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Integrating Big Data Intelligence into K-12 Schools Campus Safety Management

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Abstract: *The safety of K-12 schools has always been a paramount concern. As society progresses and technology advances, the utilization of big data intelligence to innovate campus safety management has emerged as a significant area of research. This study identifies four prevalent issues in the current safety management practices of K-12 schools: a deficiency in safety education and awareness, limited capabilities for risk prediction and early warning, lagging emergency response systems, and ineffective inter-departmental communication. By applying big data intelligence, this paper proposes the development of four novel platforms for enhancing safety management in K-12 schools: a Machine Learning-based Safety Education Platform, a Big Data-based Risk Prediction and Warning Platform, an AI-based Monitoring and Response Platform and an IoT-based Safety Information Sharing Platform. These platforms aim to provide comprehensive safety management solutions encompassing real-time monitoring, early warning, incident response, in-event control, and post-incident traceability. The proposed multi-faceted approach promises to foster the improvement in K-12 schools campus safety management, thereby ensuring a safer and more comfortable learning environment.*

Keywords: *Big Data Intelligence, K-12 schools, Campus Safety, Management Innovation*

1. Introduction

Safety management in K-12 schools refers to measures including human defense, physical defense, and technical defense to prevent a wide range of safety issues both on and off campus. It aims to ensure a safe and comfortable school environment. Given the rapid development of K-12 education and prominent safety issues on campuses, it is necessary to enhance the scope and depth of big data intelligence application in safety management at K-12 schools. This paper introduces four novel AI-driven platforms for safety management at K-12 schools: a Machine Learning-based Safety Education Platform, a Big Data-based Risk Prediction and Warning Platform, an AI-based Monitoring and Response Platform and an IoT-based Safety Information Sharing Platform.

The campus Safety Management for K-12 Schools Driven by Big Data Intelligence encompasses applications in natural language processing, intelligent recognition, big data analysis, intelligent linkage control, and the Internet of Things(IoT). Large-scale data systems such as FARS, SpecialSci, CNKI, Wanfang Data and Chaoxing were utilized to search for the topic of this paper. So far, there's no direct literature specifically related to Campus Safety Management for K-12 Schools Driven by Big Data Intelligence. However, indirectly related literature is available. For instance: Liu Weiming conducted research on the scope and measures of artificial intelligence application in smart campuses of K-12 schools (Teaching and Management, 2022(18)) [1]. Zhu Maolin explored the intelligent management mode of hazardous chemicals in K-12 schools laboratories (Experimental Teaching and Instruments, 2022(03)) [2]. Jin Yinan conducted research on the problems and solutions of food safety supervision in K-12 schools canteens (Master's thesis, Shanghai Normal University, 2021) [3].Yang Yong explored the laws and methods of "school safety risks" prevention and control based on the practical work of educational departments in Erdao District, Changchun City (Jilin Labor Protection, 2021(02)) [4]. Miao Xuanyan conducted research on the content, methods, and applications of smart campus construction in middle schools (Master's thesis at Nanjing University, 2019) [5]. Chen Ning et al. conducted research on a Campus Intelligent Safety Supervision System Based on RFID (International Journal of Online Engineering, 2017(11)) [6].Zeng Feiyun conducted research on the status quo, existing problems, and countermeasures of "smart campus" construction in K-12 schools in Shenzhen (Master's thesis at Shenzhen University, 2017) [7]. Ren Xiaoqian analyzed, designed, and implemented security monitoring systems for K-12 schools (Master's thesis at Ocean University of China, 2014) [8]. Pu Xu discussed what

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should be built in smart classrooms in K-12 schools in China (Master's thesis at Central China Normal University, 2013) [9]. Lei Jing et al. conducted research on an RFID-based intelligent management system for safety in K-12 schools campus (China Educational Technology Equipment) [10].

In summary, the above reviewed literature and other sources have studied the theoretical frameworks, methodologies, measures, and applications of big data intelligence driven safety management in K-12 schools campus. The existing studies provide valuable insights for future research, but they also have some common limitations: First, the management policies and regulations are not comprehensive enough and have some gaps that need to be addressed. There have been many accidents in K-12 schools campus in recent years, some of which are serious or even fatal. It indicates that the management policies and regulations are not strict, practical and detailed enough. Second, the intelligent security monitoring systems are not based on thorough needs analysis and do not have all the necessary functions. For example, it does not have intelligent identification, timely alarm and linkage disposal functions, which can not effectively prevent accidents. Third, there is no effective integration between the management theory system and the intelligent supervision system. They have not established a data intelligence management system that covers the whole process of K-12 schools campus safety management in all scenarios and links. The advanced technology has become a mere ornament or a showpiece in K-12 schools safety management to some extent.

2. The Current State and Challenges of Safety Management in K-12 schools campus

2.1. Insufficient Safety Propagation Education and Weak Student Safety Awareness

- Inadequate Safety Education Curriculum.
- Monotonous Safety Propagation Methods.
- Inadequate Student Engagement.

2.2. Inadequate Safety Preventive Measures and Limited Risk Warning Capability

- Inadequate Safety Preventive Measures.
- Limited Risk Warning Capability.

2.3. Deficiencies in Emergency Response Systems, Addressing Timeliness Issues

- Absence of Intelligent Security Monitoring Systems.
- Inefficiency in Safety Emergency Response Time.

2.4. Deficient Interdepartmental Communication and Superficial Collaborative Management

- Insufficient Interdepartmental Communication.
- Impeded Information Transmission.

3. Innovations in Safety Management for K-12 Schools Campus Driven by Big Data Intelligence

The national standard, General Framework for Smart Campuses (GB/T 36342-2018), mandates the implementation of audio and video monitoring systems alongside visual alarm systems, encompassing key areas and locations on campuses. These systems are required to feature real-time capabilities for personnel and vehicle warning and control, as well as emergency command and planning. On top of that, the Guidance on the Prevention and Treatment of Bullying and Violence among Primary and Secondary School Students, issued by the Ministry of Education, underscores the need for expanding the coverage of public safety video monitoring systems across school campuses and surrounding areas. It emphasizes the integration of video images to enable predictive warnings, real-time monitoring, trajectory tracking, and dynamic control of illicit activities involving adolescents.

Both the national standard and the Ministry of Education's guidelines demand a profound integration of "technical defense" with safety management in k-12 schools campus. This integration, facilitated by smart technologies, aims to establish four new platforms for safety management, as illustrated in Figure

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1.

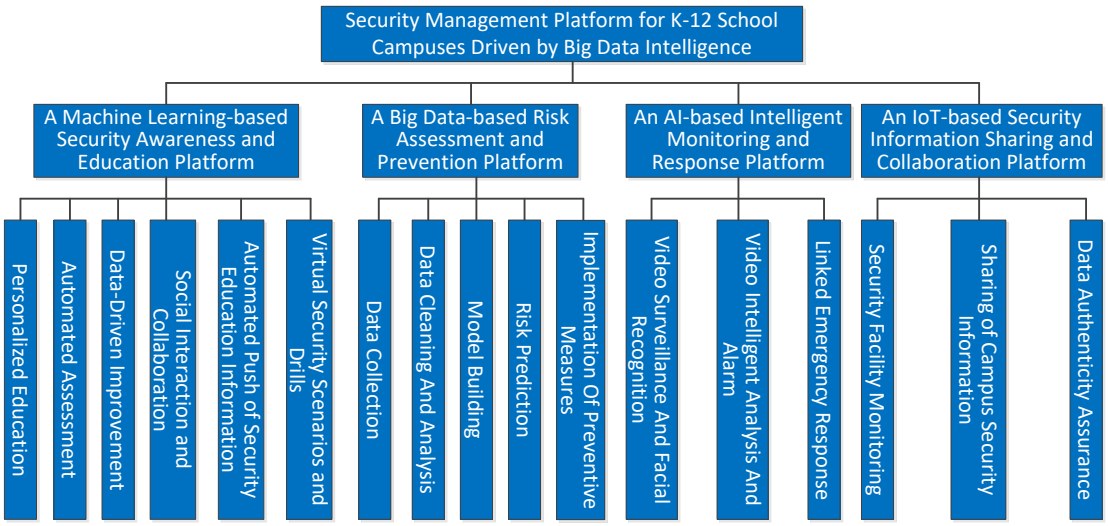

Figure 1: Security Management Platform for K-12 Schools Campus Driven by Big Data Intelligence

3.1. Machine learning based security promotion and education platform

A machine learning based security promotion and education platform refers to an online platform that utilizes machine learning technology to provide security promotion and education services, with the aim of improving the pertinence and effectiveness of security education.

3.1.1. Personalized education

Based on machine learning algorithms, the platform can intelligently recommend based on user needs and interests, and provide personalized security promotion and educational content. For example, for different age groups and student groups, the platform can customize corresponding safety education courses based on individual characteristics and learning progress.

3.1.2. Automated evaluation

The platform can use machine learning algorithms to automatically evaluate the user's understanding and skill level of security knowledge. By providing online quizzes, Q&A exercises, or simulated practices, collect student learning data and generate feedback and evaluation reports based on data analysis to help students understand their mastery of safety knowledge.

3.1.3. Data driven improvement

The platform can collect and analyze student learning data, such as learning history and mastery of knowledge points, and use machine learning algorithms to discover weak points and common errors in student learning, thereby optimizing and improving teaching content. In this way, the platform can provide more efficient and targeted security promotion and education services by continuously optimizing algorithms and updating courses.

3.1.4. Social interaction and collaboration

The platform can provide social interaction functions, such as online discussions, group activities, and collaborative projects, encouraging knowledge sharing and collaborative learning among students. Through machine learning technology, the platform can also identify collaborative learning opportunities between users and recommend relevant content and suitable learning partners.

3.1.5. Automatic push of security education information

Using machine learning algorithms, students can analyze their usage habits and feedback data, choose appropriate push methods and times, and push through various channels, such as mobile application notifications, emails, SMS reminders, etc., to improve the visibility and acceptance of information.

3.1.6. Virtual security scenarios and drills

Virtual reality technology is used to create simulated security scenarios, such as fire escape, emergency response, etc. Virtual security equipment and tools can also be provided, such as firefighting

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equipment, first aid kits, etc., allowing learners to have practical experiences and drills in the virtual environment.

3.2. Risk assessment and prevention platform based on big data

The use of big data technology can effectively improve the pertinence and timeliness of campus safety management in primary and secondary schools, prevent and reduce the occurrence of various safety accidents. One is to collect scale data related to campus safety, such as student behavior, campus environment, equipment operation, meteorology, etc., especially the collection of abnormal student behavior data; The second is to clean and analyze the collected data, eliminate useless data to obtain effective data, and analyze the patterns, trends, and abnormal situations contained in the data to identify potential security risks; Thirdly, based on the processed effective data, establish a campus security risk assessment model; Fourthly, by constructing a risk assessment model, various safety risks within the campus can be predicted, especially for larger safety risks such as student suicide, campus bullying, campus fires, and traffic accidents; The fifth is to develop targeted preventive measures for potential safety accidents based on risk prediction results, such as conducting mental health education and consultation, increasing the construction of intelligent monitoring equipment, strengthening campus patrols of personnel, and reminding teachers to pay special attention to students with abnormal behavior.

3.3. Intelligent monitoring and response platform based on artificial intelligence

The intelligent monitoring and response platform based on artificial intelligence can achieve real-time monitoring of campus safety, automatic identification and linkage alarm of abnormal behavior, as well as fast and effective linkage emergency response, greatly improving the timely handling and prevention ability of campus safety accidents.

3.3.1. Utilize video surveillance technology and facial recognition technology to achieve all-weather monitoring of important campus areas

By installing video surveillance equipment and facial recognition systems, important areas such as classrooms, playgrounds, stairs, and gates on campus can be monitored 24/7. Facial recognition technology is used to identify and record the identity of individuals entering and exiting the campus, ensuring that only authorized personnel can enter the campus, thereby improving the security and reliability of the campus.

3.3.2. Real time analysis of surveillance videos using AI technology to identify abnormal student behavior and trigger alarms

There are ten common abnormal behaviors among students in primary and secondary school campuses, as shown in Table 1:

Table 1: Ten Common Abnormal Behaviors of Students in K-12 Schools Campus.

No	Abnormal Behaviors	Expressions
1	Campus brawl	Physical conflict or violent behavior among students
2	Student bullying	Verbal or physical bullying behavior among students
3	Self harm and suicide	Students may harm themselves or attempt suicide
4	Students skip classes	Students leave the classroom or campus without permission, miss classes or go out without permission
5	Campus harassment	Students harass, prank, or engage in inappropriate behavior towards others
6	Intense gaming activities	Students participating in dangerous games or activities may cause harm
7	Carrying prohibited items	Students carrying knives, fireworks, or other prohibited items
8	Not following classroom discipline	Intentionally shouting and disturbing classroom or self-study order, affecting the normal learning of classmates and the normal teaching of teachers
9	Destruction of public property	Damaging public facilities and equipment on campus or classrooms, damaging flowers and trees, trampling on lawns, damaging greenery, etc
10	Improper dressing	Students do not wear prescribed school uniforms or wear exaggerated or revealing clothing

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Using AI technology to analyze surveillance videos in real-time and trigger alarms can help campus managers take timely measures to prevent and respond to these abnormal behaviors.

One is automatic monitoring and alarm for campus brawls and student bullying. Using computer vision technology to detect physical conflicts or abnormal behavior through surveillance videos and identify participants. Using behavior recognition algorithms to analyze speech and body movements to determine the presence of bullying behavior. When violent or bullying behavior is detected, immediately trigger the alarm system to notify campus security personnel and relevant faculty and staff.

The second is automatic monitoring and alarm for self harm and suicidal tendencies. AI technology can identify emotional and behavioral changes in students, such as expressions and postures of anxiety, depression, etc. Based on speech and text analysis, detect negative emotions and suicidal tendencies expressed by students. Once it is discovered that students may have suicidal intentions, an emergency alarm should be triggered immediately, and psychological counselors or other professionals should be notified for intervention and assistance.

The third is automatic monitoring and alarm for students skipping classes. Use facial recognition technology to detect whether students have left the classroom or campus, and verify their identity with student information. AI algorithms can analyze crowd gathering and student movement trajectories, and timely detect student departure behavior. Once a student skips class without permission, the system can automatically trigger an alarm to notify the class teacher or relevant person in charge.

The fourth is automatic monitoring and alarm for campus harassment and intense gaming activities. Real time target recognition and behavior analysis using surveillance videos to detect inappropriate words, actions, and dangerous activities among students. Based on image and sound recognition technology, determine whether students engage in harassing behavior or participate in dangerous games. After discovering harassment or dangerous behavior, immediately trigger the alarm mechanism and notify relevant teachers and security personnel to intervene and handle.

The fifth is automatic monitoring and reporting of carrying prohibited items, non-compliance with classroom discipline, damage to public property, and improper attire. Install smart cameras or sensor devices to monitor students in real-time and detect violations. Using image recognition and behavior analysis techniques to detect whether students are carrying prohibited items, disrupting classroom order, damaging public property, or wearing inappropriate clothing. When the above abnormal behavior is detected, the alarm system will be immediately triggered to notify relevant management personnel for disposal and punishment.

When implementing AI technology for real-time analysis of surveillance videos and triggering alarms, schools need to ensure legality and compliance, and pay attention to protecting student privacy.

3.3.3. Establish an intelligent emergency response system, quickly dispatch resources, and activate emergency plans

In emergency situations, intelligent monitoring and response systems based on artificial intelligence can quickly dispatch various resources on campus, including manpower, materials, and equipment, and activate corresponding emergency plans. For example, if a fire occurs on campus, the system will automatically activate the fire emergency plan, including measures such as automatic sprinkler extinguishing and emergency evacuation. In addition, the system can automatically contact relevant emergency departments and personnel according to the requirements of the contingency plan, coordinate and handle accidents, effectively reduce the risk of escalation of the situation, and record the entire emergency response process for subsequent summary and analysis.

3.4. A Security Information Sharing and Collaboration Platform Based on IoT Technology

3.4.1. Using Internet of Things technology to build a campus security awareness network and monitor the real-time operation status of campus security facilities

Through the Internet of Things technology, various security facilities on campus will be intelligently transformed to enable real-time transmission and feedback of information. These information can be collected and organized through the campus security perception network, achieving real-time monitoring of the operation status of campus security facilities. Once an abnormal situation is detected, the system will automatically issue an alarm and notify relevant personnel to handle it, thereby achieving better prevention and preparation for campus security management.

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3.4.2. Integrating campus security related information using cloud computing platforms to achieve cross departmental and cross hierarchical information sharing

Through cloud computing platforms, campus security related information can be centrally managed and integrated, breaking down information barriers and achieving information sharing. Information between different departments and levels can be interconnected, improving information utilization and collaborative efficiency. This can not only improve the efficiency of campus security management, but also better achieve information sharing and collaborative work, ensuring the security and stability of the campus.

3.4.3. Utilizing blockchain technology to ensure transparency in information sources, ensuring data authenticity and immutability

Through blockchain technology, the source of campus security data can be clearly recorded and traced, ensuring the authenticity and reliability of the data. Meanwhile, the encryption algorithm and consensus mechanism of blockchain technology can prevent data from being tampered with or forged, ensuring the immutability of data. This can ensure the security and credibility of campus security data, and prevent data from being maliciously exploited or misled.

4. Conclusions

Through in-depth exploration of the application of big data intelligence technology in campus security management in primary and secondary schools, the important role and practical value of big data intelligence in improving the effectiveness of campus security management in primary and secondary schools have been revealed. By leveraging the advantages of big data intelligence, a warning type, linkage type, and collaborative campus security management platform for primary and secondary schools can be built, which can achieve real-time monitoring, warning, response, in-process control, and post event traceability of campus security in primary and secondary schools. This can promote the continuous improvement of campus security management in primary and secondary schools.

At the same time, the application of big data intelligence has also brought new challenges to campus security management in primary and secondary schools. It is necessary to focus on issues such as data privacy and security, high technical complexity and maintenance costs, increased information asymmetry and management difficulty, and lack of unified standards and norms, and take corresponding measures to respond and solve them.

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