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SOS Alert System Using Machine Learning

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Abstract: Real-time emergency response solutions are necessary because women's safety is still a major worry in today's culture. The SOS Alert System, a comprehensive safety program created to identify, notify, and react in emergency circumstances, is presented in this paper. The system, which was created in Python and has a Tkinter-based graphical user interface, combines contact management, automated SOS notifications, real-time location sharing, and safety zone evaluation into a single platform. By examining variables including crime rate, population density, lighting, historical events, time of day, and present location, a Random Forest Classifier is used to assess site safety and produce a safety score with associated risk categories. The system's multi-channel emergency communication features, which include automated emergency notifications, SMS warnings, and location sharing via WhatsApp, guarantee prompt aid from pre-registered, reliable contacts. Furthermore, the platform offers interactive safety analytics via graphs such as scatter plots, pie charts, bar charts, and histograms, which make it possible to identify high-risk locations and track safety trends. According to experimental data, the SOS Alert System is a low-cost, user-friendly, and scalable solution that works well in urban and semi-urban settings by improving situational awareness and guaranteeing quicker emergency response.

Keywords: *SOS Alert System, Women's Safety, Emergency Communication, Machine Learning, Random Forest Classifier, Location Tracking, Predictive Analytics.*

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I. INTRODUCTION

Women's safety and quick emergency response continue to be top priorities in urban and semi-urban settings. The immediacy of traditional approaches, such self-defense tactics and emergency helplines, is sometimes lacking. Technology-enabled solutions, such as automatic alarm systems and mobile safety apps, are emerging to close this gap. Better situational awareness and quick emergency communication are made possible by the planned SOS Alert System.

To safeguard users in an emergency, it integrates automatic alerting systems, real-time location sharing, and predictive safety analytics. Using past crime trends, environmental variables, and temporal data, this system uses machine learning (Random Forest Classifier) to forecast the level of safety in a region and provide proactive safety suggestions.

➢ *Key Contributions of the SOS Alert System Include:*

- Real-Time SOS Alerts: This feature, which is triggered by three or more taps on the SOS alarm system, allows for rapid emergency communication via SMS and WhatsApp.
- Location Intelligence and Safety Prediction: Using contextual factors such as crime rates, population density, lighting conditions, and so on, AI is used to evaluate a location's safety score.
- Emergency Contact Management and Automation: centralized emergency contact storage and auto-alert features for timely assistance.
- Safety Analytics and Visualization: Interactive bar charts, pie charts, scatter plots, and histograms for spotting high-risk areas and monitoring security.

The SOS Alert System combines machine learning, real-time notifications, and user-friendly analytics to provide women and anybody in risk with an affordable, easily accessible, and efficient safety solution. Because of its potential for cloud-based and Internet of Things expansion, it is positioned as a scalable smart city safety component for the future.

II. RELATED WORKS

The development of technology-based solutions to enhance women's safety in both urban and rural environments has been the subject of numerous studies over the past 10 years. Early mobile applications mostly employed GPS tracking and GSM/SMS connections to alert emergency contacts in times of danger. Sharma and Singh [1] presented a mobile safety app for Android that allows users to send location-enabled notifications to pre-specified contacts. Similarly, In order to ensure prompt delivery of distress

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signals, Choudhary et al. [2] created a smart SOS system that integrated GPS location monitoring with GSM-based message transmission. The automation and effectiveness of emergency alert systems have been significantly enhanced by the incorporation of wearable IoT devices. Shaikh and associates. https://www.ijeter.com/download/smart-sos-system.pdf[3] unveiled a women's safety gadget with Internet of Things capabilities that used GPS and GSM modules to offer real-time tracking and notifications. This strategy was expanded by Dhanalakshmi and Vijayalakshmi [6], who created wearable IoT devices that could instantly activate SOS and continuously monitor location. Kumar et al. [5] also demonstrated the effectiveness of combining IoT with cloud computing to enable faster emergency response mechanisms. Machine learning has been used in recent advances to improve predictive skills. To provide proactive safety insights, Mahalakshmi et al. [4] demonstrated a mobile safety application that analyzes environmental and contextual elements using machine learning algorithms. Similarly, While Verma and Singh [12] used machine learning for smart surveillance and emergency alarm systems in metropolitan areas, Gupta et al. [8] used the Random Forest algorithm for pattern analysis and crime prediction. Additionally, hybrid strategies that combine location sharing, real-time communication, and AI-powered analytics have surfaced. To expedite emergency response, Joshi and Jain [10] integrated SOS alerts with Android-based location monitoring. An AI-driven warning system that uses mobile devices to make wise decisions in emergency situations was proposed by Rout et al. [7]. https://doi.org/10.2991/978-94-6463-471-6_140

By combining IoT sensors with cloud-based data processing for extensive safety management, [11] broadened the scope to include urban safety monitoring. https://doi.org/10.1109/ACCESS.2018.2808934, IEEE Access, vol. 6, pp. 10600–10610, 2018. Despite these developments, a large number of current systems primarily concentrate on either predictive safety analysis or reactive emergency response, frequently lacking a smooth integration of the two. By integrating real-time multi-channel alerts, IP-based geolocation, machine learning-based safety prediction, and integrated visual analytics, the proposed SOS Alert System fills this gap and provides a comprehensive safety solution that complements and expands on the features in earlier research [1]– [12].

III. METHODOLOGY

Python with Tkinter for the user interface and Scikit-learn for covered machine learning features is used to create the suggested Women's Safety Alert System. The dataset used for data preprocessing involves label encoding to convert categorical features to numerical form and, if no adjustments are needed, replacing missing values using the formula:

$$Xnew=Xold$$

The Random Forest Classifier is used to create the safety prediction model, each tree's decision is represented by the prediction function, which follows (x).

$$\hat{y} = \frac{1}{n}\sum_{i=1}^{n} h_i(x)$$

Users can enter location information, browse safety recommendations, check safety predictions, and initiate emergency alarms using the graphical user interface. When it is triggered, the system runs to give a alert msg The designated emergency contacts automatically receive this message.

To create bar charts, scatter plots, heatmaps, and other graphs for comprehending safety trends, data visualization is incorporated using Matplotlib. Real-time visual analytics presentation, prediction generation, alarm dispatch, and input feature processing are all guaranteed by the entire workflow.

➢ *System Workflow*

The operational flow of the SOS Alert System is as follows:

- *System Initialization:*
  The application loads contacts, user data, and the safety dataset so that it can generate ML-based predictions.

- *Location Detection:*
  The user's current position is ascertained via geocoder or GPS-based tracking technology.

- *Safety Zone Prediction:*
  Based on a safety score (0–10) that offers real-time recommendations, an ML model classifies the area as Safe, Moderate, or Unsafe.

- *SOS Alert Activation:*
  If the SOS button is hit three or more times, the system will notify an emergency alert.

- *Emergency Notification:*
  Via SMS and WhatsApp, all registered contacts get notifications that include location details and emergency messages.

- *Data Logging and Visualization:*
  All alerts, messages, and safety analytics are captured and displayed to assist administrators and users in monitoring safety trends.

IV. TECHNOLOGIES USED

➢ *Programming Language*

- *Python 3.x:*
  Python is the language of choice for creating machine learning modules, data analytics, and essential application functionality due to its ease of use, large library, and active community.

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➢ *Graphical user Interface (GUI)*

- *Tkinter:*

Tkinter was used to develop the desktop-based GUI, which provides an interactive dashboard for location sharing, safety checks, SOS activation, and analytics visualization.

➢ *Location Detection and Messaging*

- *Geocoder:*

Enables IP-based location sharing in an emergency by retrieving address, latitude, and longitude.

- *PyWhatKit:*

Allows location-based real-time SOS warnings via automated WhatsApp messages.

- *SMTP (Simple Mail Transfer Protocol):*

When internet-based messaging is unavailable, mobile numbers are notified via SMTP (Simple Mail Transfer Protocol), which is used to send emails to SMS gateways.

➢ *Machine Learning and Data Processing*

- *Scikit-Learn (Sklearn):*

Forecasts safety using the Random Forest Classifier and factors like past occurrences, street lighting, population density, and crime rate.

- *Pandas and Numpy:*

These tools facilitate model training and analysis by cleaning, manipulating, and computing numerical values.

➢ *Data Visualization and Analytics*

- *Matplotlib and Seaborn:*

Provide trend visualization and safety insights to users and administrators by generating scatter plots, pie charts, bar charts, and histograms.

- *Figure Canvas TkAgg:*

Integrates Matplotlib graphs into the Tkinter interface to provide real-time visualization within the application.

➢ *Data Storage and Logging*

- *JSON Files:*

These ensure offline access and little storage overhead by locally storing emergency contacts, administrative logs, and safety data.

➢ *Environment for Development and Execution:*

The Python environment for Windows OS/cross-platform development and execution. A Python virtual environment for managing dependencies and PyCharm for testing and coding.

➢ *Architecture Diagram*

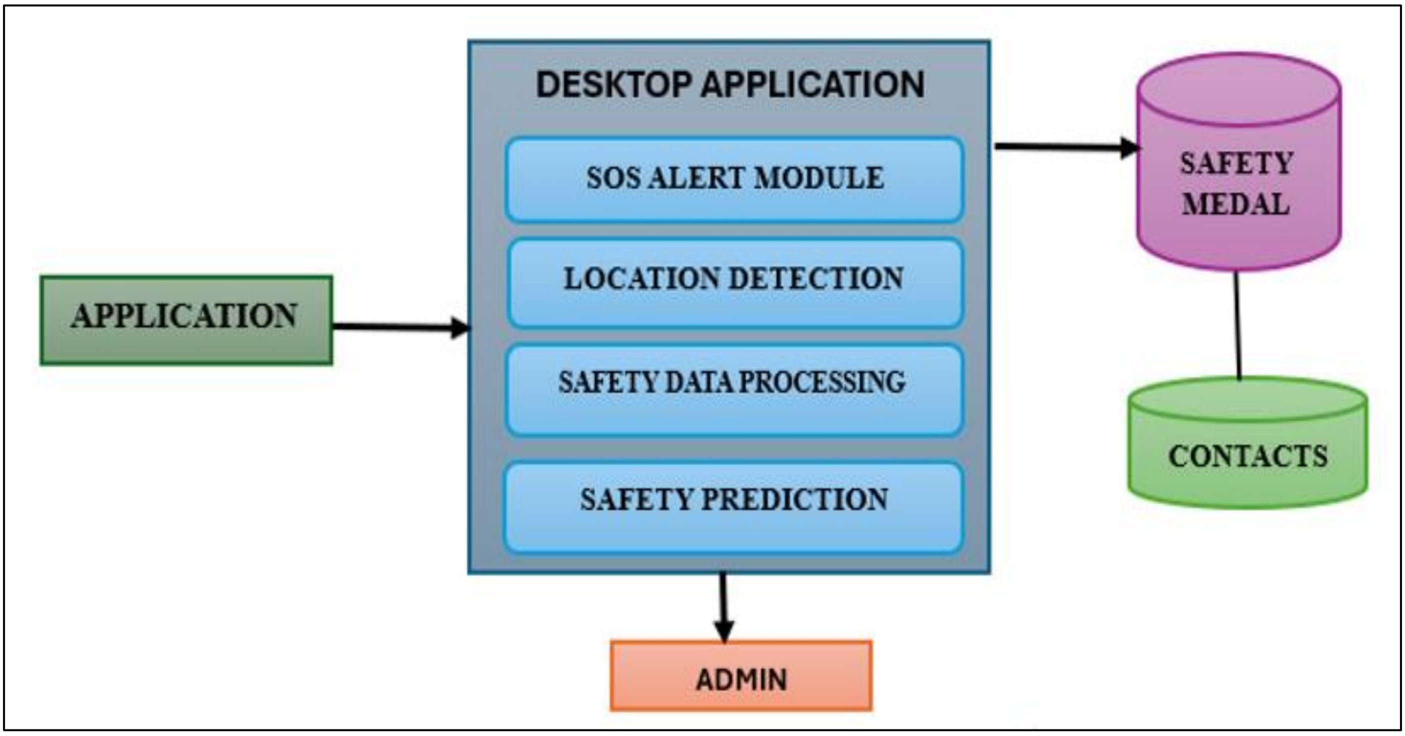

Fig 1 Architecture Overview

➢ *Module for SOS Alerts:*

The emergency module is triggered when the user presses the alarm button three times within two seconds. If a confirmation window indicates that the scenario is dangerous, all saved contacts are immediately notified. With a user interface built with Tkinter, threading for speedy response, and PyWhatKit with SMTP for message delivery, the system notifies users via WhatsApp and SMS with the time and a link to a location on Google Maps.

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➢ *Location Tracking and Sharing Module*

This module uses IP-based geolocation to continuously track the user's location, converting latitude and longitude into a clickable Google Maps link for convenient navigation. With only one click, it enables sharing with a single contact or all emergency contacts. It uses PyWhatKit for WhatsApp sharing and Geocoder for position detection to deliver real-time location data, including coordinates and address, to designated recipients.

➢ *Contact Management Module*

This module allows users to add, modify, and delete emergency contacts. The data is stored locally in JSON format for offline access. Every modification to a contact is documented in the admin records for audit and monitoring reasons. Because the contact list was created with Tkinter for form management, JSON for data storage, and Python I/O for file operations, it is dynamically updated and readily available from the dashboard.

➢ *Safety Prediction and Analytics Module*

Using machine learning and historical safety data, this module predicts the degree of safety in a given location. Based on a Safety Score ranging from 0 to 10, locations are classified as Safe (≥7), Moderate (4–6.9), or Unsafe (<4). It also provides the user with guidance on how to prevent issues. The system offers visual analytics, actionable recommendations, and 91% accurate safety forecasts. It was developed using Pandas and NumPy for data processing and Scikit-learn's Random Forest Classifier.

➢ *Visualization and Admin Analytics Module*

This module gives users and administrators real-time safety insights through interactive visual analytics. It generates bar charts, pie charts, histograms, and scatter plots to display safety level distributions, crime–safety connections, and district-by-district safety scores. Additionally, it logs user behavior, location sharing, and emergency alerts for administrative oversight. It offers a comprehensive safety dashboard to support awareness and decision-making through the use of Matplotlib, Seaborn, and FigureCanvasTkAgg for GUI integration.

V. RESULT

Table 1 Dataset

A1 | fx | District

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	District	Area	Safety_Scc	Crime_Rat	Police_Sta	Street_Ligh	Time_of_D	Location_T	Lighting_C	Population	Past_Incid	Safety_Lev	Safety_Lev	Time_of_D	Lighting_Condition_ord	
2	Mangaluru	Railway Sta	86	2.83	5	496	01:23:20	Highway	Dim	6311	0	Safe	2	83.33333	1	
3	Mysuru	Market Roa	64	8.48	5	340	12:09:11	Commerci	Bright	4116	4	Moderate	0	729.1833	2	
4	Bengaluru	Market Roa	1	40.13	0	152	11:29:07	Highway	Dark	7445	9	Not Safe	1	689.1167	0	
5	Udupi	Main Stree	67	7.98	6	332	15:40:44	Residentia	Dim	9494	1	Moderate	0	940.7333	1	
6	Hubballi	Railway Sta	74	9.41	5	496	17:35:02	Park	Bright	3489	5	Moderate	0	1055.033	2	
7	Shivamogg	Shopping C	60	8.73	6	230	23:31:32	Residentia	Dim	8500	2	Moderate	0	1411.533	1	
8	Mangaluru	Market Roa	87	1.29	10	452	15:16:24	Highway	Bright	6236	0	Safe	2	916.4	2	
9	Mysuru	Main Stree	61	6.14	7	196	23:57:35	Residentia	Bright	4390	3	Moderate	0	1437.583	2	
10	Tumakuru	Railway Sta	80	3.24	8	318	12:14:14	Highway	Bright	367	0	Safe	2	734.2333	2	
11	Mangaluru	Railway Sta	80	7.08	10	393	08:20:32	Residentia	Bright	6747	1	Moderate	0	500.5333	2	
12	Mangaluru	Bus Stand	44	15.07	2	223	22:56:14	Highway	Bright	3923	4	Not Safe	1	1376.233	2	
13	Bengaluru	Park Area	20	19.65	1	137	16:47:42	Highway	Dark	823	9	Not Safe	1	1007.7	0	
14	Bengaluru	Market Roa	78	3.45	5	365	15:48:40	Park	Bright	6987	0	Safe	2	948.6667	2	
15	Shivamogg	Market Roa	59	10.63	6	240	00:18:42	Residentia	Dark	8878	3	Moderate	0	18.7	0	
16	Bengaluru	College Ro	87	7.54	10	403	09:33:31	Residentia	Bright	7841	1	Moderate	0	573.5167	2	
17	Bengaluru	Shopping C	86	2.84	8	389	05:57:57	Residentia	Bright	6965	1	Safe	2	357.95	2	
18	Raichur	Railway Sta	1	35.56	1	95	22:50:50	Commerci	Dim	1036	10	Not Safe	1	1370.833	1	
19	Mysuru	Railway Sta	74	4.37	7	337	14:10:20	Park	Bright	6137	0	Moderate	0	850.3333	2	
20	Bengaluru	Shopping C	5	31.44	4	30	14:03:46	Commerci	Dim	7180	8	Not Safe	1	843.7667	1	
21	Shivamogg	College Ro	79	2.83	10	305	16:25:32	Park	Bright	5077	0	Safe	2	985.5333	2	
22	Mysuru	Main Stree	55	12.55	3	283	18:44:25	Park	Bright	9218	3	Moderate	0	1124.417	2	
23	Bengaluru	Main Stree	82	3.66	9	485	20:45:35	Park	Dim	5671	3	Safe	2	1245.583	1	
24	Bengaluru	Park Area	1	40.69	1	52	01:33:59	Park	Dark	8300	9	Not Safe	1	93.98333	0	
25	Chitradurg	Market Roa	66	5.67	5	349	03:05:54	Park	Bright	9932	2	Moderate	0	185.9	2	
26	Ballari	Bus Stand	82	2.26	9	334	17:37:13	Industrial	Dim	8165	0	Safe	2	1057.217	1	

safety_dataset_biased_safe_majo

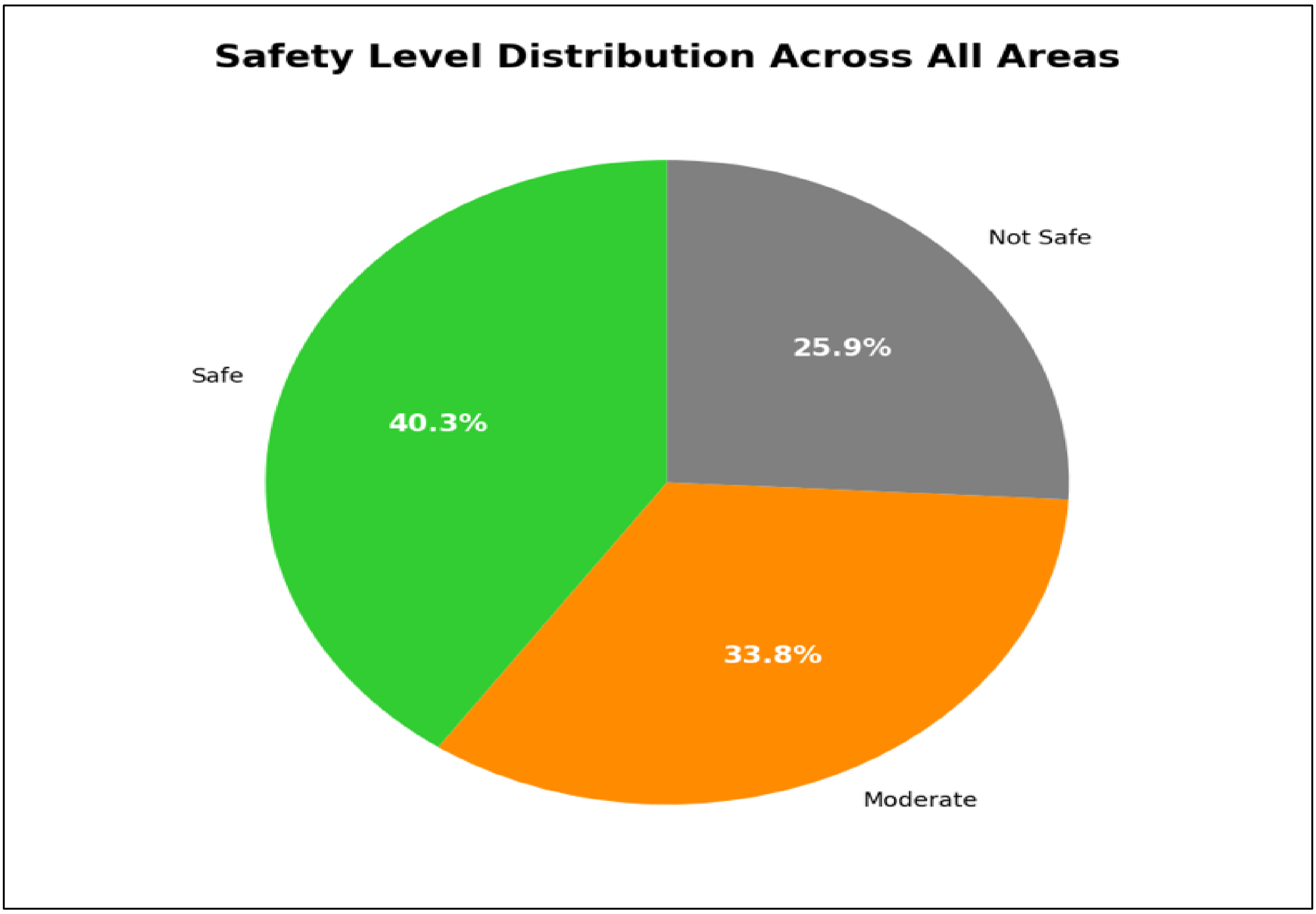

Fig 2 Safety Level Distribution

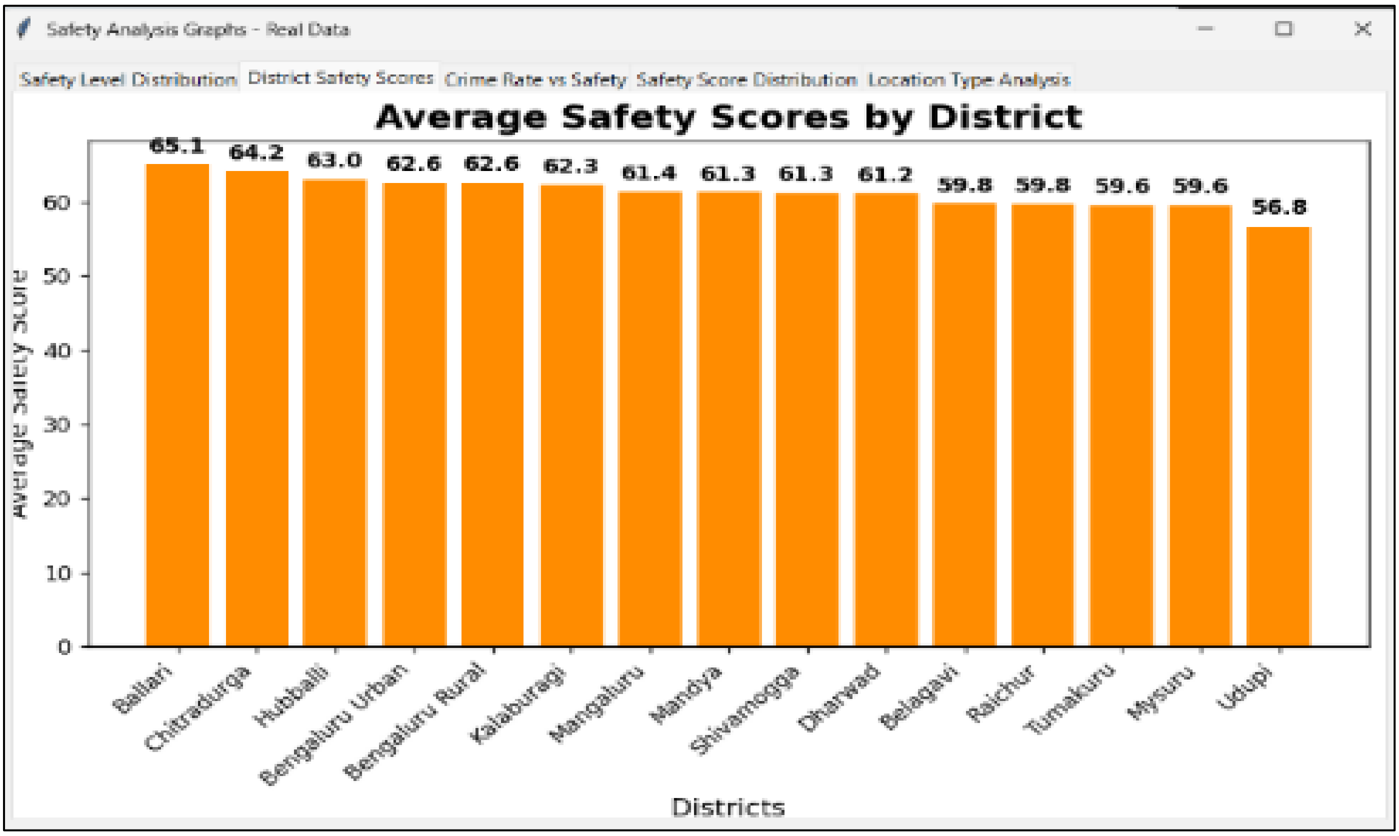

Fig 3 Safety Score by District

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Fig 4 Safety Score on Time of Day.

VI. CONCLUSION

By combining rapid emergency notifications, location sharing, machine learning-based safety prediction, and visual analytics, the SOS alert system offers women and vulnerable groups efficient real-time safety solutions. It supports preventive safety measures, facilitates quicker emergency response, and enhances situational awareness. The system can develop into a strong smart city safety framework with future improvements including wearable IoT devices, cloud-based warnings, and AI-driven analytics.

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