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Software Development

Group Project

Project Proposal

Group CS-152

	Full Name	UoW Number	IIT ID Number	Tutorial Group
1.	Mihara Perera	w2051956	20231734	CS - 02
2.	Maariya Marzook	w2083148	20230906	CS - 02
3.	Sanali Lokuge	w2051958	20231748	CS - 05
4.	Raahim Aslam	w2051927	20231463	CS - 05
5.	Shahnaz Fassy	w2084744	20233164	CS - 17
6.	Neovin Peiris	w2052979	20222077	CS - 08

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1.0 Problem

1.1 Introduction to the Problem

Land evaluation and construction planning requires referencing numerous government imposed laws and regulations. Such regulations are specialized for numerous scenarios and therefore manual sorting and referencing is both a tedious and impractical task. This in turn increases the likelihood of property and construction plans getting rejected when applied for government approval.

1.1.1 Problem Background and Statistics

A land feasibility study is vital before investing in a land or starting a construction. Insufficient knowledge regarding relevant land regulations, conservation acts, specialized zonal regulations, potential environmental risks and impacts (Landslides, air quality) and other important factors lead to numerous issues when either applying for approval for constructions or during government on-site regulation checks. Being unaware of whether a construction is viable on a specific land, and if the construction meets all required regulations, till only after purchases have been made and resource investments have been done, has been a prevalent issue in the building and construction industry for over several years.

A survey conducted by KPMG Global Construction highlights that 23% of the projects underperformed, and only 31% of the projects remained within their budget. An application where a land buyer or designer can evaluate the land and perform a feasibility study could have made the investor aware of the viability of their project beforehand so they can take actions before the construction is done.
https://kpmg.com/ie/en/home/insights/2023/06/global-construction-survey-deal-adv.html\

U.S. Bureau of Land Management data shows that non-compliance with building regulations results in over $5 billion annually in fines, penalties, and rework. Land buyers, developers and designers are unaware of the regulations specific to their land until the project is submitted for approval or until the construction is done. This may lead to the entire project being rejected or people continuing with the constructions via illegal methods.
https://reyabogado.com/us/what-happens-if-building-regulations-are-not-met/?

1.1.2 Example Scenarios of the Problem

I. For Land Buyers / Clients / Developers:

A person wants land for a commercial construction. He chooses a land where the general regulations abide by for his project. After investing in it and finally submitting the project for approval, the commercial regulations don't abide by his project. Then the whole proposal is rejected and he is unable to continue on the project. Then he might tend to get approval illegally for the same project as another type of construction. After receiving approval he'll construct the commercial building he intended to build before and this will raise many issues after the construction is done.

> Eg: A client wants to construct a press on Ratmalana, he buys land that abides by the construction rules. After getting approval and completing the project, the type of construction becomes an issue because of the chemical and sound impact of it. After investing so much on the project, he will have to give up.

II. For Designers / Architects / Planners:

An architect initiates the design development phase after visiting the site and considering the general regulations that relate to construction. Once the design is completed and submitted for the approval process, the project might not abide by the specialized parameters. Then the architect has to initiate the drawing process again as he was unaware of those regulations before. It is not time-efficient to repeat the same planning process again.

> Eg: If an architect plans a construction design for a coastal area land, then the general regulations say that a plot coverage of 60%(approximately) of the land is allowed for construction, but in specialized regulations it says that a tourism based projects can take only up to 30% of the land.Therefore, the whole construction will have to be redesigned from the beginning.

III. For the Authorities:

When a project is submitted they have to go through all the types of regulations manually and check if the project abides by them. This is time consuming and a repetitive process for each project. Also it is complicated because once the project is rejected, the same process will happen again for the updated submission. They are unable to give the complete feedback real-time regarding all the processes. Reason is as there are many regulation categories that are connected

to other authorities, though one parameter is accepted in one authority but others will not accept it.

1.1.3 Attempted Solutions of the Competitors

While there are no direct competitors having all the features of our application, there are several websites and applications that provide partial solutions to the problem at hand.

Given below is a table comparing the existing solutions of potential competitors and the features that we intend to incorporate in our application.

Website/Application	Available Features	Features that can be added
Realtor.com https://www.realtor.com/	Provides flood and wildfire risk data based on factors like vegetation and property vulnerability.	Include an in depth, location based topographical analysis using satellite data and extending the risk mapping.
FLoodSmart https://www.floodsmart.com/ ArcGIS https://www.arcgis.com/index.html	Provides flood and landslide risk assessments, and recommendations for risk mitigation.	
LandInsight https://www.landinsight.co/	Provides data for property evaluation and real-time insights on land and housing values. Can overlay geographic data for risk assessment.	Integrate regulatory data based on government requirements and regulations and filtering it to what is relevant for a particular construction project. Providing a custom report based on the exact location.
LandVision https://www.landvision.in/	Provides demographic, environmental, and regulatory data specific to land development.	Provide a specific area-based environmental risk report.

Moreover, the above mentioned applications and websites are primarily used in particular countries like the United States or the United Kingdom and consist of the regulations applicable to those regions only. Their datasets are region specific and cannot be used globally, or for Sri Lanka, unless custom data is integrated into them.

2.0 Proposed Solution

An application that assists users in making informed property purchases and construction plans by providing them with filtered regulation reports specific to the users requirements. Additionally, provides the users with valuable statistics and insights on potential environmental and geographical risks. The application will aim to address the difficulties users and the related parties face in navigating the vast number of regulations and factors that need to be considered for property plans, land purchases and building/construction proposals, as well as minimize the possible complications and losses incurred by the current lack thereof of convenient and simplified access to such crucial information.

3.0 Target Audience

I. People Who want to buy Land/Properties:

This app can provide essential details about property attributes, pros and cons, environmental and regulatory data, and potential uses. This data helps buyers make informed decisions by comparing plots, reviewing market trends, and assessing factors like access, infrastructure, and proximity to amenities.

II. Architects:

1. Site Assessment and Compliance
    - Architects need to assess sites for compliance with:
        - zoning laws
        - building codes
        - environmental regulations.

2. Feasibility Analysis
    - The app can assist architects in evaluating the feasibility of projects by providing information on permissible uses, restrictions, and building heights for specific areas. This ensures project proposals are viable and meet regulatory standards, which reduces redesigns due to non-compliance.

3. Updated Regulations

- With frequent updates from government documents, architects receive real-time insights into changing policies, reducing the risk of non-compliance due to outdated information.

4. Documentation and Reporting
    - Architects can access detailed regulatory information to back up design decisions or provide reports to clients and city planners, which facilitates smoother project approvals and client transparency.

III. Real Estate Enthusiasts:

Enthusiasts interested in tracking property values and trends can use the app to stay updated on new listings, zoning changes and potential growth or risks in specific areas.

IV. Researchers:

Researchers in urban planning, environmental science, and social policy can analyze data on property use, zoning patterns, and land suitability.

V. Lawyers/Legal Advisors:

1. Resource for Legal Guidance:
    - Client Consultations: Lawyers can use the app to assist clients in understanding the implications of land use and potential legal risks associated with specific land ownership or usage. This can be particularly helpful in cases involving disputes over property boundaries, land use, or environmental regulations.

4.0 Features of the Solution

I. Filtered Regulations Report

Feature Description: When the user enters the location of the property, the app accesses a database and provides the user with a report containing only the laws and regulations that need to be considered for that specific property.

Purpose: The main target of our application is to address the knowledge gap of our target audience and make construction laws and regulations easily and conveniently accessible to them. Therefore, the first priority feature of our application will be to provide the user with such a filtered report of all available construction and property laws that are applicable to the users' property or construction in particular. This feature simplifies the process of researching regulations, allowing users to easily access the information they need to navigate local requirements.

II. Risk Awareness Report

Feature Description: When the user enters the location of the property, satellite mapping is used to survey the surrounding terrain of the property and determine potential risks from surrounding topography. (eg: risk of landslides, etc)

Purpose: While legal complications of unknowingly violating construction laws would be our audience's main challenge, we identified that prior knowledge and awareness of possible geographical and environmental risks that they may face following the purchase of a property or completion of a construction, would save them from suffering from the losses of unforeseen environmental threats that come after constructions are completed. By presenting this information, the Risk Awareness Report enables users to make decisions about their land development projects, minimizing risks and enhancing safety measures.

III. Property Plan Annotation

Feature Description: When the user provides a property plan, an algorithm analyzes the document, and marks and annotates the exact positions of the construction plan that are in violation with existing construction regulations, as well as provides suggestions for the optimal placement of features such as drainage systems and blind walls.

Purpose: Clients or architects, who may have already completed the stage of drawing a construction plan or proposal, would benefit from a technology that can instantly analyze and point out any errors in the document, instead of reading through all the regulations which should have been considered for the particular construction. Furthermore, this feature increases the property's functionality, while also encouraging environmentally friendly and efficient design methods.

5.0 Resource Requirements

5.1 Technology Stacks & Software Requirements

I. Software and Technologies Needed for Filtering Regulation Reports

A pre-trained machine learning model may be used for the purpose of filtering regulation reports. These models are trained on a large dataset and can be used as a starting point for developing other models.

In order to ensure this feature works as intended, the following technology stacks are required for each given process:

1. .Text Extraction
    - Libraries such as PyMuPDF or PDFPlumber are capable of extracting structured text by recognizing paragraphs, tables,headers, etc.
    - Natural Language Processing (NLP) libraries like spaCy or NLTK can be used to detect and segment sections based on linguistic patterns. They can be used to support the identification of sentence boundaries, paragraphs, and common legal language patterns and extract specific information based on keywords or topics from the documents containing regulation information.
    - Automated labeling with heuristics are useful to create rules to label these sections automatically if certain sections consistently contain keywords such as ‘regulations’ or ‘zoning’.

2. Key Information Extraction for Database creation
    - Named Entity Recognition (NER) can be used in the identification of key terms of phrases such as regions or regulatory types.

3. Image Processing
    - Models such as ResNet are pre-trained on massive image datasets and may be used for object detection, image classification and segmentation..

II. Softwares and Technologies Needed for Risk Report Generation

A combination of satellite mapping technologies for surrounding terrain and topography analysis, computer vision to map and compare satellite report/imagery with available diagrams and maps of potential risk areas are necessary for the risk report generating feature the project aims to implement.

The following technology stacks may be used to overlay landslide risks data with the use of computer vision and various other techniques:

1. Public APIs or Data Layers in NBRO (National Building Research Organization)
    - If there are public APIs (GeoJSON or shape files) in the NBRO website, where we can access the data of landslide risk areas, computer vision image processing will not be necessary.
      Note: GeoJSON is a format used to represent geographic data in a way that computers can easily read and understand. In GeoJSON, various shapes and locations on a map may be described and each shape has coordinates that indicate where it is located. It is commonly used in web mapping applications because it works well with modern web technologies.
    - The currently existing geo-spatial database provided by NBRO: https://nbro.gov.lk/index.php?option=com_content&view=article&id=531&Itemid=515&lang=en#spatial-databases

2. Computer Vision Processing
    - Libraries such as Selenium for Python and Puppeteer for JavaScript can be used to capture screenshots of the map regularly or when a user inputs the location.
    - To facilitate the use of computer vision in this feature, the screenshotted map images will be used to analyze map features and identify risk zones.
      Note: Computer vision and other image processing libraries are limited to analyzing static images and videos, rather than dynamic or interactive images or maps. Therefore, it is essential to use the mentioned libraries.
    - Geographic Information System (GIS) libraries like GeoPandas (for geospatial analysis), Rasterio (to read and write geospatial raster data and handle satellite imagery or scanned maps) or PostGIS (to store risk zones as polygon shapes in a spatial database) should be used to work with geospatial data.
    - OpenCV can be used to find pre-trained models. Furthermore, YOLO is a model that may be used for real-time object detection.
    - Faster R-CNN offers high accuracy and Mask R-CNN may be used to identify risk zones.

3. Over Laying in the User Location
    - Geospatial web-based tools such as Leaflet or Mapbox may be used to overlay the land risks on the user's map.
    - QGIS and ArcGIS can visualize these layers directly within these tools. (Link to a map tool using QGIS: https://qgis.org/project/overview/)
    - Google Maps API can be used to retrieve geospatial coordinates when the user inputs the location.
    - Google Maps Polygon API can be used to overlay risk zones if the user's land coordinates match a risk zone

III. Softwares and Technologies Needed for Land/Property Plan Annotation

For this feature, various annotation software and technology stacks as well as a development of an algorithm to determine the parameters and optimal areas of the provided property plan to annotate will be required. Furthermore, text/image reading technology to scan the property plan and convert values to usable data values are required to ensure the feature works as intended.

1. Algorithm Development
    - To ensure compliance with regulations, a Python-based algorithm can be created using libraries like Shapely and Pyproj for spatial geometry processing.
    - This algorithm would compare the 3D property model's dimensions and placements with legal restrictions, such as maximum building heights, and if any part of the model violates the regulations the algorithm should be able to indicate these areas by identifying specific points or regions within the 3D structure.

2. Text/Image Reading Technology
    - This is required for the purpose of reading or scanning the property plan to convert values to usable data values.
    - To capture text-based information such as labels and dimensions from the provided land/property plan, Tesseract OCR can be combined with OpenCV to accurately extract text from an image of the plan.

3. Annotating a Provided Property Plan
    - The use of computer vision pipelines such as MapReader allow retrieving maps via web-servers, the preprocessing and division of them into annotated patches and the creation of structured data about map content. (Link to more information about the MapReader library: https://github.com/maps-as-data/MapReader)

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QGIS Example
https://qgis.org/project/overview/)

MapReader Technology
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