Trends in Social Sciences and Humanities Research
ISSN: 2959-9938
DOI: https://doi.org/10.61784/tsshr3137

SITUATION AWARENESS THEORY MODEL FOR URBAN THEFT CRIME

LiNing Yuan[1], SuZhen Luo[2], ZhiSong Wu[3], ZhongYu Xing[1*]
[1]*School of Information Technology, Guangxi Police College, Nanning 53028, Guangxi, China.*
[2]*Ministry of Public Sports, Guangxi Police College, Nanning53028, Guangxi, China.*
[3]*School of Public Policy and Management, Guangxi Police College, Nanning 53028, Guangxi, China.*
Corresponding Author: ZhongYu Xing, Email: XingZhongyu@gxjcxy.edu.cn

Abstract: Under the new security situation, the problem of urban theft and crime is becoming increasingly prominent, posing a serious threat to social security and stability. The traditional crime governance model has limitations in post investigation and passive defense, making it difficult to achieve early warning and active intervention in crime. In view of this, by constructing a theoretical model of urban theft crime situational awareness based on big data and artificial intelligence, and leveraging the role of public safety intelligence as a "prophet, first mover, and first mover", we can assist in risk identification and monitoring under the background of "big security", promote the forward movement of risk warning "gateway", and provide solid theoretical support for establishing a modern public safety prevention and governance system that is globally linked and three-dimensional efficient. This is of great significance for promoting the intelligent and precise development of urban security and governance.
Keywords: Urban theft crime; Situational awareness; Data mining

1 INTRODUCTION

In the context of rapid urbanization, the problem of urban theft has become increasingly prominent and has become an important factor affecting social security and stability[1]. With the rapid development of information technology, especially the widespread application of big data and artificial intelligence, unprecedented opportunities have been provided for urban crime governance[2]. However, how to effectively utilize these advanced technologies to achieve precise perception and efficient response to urban theft crime is still an important issue that urgently needs to be addressed.

The traditional crime governance model often relies on post investigation and passive defense, making it difficult to achieve early warning and active intervention in crime[3-5]. In addition, urban theft crimes are showing a trend of diversification, concealment, and intelligence, making traditional governance methods increasingly inadequate[6]. Therefore, building a theoretical model that can perceive the real-time and dynamic situation of urban theft crimes has become the key to improving the efficiency of crime governance and ensuring urban safety[7].

This study aims to propose a theoretical model for urban theft crime situational awareness based on big data and artificial intelligence[8]. This model will reveal the spatiotemporal distribution patterns, modus operandi characteristics, potential high-risk areas, and victim groups of urban theft crimes through in-depth mining and analysis of relevant data[9-11]. It will provide scientific decision support for public security departments and achieve precise prevention and efficient crackdown on crimes.

The significance of this study lies in, on the one hand, promoting the development of urban crime governance towards intelligence and precision through the construction and application of theoretical models; On the other hand, it provides new ideas and methods for academic research and practical exploration in related fields, promoting the continuous improvement of urban safety and governance systems.

In summary, this study will delve into the construction and application of a theoretical model for urban theft crime situational awareness, in order to contribute new wisdom and strength to urban crime governance.

2 OVERALL STRUCTURE OF THEORETICAL MODEL

The theoretical model of urban theft crime situational awareness is a typical complex system, based on system science theory and intelligence science theory, supported by big data technology and artificial intelligence technology, and constructed by drawing on existing intelligence process models and intelligence perception frameworks. This model decomposes urban theft crime situation perception into four modules: theft crime data perception, theft crime intelligence characterization, theft crime situation perception, and theft crime intelligence response, as well as intelligence functions such as data acquisition, data parsing, data fusion, intelligence perception, intelligence characterization, situation perception, situation understanding, situation prediction, monitoring and warning, decision response, and post evaluation. The specific content of each module and function of the model is shown in Table 1.

Table 1 Analysis of the Theoretical Model of Urban Theft Crime Situation Perception

Perception Process	Specific Content	Intelligence Function	Specific Content

Theft crime data-aware	The perception of theft crime data aims to perceive and extract public safety and criminal intelligence data, including three intelligence functions (data acquisition, data parsing, data fusion) and two intelligence tasks (environmental data extraction, multi-source data fusion).	Data Acquisition	Comprehensively perceive and extract criminal intelligence data in the urban security environment.
		Data Analysis	Clean the collected raw criminal intelligence data and achieve data standardization.
		Data Fusion	Adopting an aggregation management mode, integrating heterogeneous data modalities, promoting the fusion of multi-source criminal big data, and forming a data stream for intelligence characterization.
Theft crime Intelligence characterization	The characterization of theft crime intelligence aims to perceive the risk scenario of theft crime and establish a matching mechanism between public security work and business needs, including two intelligence functions (scenario perception, intelligence characterization) and two intelligence tasks (scenario task matching, dynamic judgment and detection).	Intelligence Perception	By using clustering analysis, risk assessment, and other methods, we can extract intelligence information from various types of crime data and identify potential crime risk scenarios.
		Intelligence Characterization	Accurately identify and describe implicit intelligence, provide customized intelligence services for explicit intelligence needs, and ensure the adaptability and effectiveness of public security intelligence work.
Theft crime situational awareness	By utilizing the output intelligence flow characterized by intelligence, high dynamic and sustained perception of theft crime risks is achieved, including three intelligence functions (situational awareness, situational understanding, situational prediction) and two intelligence tasks (risk identification and monitoring, risk situational assessment).	Situational Awareness	Identify and extract various risk factors through criminal intelligence and risk data perception.
		Situational Understanding	Analyze the inherent correlation and evolutionary logic of theft criminal activities, apply understanding algorithms and relevant theories, and transform situational awareness risk signals into an interpretable crime pattern system.
		Situation Prediction	Forward looking deduction focusing on crime risks, using predictive algorithms for situation prediction, predicting and evaluating the degree of harm, evolution path, migration probability, and target priority of crime risks.
Theft crime Intelligence response	Providing support for optimizing police resource allocation and achieving scientific decision-making through crime situational awareness, including three intelligence functions (monitoring and early warning, decision response, post evaluation) and two intelligence tasks (risk intelligence push, risk prevention and control decision-making).	Monitoring And Early Warning	Real time monitoring and tracking of the development and evolution trends of crime risks, timely pushing warning information to communities and public security intelligence personnel, ensuring efficient and accurate intervention in theft crime risk management.
		Decision Response	Based on the evolution path of theft crime risk, triggering factors, and characteristics of criminals, scientific and effective prevention and control measures should be taken to reduce or eliminate crime risk, and prevent crime risk from transforming into actual criminal behavior.
		Post Event Evaluation	Through intelligence detection and response, further allocate police resources to prevent secondary and derivative criminal incidents, conduct criminal damage assessments, trace prevention and control processes, and evaluate the effectiveness of

intelligence assistance for responding to criminal risks or incidents.

3 PERCEPTION OF THEFT CRIME DATA

The comprehensive perception of theft crime data is an important fundamental work to ensure the accuracy and timeliness of public security intelligence work under complex conditions, and it is also an important method to eliminate the problem of incomplete criminal information in the intelligence decision-making process. For the perception of theft crime data, firstly, various intelligence data in the urban security environment are monitored, scanned, and extracted through horizon scanning method. Then, multi-source criminal intelligence data is annotated and processed through data parsing and data fusion to form a data stream for intelligence drawing process.

3.1 Criminal Data Acquisition

The perception of theft crime data emphasizes the real-time perception and acquisition ability of multi-source intelligence data, and focuses on the real-time monitoring and scanning of potential intelligence data in urban security environments. According to existing research, urban safety environment is usually divided into remote environment and task environment, covering political, legal, technological and other safety fields (such as technological changes, social structure changes, policy adjustments, etc.), with a large amount of data and complex forms. Therefore, the systematic acquisition and integration of multi-source data is an important foundational work for constructing a theoretical model of theft crime situational awareness. Horizon scanning, as a forward-looking monitoring method, continuously scans heterogeneous data sources such as open source intelligence data (social media, video surveillance, IoT devices, etc.) and national security related agency data (government work reports, judgment documents, etc.), achieving "systematic" acquisition of multi-source intelligence data in complex urban security environments and establishing an early identification framework for criminal risk signals. During the scanning process, specialized data probes can be deployed to capture real-time and dynamic data information in key areas such as social security, achieving refined crime data perception and improving the timeliness and completeness of criminal intelligence production.

3.2 Multi Source Data Fusion

The sources of theft crime intelligence data are extensive, massive, and complex in form. Only by fully integrating intelligence data from different dimensions and granularities can a standardized information flow be formed for the input intelligence characterization process. Data parsing is a prerequisite for data fusion, which involves data preprocessing to achieve data cleaning such as filling, denoising, and repairing of raw data. At the same time, it relies on data assimilation theory to achieve standardization and spatiotemporal granularity alignment of crime data. Data fusion is the further sorting of criminal intelligence data through aggregation management, using clustering, correlation, and classification algorithms to extract potential feature information contained in the data, integrating heterogeneous data modalities (structured case records, unstructured video streams, etc.), and constructing data streams for intelligence characterization. In practical work, because a large amount of intelligence data is distributed on the Internet platform and there is a "data barrier" with the public security intranet, the extraction and fusion of large-scale and real-time urban security data is limited. Therefore, building an efficient collaboration mechanism and fusion mode has become the key task of intelligence data sharing and fusion at this stage. In addition, we should actively promote the construction of a management system for theft of criminal data resources, securely store and manage criminal data, prevent the leakage of confidential information, and effectively safeguard data security.

4 CHARACTERIZATION OF THEFT CRIME INTELLIGENCE

The characterization of theft crime intelligence is the construction of a coupling mechanism between intelligence perception and decision-making needs, relying on intelligence theory and intelligence data for continuous understanding and feedback, systematically deconstructing intelligence information such as theft behavior subjects and environmental interaction patterns, and generating intelligence flows for situational awareness. For the characterization of theft crime intelligence, one is to explore the "implicit" information contained in intelligence data through intelligence perception, identify potential risk scenarios, and allocate existing intelligence resources reasonably; The second is to clarify the "explicit" intelligence needs through intelligence characterization, implement customized intelligence work, and improve the accuracy and efficiency of intelligence work.

4.1 Criminal Intelligence Perception

Due to the complexity and diversity of crime risk scenarios, a comprehensive perception of various risk factors is a prerequisite for ensuring the effectiveness of intelligence work. The perception of theft crime intelligence is a systematic methodology based on relevant theories of intelligence and criminology, which constructs a dynamic monitoring and analysis system for criminal activities. Its core is to perceive the "potential" risk information and "implicit" intelligence needs contained in intelligence data through analysis algorithms such as correlation analysis and

risk assessment. At the same time, deconstructing the environmental triggering mechanisms and subject object behavior patterns of theft crimes, utilizing intelligence perception and analysis methods to form expert knowledge and experience, and constructing a theft crime risk case database and knowledge base. To avoid knowledge redundancy and overload in the database, algorithms such as association and clustering are used to infer and classify the risk scenarios of newly added intelligence data, making the entire intelligence perception process more scientific and efficient.

4.2 Criminal Intelligence Characterization

In the context of "big security" and "big intelligence", the interaction between criminal subjects, environmental factors, and behavioral patterns presents multidimensional dynamic correlation characteristics, making the process of characterizing theft crime intelligence also require the implementation of systematic thinking. On the one hand, by actively monitoring crime triggering factors, deeply analyzing the "implicit" intelligence needs of law enforcement agencies, and establishing a scenario matching mechanism that is in line with business reality. At the same time, combined with the demand feedback closed-loop mode, a new round of crime data scanning and extraction will be carried out to promote iterative optimization of data collection dimensions. On the other hand, in response to the clearly defined "explicit" intelligence needs of law enforcement agencies, targeted perception and analysis of criminal intelligence data is carried out, strengthening the cognitive collaboration between intelligence analysts and law enforcement workers, and promoting the evolution of intelligence characterization process towards flatness and precision. Compared to traditional crime situational awareness systems that monitor the entire amount of data indiscriminately, this intelligence characterization architecture is designed with demand matching and feedback mechanisms, which can focus on the dynamic tracking and deep mining of high-value intelligence clues, achieve targeted optimization of intelligence resources, and avoid waste of resources such as "manpower", "material resources", and "computing power".

5 PERCEPTION OF THEFT CRIME SITUATION

Situational awareness is a way to enhance the ability to detect, understand, analyze, and respond to security threats from a global perspective, based on security big data. By collecting, integrating, and analyzing potential patterns and information contained in multi-source data in real time, it understands the current situation, predicts future trends, and assists in the decision-making process. In the field of public safety, situational awareness technology can help public security grasp urban safety dynamics, optimize security risk prevention and control, and police resource scheduling, further enhancing urban resilience. For the perception of theft crime situation, the classic theoretical framework Endsley model is used to construct, which includes three levels: theft crime situation perception, theft crime situation understanding, and theft crime situation prediction. At this point, the perception process of theft crime can be understood by obtaining, processing, and analyzing criminal intelligence data to explore the current behavior patterns, harmfulness, and risk evolution trends of theft crime.

5.1 Criminal Situation Awareness

Situational awareness is the initial level of theft crime situational awareness. Firstly, situational awareness algorithms are used to identify and extract various risk factors, construct a dynamic monitoring network for criminal activities, and accurately detect theft crime risks; Then, using learning rules and distributed reasoning methods, abnormal behavior patterns, environmental vulnerability mutations, and other risk and threat attributes are captured to achieve preliminary extraction or localization of criminal risk signals; Finally, by using a spatiotemporal prediction model to analyze crime data, the spatiotemporal correspondence between theft behavior and risk is analyzed, and a theft crime risk situation map is constructed. Situational awareness emphasizes the active detection ability of triggering factors for theft crimes, essentially achieving the "visualization" and "focus" of potential characteristics of criminal behavior through the perception of criminal intelligence and risk data.

5.2 Understanding the Criminal Situation

Situation understanding aims to analyze the inherent correlation and evolutionary logic of theft criminal activities, and use understanding algorithms to transform intelligence theory, criminology theory, and situational awareness risk signals into an interpretable crime pattern system. The process of situation understanding relies on the professional knowledge of expert teams, and through human-computer interaction, introduces a criminal intelligence understanding and analysis architecture based on artificial intelligence technology to promote intelligence tasks such as theft threat situation assessment, risk situation assessment, and risk evolution monitoring. In fact, this process focuses on multidimensional evaluation of crime triggering factors and causal chain reasoning, supporting the cognitive transition of law enforcement departments from phenomenon description to mechanism interpretation, and providing identifiable and interpretable theoretical anchors for the formulation of prevention and control strategies.

5.3 Crime Situation Prediction

Situation prediction focuses on forward-looking deduction of criminal risks, using prediction algorithms for situation assessment and prediction, tracking the evolution path of theft crime risks, assessing the degree of harm caused by theft crimes, and further perceiving potential derivative risks. At the same time, this process relies on the "swarm intelligence collaboration" technology to promote collaborative intelligence strategy analysis through interdisciplinary and cross platform collaboration, and implement efficient intelligence sharing mechanisms. In addition, constructing a "situation map" of theft crimes, quantitatively evaluating potential crime hotspots, spatiotemporal migration patterns, and the level of harm caused by criminal behavior, outputting predictions of crime transfer paths and prioritization of prevention and control targets, optimizing decision-making and resource allocation, thereby promoting the transformation of crime prevention and control from the "post disposal" paradigm to the "pre blocking" paradigm.

6 THEFT CRIME INTELLIGENCE RESPONSE

Criminal risk is a direct reflection of the potential occurrence of criminal events, and high-risk environments can significantly increase the probability of criminal events occurring. If prevention is not effective, it is highly likely to trigger criminal behavior. The response process of theft crime intelligence is based on the theory of intelligence led policing, combined with the theory of emergency life cycle and the general law of public safety risk evolution. The evolution of crime risk is divided into the pre risk evolution stage, the mid risk evolution stage, and the post risk evolution stage, corresponding to three intelligence functions: monitoring and early warning, decision-making response, and post evaluation. A closed-loop governance system of "early warning response evaluation" is formed to achieve full cycle control of crime risk.

6.1 Monitoring and Early Warning

Monitoring and early warning is the leading link in responding to theft crime intelligence, which comprehensively identifies potential crime risks through crime situational awareness in the pre evolution stage of crime risk. Relying on the strategy of "collective intelligence collaboration", we promote the integration of multi-source crime situation intelligence from networks, communities, public security, and other sources. Based on the actual needs of public security intelligence departments for risk situations, we push multi granularity warning intelligence such as community level risk indices and street level crime time distribution. In addition, by fully utilizing the "situation map" of crime risk, the development and evolution trend of theft crime can be tracked in real time, and the probability of risk transmission can be quantified based on the thermodynamic model of crime. High dynamic monitoring of key areas can be carried out to provide high confidence prior decision-making basis for public security departments.

6.2 Decision Response

Decision response focuses on the efficient transformation of early warning intelligence into prevention and control actions, that is, in the mid-term stage of crime risk evolution, crime situation intelligence is used to enable public security intelligence departments to fully understand the occurrence conditions, risk hotspots and evolution paths of theft crimes, as well as the inherent connections or similarities between different theft crime events, and to take scientific and effective measures to eliminate potential crime risk points and prevent the occurrence of criminal events. At the same time, based on actual crime risk situation intelligence and Pareto front analysis, a multi-level decision-making space of "patrol density response time prevention and control coverage" is constructed to determine the optimal police deployment plan. In addition, utilizing existing intelligence information and historical case information to construct an updated reasoning knowledge base and experience knowledge base, ensuring the sharing of intelligence resources among multiple departments and serving the governance of criminal security risks.

6.3 Post Evaluation

Post evaluation is the process of revealing the net effect of prevention and control measures and the reproduction of intelligence knowledge, that is, in the post event stage of risk evolution, continuous and highly dynamic intelligence perception is used to prevent the occurrence of secondary and derivative crimes, and the intervention efficiency, response speed, and accuracy of intelligence perception and response work are retrospectively evaluated. Assess the economic damage, facility damage, and negative social impact of theft incidents, and perceive changes in the community and public security perception index. In addition, establish a dynamic feedback mechanism of "prevention and control intensity crime evolution", inject the results of crime risk governance assessment into the risk analysis model and patrol strategy adjustment rule library, form a cognitive loop of "intervention evaluation optimization", continuously accumulate experience and strategies in theft crime governance, and promote the transformation of governance work mode from short-term prevention to long-term resilience construction.

7 CONCLUSION

A comprehensive understanding of the public safety situation, timely crackdown on illegal and criminal activities, and accurate elimination of criminal risks and hidden dangers are prerequisites for achieving modernization of social governance capabilities. By relying on crime situational awareness technology, a new concept, new ideas, and new

methods for the governance of theft crime intelligence have been formed. A theoretical model of crime situational awareness that integrates theft crime data perception, theft crime intelligence characterization, theft crime situational awareness, and theft crime intelligence response has been constructed, which can consolidate the theory of public safety intelligence, enhance community risk monitoring and early warning capabilities, promote the practical application of intelligence perception, and establish a comprehensive, three-dimensional and efficient social security protection system.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

This work was supported in part by the Social Science Fund of Guangxi under Grant 23FTQ005 and the Project for Enhancing Young and Middle-aged Teacher's Research Basis Ability in Colleges of Guangxi under Grant 2024KY0904.

REFERENCES

[1] Liu L, Ji J K, Song G W, et al. Hotspot prediction of public property crime based on spatial differentiation of crime and built environment. Journal of Geo-information Science, 2019, 21(11): 1655–1668.
[2] Han X G. Prediction method of theft crimes in urban: An integrated model of LSTM and ST-GCN. Beijing: Chinese People's Public Security University, 2021. DOI: 10.27634/d.cnki.gzrgu.2021.000042.
[3] Xiao Luzi, Liu Lin, Song Guangwen, et al. Impacts of community environment on residential burglary based on rational choice theory. Geographical Research, 2017, 36(12): 2479–2491. DOI: 10.11821/dlyj201712017.
[4] Long Dongping, Liu Lin, Feng Jiaxin, et al. Comparisons of the community environment effects on burglary and outdoor-theft: A case study of ZH peninsula in ZG city. Acta Geographica Sinica, 2017, 72(2): 341–355. DOI: 10.11821/dlxb201702013.
[5] Liu Lin, Chen Debao, Xu Chong, et al. Comparative study on the influencing factors of the distribution of near repeat cases and isolate cases of burglary. Scientia Geographica Sinica, 2021, 41(9): 1625–1633. DOI: 10.13249/j.cnki.sgs.2021.09.014.
[6] Song Guangwen, Xiao Luzi, Zhou Suhong, et al. Impact of residents' routine activities on the spatial-temporal pattern of theft from person. Acta Geographica Sinica, 2017, 72(2): 356–367. DOI: 10.11821/dlxb201702014.
[7] Xu Jiaxiang, Chen Peng, Chen Jianguo. Research on spatial-temporal distributions of burglary based on environmental criminology: Based on the analysis of crime in Beijing. Human Geography, 2018, 33(1): 43–50. DOI: 10.13959/j.issn.1003-2398.2018.01.006.
[8] Di Mauro M, Galatro G, Fortino G, et al. Supervised feature selection techniques in network intrusion detection: A critical review. Engineering Applications of Artificial Intelligence, 2021, 101: 104216.
[9] Zhao D, Song H, Li H. Fuzzy integrated rough set theory situation feature extraction of network security. Journal of Intelligent & Fuzzy Systems, 2021, 40(4): 1–12.
[10] Zhao L, Wang J, Chen F, et al. Spatial event forecasting in social media with geographically hierarchical regularization. Proceedings of the IEEE, 2017(10): 1953–1970.
[11] Yang W, Liu X, Liu J, et al. Prediction of collective actions using deep neural network and species competition model on social media. World Wide Web, 2019, 22(6): 2379–2405.