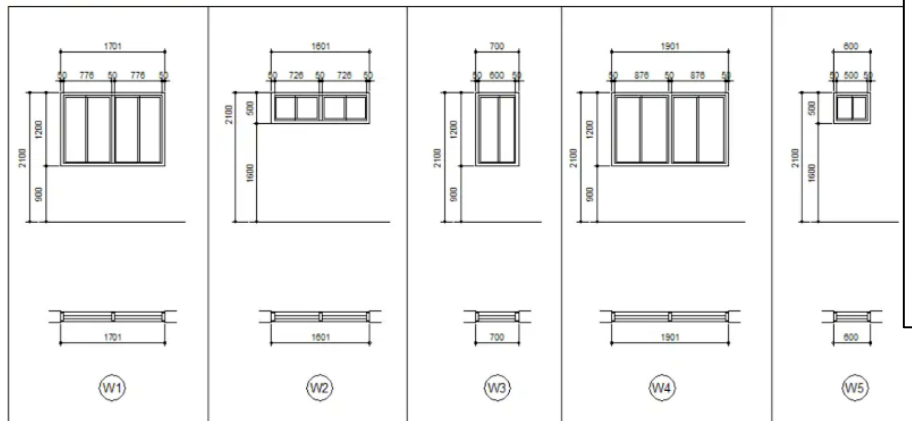
Click the link below to open the GPT-4o-Mini application for text file parsing in a new tab.

Open GPT-4o-Mini Text File Parser

Sample Data: Intent & Requirements (jpg & pdf)

Sample Data

WINDOW SCHEDULE



Use of non-sensitive datasets
such as
Window Schedule captured online,
BCA Approved Document
SCDF Fire Code 2023 Chapter 4

Building and Construction Authority

APPROVED DOCUMENT

ACCEPTABLE SOLUTIONS

CHAPTER 4

4.1 GENERAL

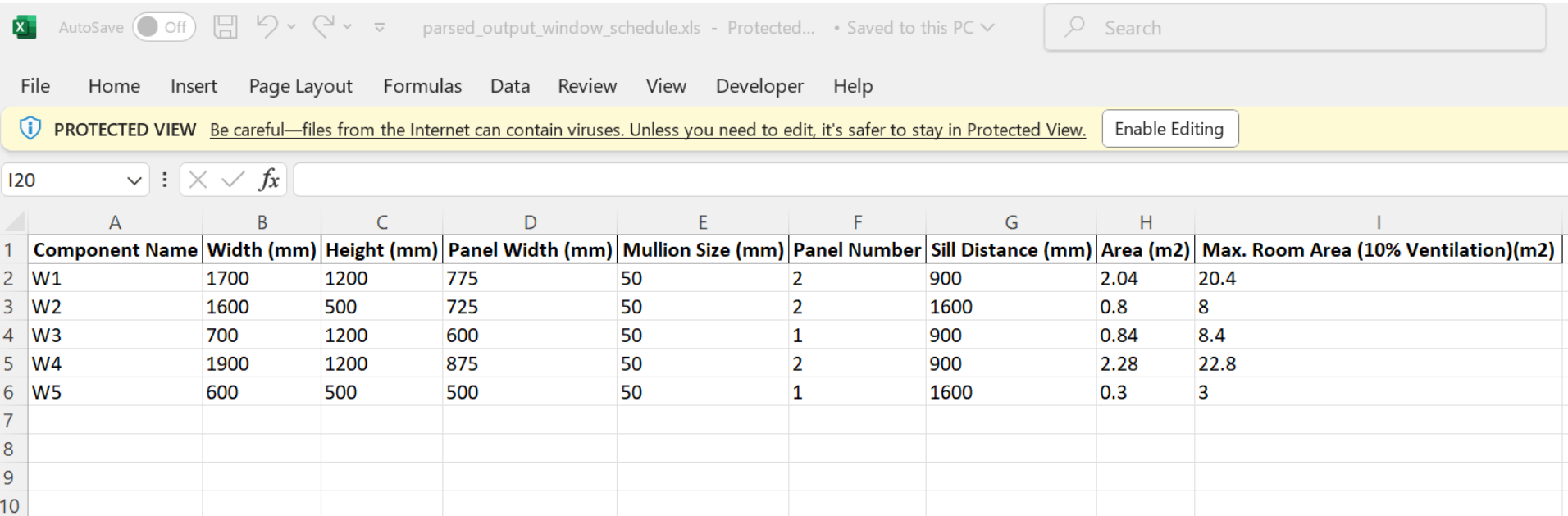
4.1.1 General

The purpose of this Chapter of the Code is to make provision for space around buildings to enable effective mounting of rescue and external fire fighting operations.

EXPLANATIONS & ILLUSTRATIONS

No illustration.

Output: Tabulated Measurable Data (xls)



The screenshot shows a Microsoft Excel spreadsheet titled "parsed_output_window_schedule.xls - Protected...". The spreadsheet is in Protected View mode, with a yellow warning bar at the top stating "Be careful—files from the Internet can contain viruses. Unless you need to edit, it's safer to stay in Protected View." and an "Enable Editing" button. The ribbon at the top includes tabs for File, Home, Insert, Page Layout, Formulas, Data, Review, View, Developer, and Help. The formula bar shows "120" and a function icon. The data table has 9 columns: Component Name, Width (mm), Height (mm), Panel Width (mm), Mullion Size (mm), Panel Number, Sill Distance (mm), Area (m2), and Max. Room Area (10% Ventilation)(m2). The table contains 5 rows of data (W1 to W5) and 5 empty rows (7 to 10).

	A	B	C	D	E	F	G	H	I
1	Component Name	Width (mm)	Height (mm)	Panel Width (mm)	Mullion Size (mm)	Panel Number	Sill Distance (mm)	Area (m2)	Max. Room Area (10% Ventilation)(m2)
2	W1	1700	1200	775	50	2	900	2.04	20.4
3	W2	1600	500	725	50	2	1600	0.8	8
4	W3	700	1200	600	50	1	900	0.84	8.4
5	W4	1900	1200	875	50	2	900	2.28	22.8
6	W5	600	500	500	50	1	1600	0.3	3
7									
8									
9									
10									

https://storage.cloud.google.com/data_parsing/parsed_output/window_schedule.xls

Output: Parsed Requirements (txt)

```

# Window Requirements Comparison and Compliance Check

This document compares the stringent window requirements from Approved Document V7.03 and SCDF Chapter 4 with the data from 'parsed_output/window_schedule.xls' (assuming this file contains details of all windows in the building, including dimensions, type, location, and intended use). It highlights potential non-compliances and areas needing further investigation.

## 1. Most Stringent Requirements

```

Feature	V7.03	SCDF Chapter 4
Ventilation	5% of floor area openable, specific calculations for different window types	High-level vents for ceilings > 10m (in addition to access openings)
FAP Dimensions	N/A	850mm x 1800mm min, sill \leq 1100mm, head \leq 1800mm
FAP Placement	N/A	Max 20m spacing, facing accessway, not in specific areas (plant rooms, etc.)
Safety/Security	Fall prevention, glass at height requirements, SSG specifications	Unobstructed, readily openable from inside and out, breakable glazing for FAPs
Energy Efficiency	Air leakage rates for air-conditioned buildings, RETV/ETTV requirements	N/A

```

## 2. Potential Non-Compliances

This section requires cross-referencing the 'window_schedule.xls' data with the requirements above. Here's a structured approach to identifying potential issues:

**Ventilation (V7.03):**
* Calculate total openable window area from 'window_schedule.xls'. Compare with 5% of the floor area.
* Verify if effective open area calculations for different window types in 'window_schedule.xls' match V7.03 specifications.
* Check if windows open to approved locations (exterior, airwell, or recess) as per 'window_schedule.xls' and V7.03.

**FAP Compliance (SCDF):**
* Identify windows designated as FAPs in 'window_schedule.xls'.
* Verify dimensions (width, height, sill height, head height) against SCDF requirements.
* Check spacing, location, and accessway compliance based on building plans and 'window_schedule.xls' data.
* Confirm unobstructed opening and breakable glazing for FAPs. Check sunshading compliance.

**Safety/Security (V7.03 & SCDF):**
* For windows at height  $\leq$  2.4m, verify compliance with glass type and protective measures according to 'window_schedule.xls' and V7.03.
* Check SSG systems for compliance with retaining device and support requirements.

**Energy Efficiency (V7.03):**
* For air-conditioned buildings, verify air leakage rates of windows listed in 'window_schedule.xls' against SS 212.
* Check RETV/ETTV compliance based on building type and size.

**Example Non-Compliance Entry (based on hypothetical data):**

**Issue:** Insufficient openable window area in Bedroom 2.
**Requirement:** V7.03 - 5% of floor area.
**Finding:** 'window_schedule.xls' shows only 3% openable area based on window dimensions.
**Impact:** Inadequate natural ventilation.
**Recommendation:** Increase window size or add additional openable windows.

## 3. Areas Requiring Further Investigation

**Complex Window Types:** If 'window_schedule.xls' includes unusual or custom window designs, further investigation may be needed to confirm compliance with both ventilation and safety requirements.
**Interface Details:** How window frames integrate with the wall assembly requires detailed review for air leakage and thermal performance (V7.03).
**Accessibility:** While not directly addressed in the window requirements, ensure operable window hardware is accessible as per Code on Accessibility in the Built Environment.
**Firefighter Access Path:** Verify clear access path to FAPs considering potential obstructions (landscaping, security features).

## 4. Recommendations for Compliance

This section will be populated based on the findings in section 2. General recommendations include:

```

https://storage.cloud.google.com/data_parsing/parsed_output/Requirements.txt

Output: Highlighted non-compliances concerns (xls)

https://storage.cloud.google.com/data_parsing/parsed_output/check_1.xlsx

File Home Insert Page Layout Formulas Data Review View Developer Help			
<div> <div>Clipboard</div> <div>Font</div> <div>Alignment</div> <div>Number</div> <div>Conditional Formatting</div> <div>Format as Table</div> <div>Styles</div> <div>Cells</div> </div>			
B8			
Item	Design Intent Details	BCA Non-compliances	SCDF Non-compliances
1 Window Ventilation	Not specified in the provided design intent. Requires checking 'window_schedule.xls' for openable area calculations and window types.	[{'Requirement': 'V7.03 - 5% of floor area openable.', 'Potential Issue': 'Potential insufficient openable window area. Needs comparison with 'window_schedule.xls' data for total openable area vs. floor area.', 'Impact': 'Inadequate natural ventilation may impact indoor air quality and thermal comfort.', 'Recommendation': 'Verify compliance using the provided method. Increase window sizes or add openable windows if needed.'}, {'Requirement': 'V7.03 - Effective open area calculations specific to window types.', 'Potential Issue': 'Effective open area not calculated correctly for various window types in 'window_schedule.xls'.', 'Impact': 'Overestimation of ventilation capacity.', 'Recommendation': 'Cross-check 'window_schedule.xls' against V7.03 for accurate calculations.'}]	N/A for general ventilation in the provided requirements. High-level vents are separate.
2 Fire Access Panel (FAP) Windows	Not specified if any windows are designated as FAPs. Need to review 'window_schedule.xls'.	[]	[{'Requirement': 'SCDF Chapter 4 - Dimensions (850mm x 1000mm min, sill ≤ 1100mm, head ≥ 1800mm)', 'Potential Issue': 'Dimensions of FAPs (if any) not compliant.', 'Impact': 'Restricted access for firefighters.', 'Recommendation': 'Verify FAP dimensions in 'window_schedule.xls' against SCDF requirements.'}, {'Requirement': 'SCDF Chapter 4 - Placement (Max 20m spacing, facing accessway, unobstructed)', 'Potential Issue': 'Incorrect spacing, location, or obstructions near FAPs.', 'Impact': 'Delayed emergency response.', 'Recommendation': 'Check 'window_schedule.xls' and building plans for FAP placement and obstructions.'}, {'Requirement': 'SCDF Chapter 4 - Breakable glazing & readily openable', 'Potential Issue': 'FAPs with non-breakable glazing or difficult opening mechanisms.', 'Impact': 'Hinders firefighter access and rescue operations.', 'Recommendation': 'Confirm glazing type and opening mechanism for FAPs in 'window_schedule.xls'.'}, {'Requirement': 'SCDF Chapter 4 - Sunshading Obstructions', 'Potential Issue': 'External sunshading devices blocking FAP access.', 'Impact': 'Hinders firefighter access and rescue operations.', 'Recommendation': 'Ensure sunshading elements do not obstruct FAP operation.'}]
3 Window Safety and Security	Not specified. Review 'window_schedule.xls' for glass types and safety features.	[{'Requirement': 'V7.03 - Glass at height requirements (≥ 2.4m)', 'Potential Issue': 'Incorrect glass type used at height.', 'Impact': 'Risk of falling glass and injury.', 'Recommendation': 'Verify glass specifications in 'window_schedule.xls' for compliance with V7.03.'}, {'Requirement': 'V7.03 - SSG system compliance.', 'Potential Issue': 'Structural sealant glazing (SSG) systems lack proper retaining devices or support.', 'Impact': 'Risk of system failure and glass falling.', 'Recommendation': 'Verify SSG details against V7.03 for compliance.'}]	[]
4 Window Energy Efficiency	Not specified. Check 'window_schedule.xls' for air leakage rates and RETV/ETTV values.	[{'Requirement': 'V7.03 - Air leakage rates for air-conditioned buildings (S5 212)', 'Potential Issue': 'High air leakage rates exceeding permitted limits.', 'Impact': 'Increased energy consumption for air conditioning.', 'Recommendation': 'Compare air leakage rates in 'window_schedule.xls' against S5 212 requirements.'}, {'Requirement': 'V7.03 - RETV/ETTV compliance.', 'Potential Issue': 'RETV/ETTV values not compliant with building type and size requirements.', 'Impact': 'Increased solar heat gain and reduced energy efficiency.', 'Recommendation': 'Check RETV/ETTV values against V7.03 and ensure compliance.'}]	[]
5			

Output: Validations (Independent Agent)

<https://bca-project.streamlit.app/>

☐ About ☐ Enquire ☒ Require ☐ Agent ☐ Ack

■ Add New BCA Regulatory Requirements.

Authorised BCA officer can upload new Regulation here– GPT will update its answer!!

Upload a document (.txt or .md)



Drag and drop file here

Limit 200MB per file • TXT, MD

Browse files



regulatory requirements.txt 5.2KB



Will answer only if you add as file ■ .

The key concerns regarding window considerations based on the document can be summarized as follows:

1. Ventilation Compliance:

- **Openable Area:** Ensuring that the total openable window area meets the requirement of 5% of the floor area as stipulated in the Approved Document V7.03.
- **Location of Openable Windows:** Verifying that windows open to approved locations such as the exterior, airwells, or recesses to provide adequate natural ventilation.
- **Effective Open Area Calculations:** Confirming that calculations for different window types align with V7.03 specifications.

2. FAP (Fire Access Panel) Compliance:

- **Dimensions:** Checking that windows designated as FAPs adhere to the minimum requirements specified in SCDF Chapter 4, including width, height, sill height, and head height.
- **Placement and Spacing:** Ensuring proper spacing (maximum 20m) and location of FAPs facing accessways while avoiding prohibited areas like plant rooms.

3. Safety and Security:

- **Glass Specifications:** For windows located at heights $\geq 2.4\text{m}$, confirming that the appropriate glass types and protective measures are in place.
- **SSG (Structural Sealant Glazing) Compliance:** Checking that SSG systems adhere to requirements for retaining devices and support.

4. Energy Efficiency Considerations:

- **Air Leakage Rates:** For air-conditioned buildings, verifying that the air leakage rates of windows comply with SS 212 standards.
- **RET/ETTV Compliance:** Ensuring that the requirements for the Retrofitted Energy Efficiency and Total Thermal Energy Value apply based on the specific building type and size.

5. Need for Further Investigation:

- **Complex Window Designs:** If custom or unusual designs are present, further checks are necessary to ensure compliance with ventilation and safety standards.
- **Integration with Wall Assembly:** Understanding how windows integrate with walls is crucial for assessing air leakage and thermal performance.
- **Accessibility of Operable Hardware:** Ensuring that operable windows can be easily accessed as per code requirements.
- **Firefighter Access Path:** Verifying that there are clear paths to FAPs, free from obstructions, for emergency responders.

6. Recommendations for Compliance:

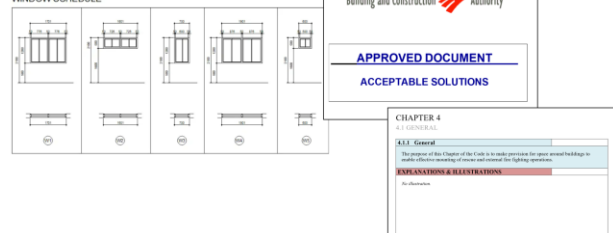
- **Engagement of Specialists:** Consulting professionals such as fire safety engineers and façade consultants for complex concerns.
- **Design Modifications:** Making necessary adjustments to window sizes, types, or placements to ensure compliance.
- **Material and Quality Control:** Selecting proper materials for glazing and framing and ensuring the quality of installation to meet performance standards.
- **Thorough Documentation:** Keeping detailed records of window specifications, calculations, and test results to demonstrate compliance.

Addressing these key areas is crucial to ensure that the window designs and installations meet regulatory requirements and provide safety, comfort, and efficiency for occupants.

What is up?



Sample Data



Data is parsed, cleaned, validated, and exported to Excel using Google Cloud Storage and Vertex AI for easy understanding.

[illegible]

☐ Open ☐ Enquire ☒ Require ☐ Agent ☐ Ack


Add New Regulatory Requirements.

Authorized BSA can update new Regulation here - GPT will update its answer!


Upload a document (txt or xls)

Drop and drag file here
Limit: 200MB per file (10, 100 MB)

Browse Files

 regulatory requirements..._1.xlsx

X

Will answer only if you add it as 

The key concerns regarding window consideration based on the document can be summarized as follows:

- Ventilation Compliance:**
 - Openable Area:** Ensuring that the total openable window area meets the requirement of 5% of the floor area is critical (noted as the Approved Minimum 0.7%).
 - Location of Openable Windows:** Verifying that windows open to approved locations (such as the exterior, awnings, or recesses) to provide adequate natural ventilation.
 - Approved Open Area Calculations:** Confirming that calculations for different window types align with VDI specifications.
- FAP (Fire Access Panel) Compliance:**
 - Dimensioning:** Checking that the total fire access panel opening is at least double to the maximum dimensions specified in BSCE Chapter 4, including width, height, all heights, and head height.
 - Placement and Spacing:** Ensuring proper spacing (minimum 20m) and location of FAPs during construction, while avoiding prohibited areas (plant rooms).

The screenshot shows a web browser window with the URL 'http://localhost:3000/api'. The page has a dark theme. On the left is a sidebar with a 'Logo' placeholder, a 'Home' link, a 'Technology' link, and a 'Authentication Required' section. The main content area is titled 'Agentic-based Analyser for Technical and Regulatory Requirements Checks'. It contains three sections: 1. 'Design Intent - Parse, Calculate & Tabulate' with a sub-header 'Click the button below' and a list of 3 steps: a) Upload the document, b) Agent will parse the document and generate design intent, c) Agent will parse, calculate and add a total value for the design intent to track. 2. 'Requirements - Parse & Compare' with a sub-header 'Click the button below' and a list of 3 steps: a) Agent will upload compliance-related requirements with the provided PDF documents from Google Cloud Storage, b) Agents will parse and calculate the difference from regulatory documents, providing detailed analysis on specific requirements, c) Get Requirements Report. 3. 'Output - Checks and Recommendation' with a sub-header 'Click the button below' and a list of 3 steps: a) Agent will use the provided analysis to check if design requirements to check against regulatory requirements, and provide recommendations for compliance, b) ACP Agent will output Report in the format as defined requirements for the checks and recommendations, c) Download Report. At the bottom, there are three sections: 'Validation - explore the use of GPT-4o-Mini Text File Parsing for topic-focused requirements' with a sub-header 'Click the link below to learn the details for the report for the use of GPT-4o-Mini Text File Parsing', 'Presentation Slides' with a sub-header 'Click the link below to learn the presentation slides for the project', and a 'Presentation Video' link.

aianalyser.streamlit.app/

Using Streamlit & GitHub for web building and deployment.

Learning Points (from Obstacles)



Functionality & User Experience:

- Use different AI models to replace functional building tasks (Limited know-how)
- Adopt a "learning while doing" approach due to time constraints (Limited time)

Technical Implementation:

- Utilize AI and programming to accelerate software learning (Difficult tools)
- Apply prompt engineering techniques to achieve effective outcomes, addressing AI hallucination risks (AI hallucination)

Innovation:

- Implement AI-driven workflows to streamline programming processes (Complex workflow)
- Automate practical processes with an interactive LLM approach (Manual processes)

Documentation:

- Prioritize documentation for learning and relearning, tackling short memory limitations (Short memory)
- Promote information sharing to support teamwork and avoid isolated work (Work-in-silos)

The background of the slide is a vibrant blue with a complex, abstract pattern. It features a network of thin white lines connecting small white dots, creating a sense of connectivity and data flow. The pattern is layered, with some areas appearing more prominent than others, giving it a three-dimensional feel. The overall aesthetic is modern and technological.

Thank you