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Data Driven Strategies for Crime Prevention: A Focus on Integrated Crime Risk Assessment System

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ABSTRACT

This paper presents the Integrated Crime Risk Assessment System (ICRAS), a mobile application developed to assist Investigation Officers (IOs) within the Royal Malaysian Police in assessing crime risks and making well-informed decisions. The app utilizes a crime risk matrix that has been designed based on a pre-established risk appetite framework, allowing officers to evaluate crime risks accurately and efficiently. By integrating diverse data sources, such as historical crime data, demographic trends, and environmental factors, the app generates a risk score that reflects the likelihood of criminal activity in various areas. This risk score is essential for guiding decision-making, ensuring that resources are allocated effectively and that law enforcement efforts are focused on the most critical areas. The system empowers IOs to make proactive, evidence-based decisions that enhance community safety. With the help of ICRAS, officers can identify potential threats early, which improves the accuracy of crime predictions and optimizes the overall effectiveness of policing strategies. ICRAS exemplifies how technology can play a crucial role in modernizing law enforcement by providing a data-driven approach to crime prevention. Ultimately, it strengthens the decision-making processes, ensuring that the Royal Malaysian Police can respond to crime risks in a more informed and efficient manner.

1. INTRODUCTION

Crime remains a major global concern, affecting individuals, communities, and public safety. Traditional crime prevention methods such as community policing and reactive enforcement focus largely on responding after incidents occur (Maidin et al., 2024). While effective in maintaining order, they often fail to address underlying causes or prevent recurrence. In contrast, proactive strategies aim to identify

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and mitigate risks before crimes take place. Central to this shift is crime risk assessment, which systematically evaluates potential threats and vulnerabilities (Wang et al., 2021). This paper explores the Integrated Crime Risk Assessment System (ICRAS) as a proactive, data driven framework for modern law enforcement. By integrating diverse data sources and applying analytical and machine learning techniques, ICRAS enhances the ability to detect high risk areas, individuals, and behaviours enabling more efficient, targeted crime prevention efforts. The objectives of this study are summarized in Fig. 1.

Fig. 1. Overview of study objectives

By shedding light on the capabilities and potential of the Integrated Crime Risk Assessment System (ICRAS), this research paper seeks to inform policymakers, law enforcement agencies, and researchers about innovative approaches to crime prevention and control in the modern era.

2. LITERATURE REVIEW

Crime risk assessment and prevention remain critical concerns for policymakers, law enforcement, and communities worldwide. Traditional crime prevention methods have largely been reactive, addressing incidents only after they occur. Recognizing the limits of this approach, recent studies have shifted toward proactive frameworks that aim to identify and reduce risks before crimes escalate. This literature review examines key developments in crime risk assessment, emphasizing the emergence and application of integrated crime risk assessment systems (ICRAS) as a data driven model for enhancing preventive strategies and decision making in modern policing.

2.1 Evolution of crime prevention and risk assessment approach

The study of crime prevention has evolved significantly over recent decades. Earlier criminological models emphasized traditional approaches such as community policing, situational crime prevention, and problem-oriented policing, each reflecting distinct philosophies in addressing crime (Burke, 2025). Community policing focused on building partnerships between law enforcement and communities, situational approaches sought to reduce opportunities for offending through environmental design, and problem-oriented policing emphasized analyzing underlying causes of recurring crimes (Diphoorn & Van Stapele, 2021; Dau et al., 2023). Despite their contributions, these models were largely reactive, addressing crime after it occurred. As limitations of reactive policing became apparent, scholars began advancing proactive and data-driven strategies. The rise of digital data and analytical tools enabled predictive crime assessment, allowing agencies to identify potential hotspots and trends through statistical and computational modelling (Mahimkar, 2021; Ekundayo, 2024).

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2.2 Integrated crime risk assessment systems (ICRAS): Applications, challenges and future directions

Building on recent technological progress, the Integrated Crime Risk Assessment System (ICRAS) represents a new paradigm in proactive crime management. Unlike traditional methods that rely on isolated datasets, ICRAS integrates spatial, temporal, behavioural, and social information within a unified analytical framework. This multidimensional approach allows for the identification of complex patterns and emerging risks through predictive modeling and machine learning (Arunkumar et al., 2025). Studies show that such systems enhance hotspot detection, response efficiency, and overall deterrence (Ahmad et al., 2024; Zhang et al., 2020). However, challenges persist. Predictive algorithms may reproduce biases embedded in historical data, potentially reinforcing unequal policing practices (Shapiro, 2019; Alikhademi et al., 2022). Ethical concerns surrounding privacy, transparency, and accountability further underscore the need for responsible governance. As Organ et al. (2014) argue, community trust depends on fairness, openness, and human oversight. Future research should refine ICRAS accuracy and equity through algorithmic auditing, data quality enhancement, and stronger collaboration between law enforcement, policymakers, and data scientists.

3. METHOD

This research paper adopts a mixed-methods approach to investigate the concept, implementation, and effectiveness of Integrated Crime Risk Assessment Systems (ICRAS) in the context of crime prevention and law enforcement. The methodology encompasses a combination of literature review, case study analysis, data collection and analysis, stakeholder interviews and surveys, consideration of ethical considerations, validation and verification, and development of recommendations and implications.

The Data Acquisition and Integration phase collects information from police records, interviews, and questionnaires to form a unified dataset. In the Data Processing and Cleaning stage, errors, missing values, and outliers are addressed to ensure data reliability. The Data Analysis and Modelling phase applies techniques such as Random Forest to identify key trends and patterns. These findings guide the Risk Assessment and profiling process, where risks are evaluated and categorized using the Crime Risk Matrix and Risk Appetite Index. The Evaluation and Feedback phase incorporates stakeholder input to refine system performance, followed by the Output and Reporting phase, which generates structured reports for informed decision-making and crime prevention planning. The process is summarized in Table 1, while the Integrated Crime Risk Assessment System (ICRAS) workflow is illustrated in Fig. 2.

Table 1. Methodology elements

Methodology	Description
Data Acquisition and Integration	Collects and combines crime-related data from police systems, surveillance, public records, and field sources into one platform.
Data Processing and Cleaning	Validates, filters, and standardizes raw data to remove errors and inconsistencies, ensuring reliable inputs.
Data Analysis and Modelling	Applies statistical and machine learning techniques to identify patterns, hotspots, and emerging crime risks.
Risk Assessment and Profiling	Classifies locations, behaviors, or individuals into risk categories to guide priority monitoring and resource allocation.
Evaluation and Feedback Consideration	Reviews model accuracy and system performance; integrates feedback to refine and improve system capability.

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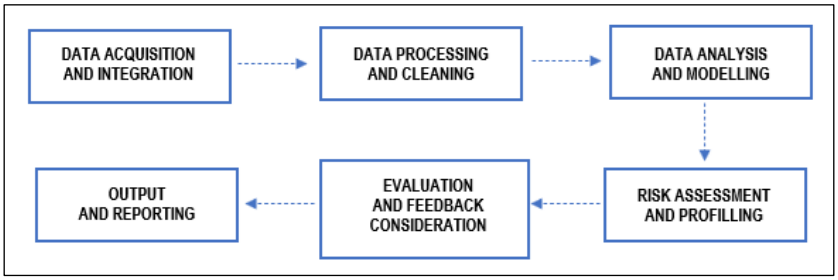

Fig. 2. ICRAS framework

4. RESULT AND DISCUSSION

4.1 Descriptive statistics

Data collected through questionnaires, interviews, and police records provided meaningful insights into participants' demographics and perceptions of crime risk. The study involved 300 respondents representing diverse age groups, occupations, and residential areas. Most participants (65%) were aged between 30 and 45, and about 40% reported having experienced crime related incidents within their neighborhoods. Notably, 80% perceived their local areas as high risk for criminal activity. Interview findings further suggested that these perceptions were shaped by a mix of personal encounters, media exposure, and awareness of local crime statistics. In terms of occupation, 45% of respondents worked in security related fields, while 35% were in administrative roles. Geographic variation was also evident urban residents expressed significantly higher concern about crime risks than those in suburban or rural regions. Table 2 below summarizes the demographic characteristics of the study participants.

Table 2. Demographic distribution and perception of crime risk among participants

Demographic category	Percentage
Age 30-45	65%
Age 46-60	25%
Age 60+	10%
Security Occupation	45%
Administrative Occupation	35%
Others	20%

4.2 Inferential statistics and analysis

The analysis found that age, occupation, and prior crime exposure significantly influenced perceptions of crime risk. Regression results showed that individuals aged 35–50 and those with firsthand crime experience were more likely to perceive high neighborhood crime risk ($\beta = 0.68$, $p < 0.05$). Similarly, respondents in security related jobs rated higher crime risk than those in administrative roles ($\beta = 0.56$, $p < 0.05$). A strong positive correlation was also found between actual crime rates and perceived neighborhood safety ($r = 0.72$, $p < 0.01$), indicating that crime data strongly shapes public risk perception. Fig. 3 illustrates these relationships, highlighting the predictive influence of demographic and experiential factors on perceived crime risk.

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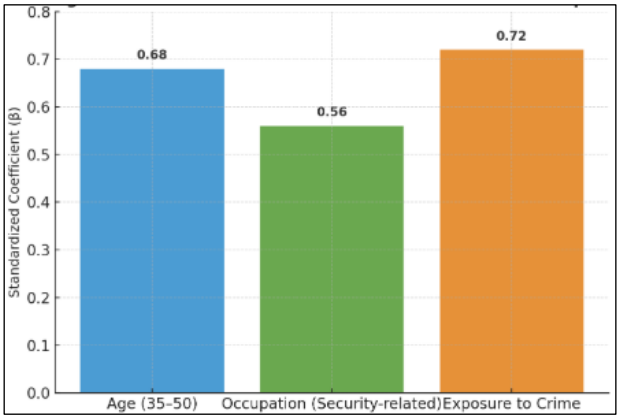

Fig. 3. Regression coefficients for predictors of crime risk perception

4.3 Risk assessment and profiling

The risk assessment evaluated neighborhoods using questionnaire data and police records. A crime risk matrix classified areas as high, medium, or low risk based on crime rates, proximity to hotspots, and socioeconomic factors. Urban centers showed a 90% crime likelihood, suburban areas 60%, and rural regions 20%. A Risk Appetite Index revealed that residents in high-risk areas had lower crime tolerance (mean = 2.1), while those in low risk areas were more tolerant (mean = 4.3) as present in Fig. 4.

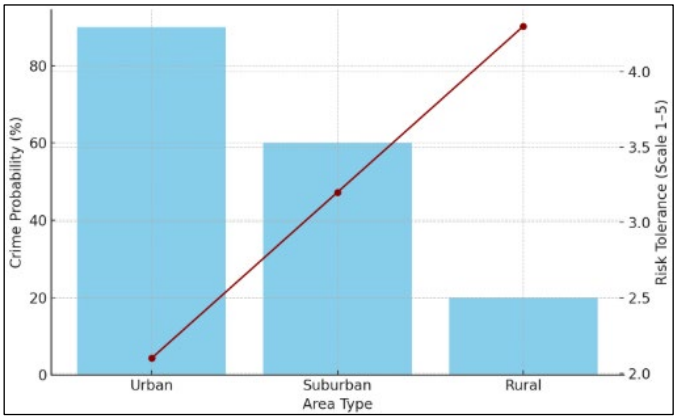

Fig. 4. Crime probability and risk tolerance by area type

4.4 Interpretation of the results

The findings from this study provide valuable insights into the factors that shape how people perceive crime risk in their neighbourhoods. Our analysis revealed that age, occupation, and personal experience with crime are key elements that influence these perceptions. Specifically, individuals who have been exposed to crime or work in security related fields tend to perceive higher levels of risk, which is consistent with earlier studies. Additionally, we found a strong correlation between public crime reports and how individuals assess their neighborhood's safety, suggesting that media coverage and crime statistics play a crucial role in shaping public perceptions. These findings align with previous research, such as the work by Girlando et al. (2021), Lechowska (2022), and Zeng et al. (2023) which also emphasized the significant influence of personal experiences and professional backgrounds on risk

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perception. However, our study introduces a new perspective by examining the role of socio economic factors and risk tolerance, areas that have received less attention in the existing literature. One limitation of this study is the reliance on self reported data, which may be subject to biases, as respondents might either exaggerate or downplay their personal encounters with crime.

Additionally, this results also highlight several critical factors that influence how individuals perceive crime risks in their neighborhoods. A key factor that emerged was personal experience. Respondents who had encountered crime firsthand or worked in security-related fields tended to perceive their environments as higher risk. This observation is consistent with existing literature, which has found that personal experiences with crime are among the most significant predictors of risk perception (Mýlek et al., 2023; Van Veen et al., 2025). Those working in security roles, in particular, are more attuned to potential threats and are generally more aware of emerging crime trends, which likely amplifies their perception of risk. Another important factor identified was media exposure. Respondents who frequently consumed crime-related media, especially local news, reported higher levels of concern about crime risk. This suggests that the way crime is portrayed in the media often sensationalized or disproportionately focused on negative incidents can influence the public's sense of insecurity. This phenomenon has been well documented in previous studies, which highlight that media reporting tends to heighten fear among the public, even when actual crime rates are relatively low (Silva & Guedes, 2023). The study also found that socioeconomic status plays a significant role in shaping perceptions of crime. People from lower-income backgrounds, who are more likely to live in areas with higher crime rates, generally considered their neighbourhoods more dangerous. This aligns with the concept of social vulnerability, where those in disadvantaged socioeconomic positions are more sensitive to crime because of the conditions and environments they live in. These findings corroborate previous studies that emphasize the importance of personal experience and occupation in shaping perceptions of crime. Research by Azevedo et al. (2021) and Avendaño et al. (2022) suggests that individuals with direct exposure to crime or those in security-related professions are more likely to see their environments as unsafe. However, this study expands on this perspective by incorporating the role of socioeconomic factors and introducing the concept of "risk appetite," which has not been explored in much detail in previous research. While much of the existing literature focuses on factors such as age and occupation, this study adds new value by highlighting socioeconomic status as an important driver of crime perception. The concept of risk appetite introduces an interesting angle on how crime perceptions evolve. It suggests that people living in high crime areas may become desensitized to crime over time, gradually developing a higher tolerance for risk. In contrast, individuals in safer areas may remain more cautious, maintaining a lower tolerance for risk. This perspective emphasizes that crime perception is dynamic, shaped by lived experiences rather than being fixed over time. Moreover, it underscore the importance of balanced crime communication. Sensationalized media coverage can inflame public fear, particularly in areas with low crime rates. Policymakers should encourage media reporting that focuses on crime prevention efforts and safety measures, rather than sensationalizing individual incidents of crime. Furthermore, communities that face socio economic disadvantage, where the perceived risk often outweighs the actual crime levels, require targeted support to address both real and perceived vulnerabilities. However, there are limitations to this study that should be acknowledged. The reliance on self reported data and the cross-sectional design limit the ability to draw conclusions about long term shifts in crime perception. Future studies could benefit from a longitudinal design that tracks changes in crime perception over time, considering the impact of evolving social, economic, and media influences.

5. CONCLUSION

This study reveals that crime perception is influenced by a range of factors, including personal experiences, occupation, socio-economic status, and media exposure. Those who have directly encountered crime or worked in security-related roles tend to view their environments as higher risk. In

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contrast, individuals from lower income backgrounds often report a stronger sense of insecurity, even when actual crime rates are not particularly high. This aligns with the concept of social vulnerability, where people from disadvantaged communities are more sensitive to crime due to their socio economic circumstances. The media also plays a significant role in shaping how people perceive crime. Our findings suggest that sensationalized crime reporting tends to heighten public fear, particularly in neighbourhoods that are relatively safe. This is consistent with existing research that points out how media portrayals of crime often exaggerate feelings of insecurity, regardless of the real levels of crime in a given area. One of the more novel insights from this study is the concept of "risk appetite". It appears that individuals living in high crime areas may develop a certain tolerance for crime over time, while those in safer neighbourhoods are generally more cautious and risk averse. This challenges the conventional view that crime perception is only shaped by the objective facts of crime data and highlights the importance of personal and social factors in shaping our perceptions. To bridge the gap between perceived and actual crime risks, this research calls for more responsible media reporting, targeted interventions for vulnerable communities, and stronger collaboration between the police and the public. Future research could benefit from longitudinal studies that integrate both subjective perceptions and objective crime data to better understand how crime perception evolves over time.

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7. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

8. AUTHORS' CONTRIBUTIONS

Mohammad Fahmi Bin Hussin: Conceptualisation, methodology; **Mohd Razif Bin Madin**: Conceptualisation, methodology, formal analysis and writing-original draft; **Khairilmizal Samsudin**: Analysis and validation; **Nor Ayu Zalina Zakaria**: Writing- review and editing ; **Siti Nor Amalina**: Supervision, writing- review and validation.

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