Received July 27, 2019, accepted August 10, 2019, date of publication August 13, 2019, date of current version August 28, 2019.
Digital Object Identifier 10.1109/ACCESS.2019.2934979

Design of Traffic Emergency Response System Based on Internet of Things and Data Mining in Emergencies

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This work was supported by the Annual Research Topics of Qingdao Shuangbai Research Project under Grant 2018-B-25.

ABSTRACT Urban emergencies are hard to avoid. Traffic emergency response after an incident plays an important role in reducing losses and is a key link in urban emergency management. However, the traditional traffic management methods have been difficult to face the complicated conditions and requirements in such problems. The introduction of Internet of Things and data mining technology to establish a traffic emergency response system under urban emergencies can significantly improve the level of urban emergency response and realize efficient intensive management. The system mainly includes sub-systems, such as personnel evacuation data collection system, vehicle operation data collection system, rescue material distribution data collection system, personnel settlement place data collection system, traffic bayonet intelligent identification system, etc. It also devises the working programs for command management, personnel evacuation and disaster disposal in case of emergency, and improves the urban emergency support management system. With the support of Internet of Things and the data mining technology, the traffic emergency response system can timely and accurately control the flowing information of personnel and vehicles, quickly and conveniently resettle personnel and vehicles, effectively carry out follow-up rescue work, effectively improve rescue efficiency and improve the level of urban management.

INDEX TERMS Internet of Things, data mining, emergencies, emergency rescue, system design.

I. INTRODUCTION

With the continuous improvement of urbanization level, the problem of loss of personnel and property caused by natural disasters, safety accidents, terrorist attacks and other unexpected incidents has become increasingly prominent [1], [2]. In the process of urbanization, the urban population and the number of motor vehicles have greatly increased, which puts forward new requirements for urban managers [3]. At the same time, the city's original road network has already taken shape, but the growth rate of vehicles is much faster than that of new roads [4]. The relationship between supply and demand inversion leads to the normalization and increasing severity of urban congestion. The traffic pressure caused by the sudden increase of vehicles has reached its limit in many large cities. If an emergency occurs, the road network is extremely broken, resulting in problems, such as personnel being unable to evacuate quickly, rescue forces being unable to come in time, rescue materials being unable to arrive at the accident site, and disorders in resettlement sites, thus causing greater losses.

The key component of the emergency traffic response plan is the selection of flow paths for personnel, vehicles and materials. On the premise of safety and short time, transferring as many people and vehicles in the affected site as possible is one of the intuitive standards to measure the feasibility of the plan [5]. With the aid of emergency evacuation paths, those who are in dangerous or affected sites can be evacuated to safe sites or resettlement places as soon as possible, thus minimizing the losses caused by emergencies. At the same time, rescue staff need to rush to the accident site for rescue, and rescue materials need to be transported to the designated place in time. Therefore, under the emergency traffic condition, how to use the existing traffic facilities and other emergency rescue and evacuation resources to carry out scientific and effective traffic organization and carry out rapid and effective evacuation and rescue work is of great significance to protect the safety of people's lives and property.

The associate editor coordinating the review of this article and approving it for publication was Mu-Yen Chen.

The underdevelopment of information collection technology and the inconvenience of information transmission and distribution will all lead that organizers of emergency response are unable to take correct countermeasures; travelers are unable to obtain timely, correct and useful information to select the optimal path for evacuation; rescue forces are unable to deliver relief supplies to the scene in time [6]–[8]. The increasingly severe situation of urban emergencies puts forward higher requirements for modern urban traffic emergency response system. It is of great significance to study the introduction of Internet of Things technology into the design of traffic emergency response system under urban emergencies to improve the level of emergency response.

II. APPLICABILITY ANALYSIS OF INTERNET OF THINGS TECHNOLOGY IN URBAN TRAFFIC EMERGENCY RESPONSE SYSTEM

With the development of Internet of Things, Internet technology has been extended and expanded. Information exchange and communication between any article and article are possible, thus realizing the connection of things. International Telecommunication Union (ITU) expanded the concepts of Internet of Things. That is, the goal of information and communication technology has developed from connecting anyone at any time and at any place to connecting any article, and the connection of things forms the Internet of Things [9]. The definition of Internet of Things of EU: The Internet of Things is a dynamic global network infrastructure with self-organization capability based on standards and interoperable communication protocols, in which physical and virtual "things" have identity, physical attributes, virtual characteristics and intelligent interfaces, and are seamlessly integrated with information networks [10]. Internet of Things technology uses information sensing equipment, such as Radio Frequency Identification (RFID), infrared sensors, GPS systems, laser scanners, etc. [11], real objects are connected to the Internet for information exchange and communication according to agreements, so as to realize intelligent identification, positioning, tracking, monitoring and management [12], [13]. The maturity and application of this technology provide new approaches, new methods and new ideas for solving urban traffic emergency response.

Facing the high pollution environment caused by emergencies, it is necessary to collect the flow data of personnel, vehicles and materials accurately in real time. However, the traditional method obviously cannot meet the requirements and needs shall be realized with the help of new technologies. The maturity of Internet of Things technology provides support to solve this key problem [14], [15]. For example, the radio frequency identification technology (RFID) in the Internet of Things technology has the characteristics of long identification distance, strong anti-interference ability, high accuracy and good data security [16]–[18], which can meet the requirements of data collection in emergencies.

The Internet of Things technology has the characteristics of intelligence, advancement and interconnection, as well as the characteristics of long-distance information transmission and strong anti-interference ability, which can meet the requirements of traffic emergency response system for data collection and transmission under urban emergencies [19], [20]. Rescue organizers can quickly and accurately receive information, grasp the evacuation of personnel and vehicles, the use of rescue personnel and materials, and take timely measures to improve rescue efficiency [21]. To sum up, the traffic emergency response system based on the Internet of Things will have advantages over the traditional emergency response system [22]. The match between the Internet of Things technology and the data information collection system under emergencies is shown in Fig. 1.

III. DESIGN OF TRAFFIC EMERGENCY RESPONSE SYSTEM UNDER URBAN EMERGENCIES

The traffic emergency response system under urban emergencies aims at rapid evacuation, personnel rescue and incident disposal. It is necessary to comprehensively consider the transportation paths of people in distress, rescue personnel, materials and equipment [23]–[25]. As the central organizer of the rescue system, it is necessary to obtain the data of the flow of personnel, vehicles and materials in time. Therefore, it is necessary to establish an emergency response system with the Internet of Things as the core technology [26].

First of all, the evacuation of trapped personnel and vehicles in emergencies is very important. On the one hand, it is to better rescue the injured, at the same time, it can also prevent more people from being injured, minimize the adverse impact of the incident, and create good external conditions for the successful disposal of the incident [1], [6]. By distributing radio frequency identification bracelet to evacuees and configuring radio frequency identification tags on vehicles, the flow information of personnel and vehicles can be accurately and quickly collected. Secondly, besides collecting the information of the evacuated vehicles, it is also necessary to collect the information of the vehicles participating in the rescue. This part of information is sent to the command center of the rescue system after big data processing to provide help for the rescue organizers to allocate vehicles. This work is jointly completed by the vehicle-mounted radio frequency identification tag, vehicle-mounted GPS system and traffic bayonet intelligent identification system [27], [40]. The allocation, transportation and distribution of rescue materials and the emergency settlement of personnel are also important issues to be considered in system design. To sum up, the traffic emergency response system under urban emergencies includes the following subsystems: personnel evacuation data collection system, vehicle operation data collection system, rescue material allocation and distribution data collection system, personnel settlement site data collection system, and traffic bayonet intelligent identification system, as shown in Fig. 2. In order to make the subsystems cooperate with each other and operate efficiently, it is also necessary to formulate detailed procedures for command and management, evacuation of personnel, disaster disposal and other work under

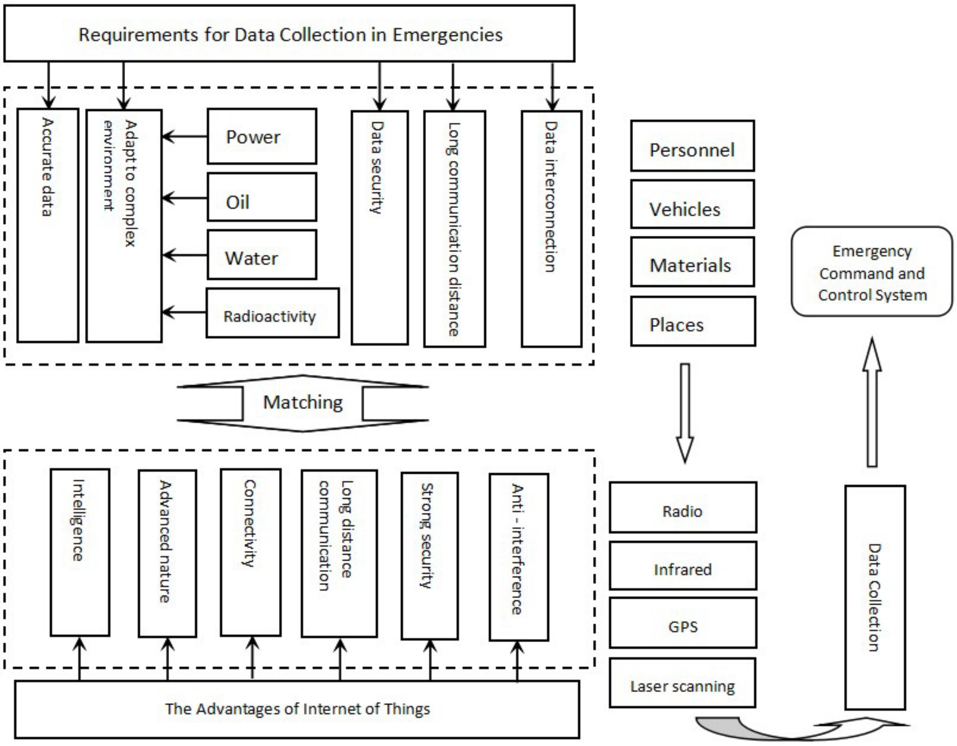

FIGURE 1. Matching of internet of things technology and data information collection system in emergencies.

emergencies. The establishment of this system plays a key role in improving the urban emergency security management system by using advanced technologies.

The traffic emergency response system adopts real-time and dynamic collection and analysis of the flow data of personnel, vehicles and materials under emergencies by using the Internet of Things technology and data mining technology. Thus, the rescue organizer can keep abreast of the latest situation of the incident and make the right decision. Compared with the traditional rescue system, the traffic emergency response system designed in this paper has the following advantages: the system has fast response speed and high accuracy. This solves the problem that the rescue organization in the traditional rescue system cannot obtain the accident scene information in time, resulting in slow response speed and high error rate; on the other hand, the system integrates personnel evacuation data, vehicle operation data, relief material configuration and distribution data, resettlement site data, and traffic card mouth data into a processing system for data analysis and processing. This can ensure the synergy between the respective systems to the maximum extent and achieve the optimal system.

IV. EMERGENCY ASSISTANT DECISION SUPPORT SYSTEM

After an emergency occurs, emergency response must be carried out as soon as possible and rescue forces from all sides must be coordinated to participate in the rescue, which puts forward higher requirements for emergency response organizers. Emergency rescue decision-making involves a wide range of aspects, many influencing factors, and complex field conditions. Most of the decision-making models are not suitable. In the actual decision-making process, the decision-making mainly depends on the practical experience of the organizers. This decision-making process relying on professional knowledge and work experience is difficult to express and realize on computer, and the correctness of the decision-making is too dependent on the decision-maker's own professional level with strong subjective uncertainty, which is difficult to meet the requirements of emergency rescue in emergencies.

In recent years, with the continuous breakthrough of data mining technology, use data mining to analyze expert experience and the establishment of expert knowledge system based on data mining have been widely used in various fields, for example, in the field of urban traffic [28], [29], [31], [32], medical field [30], [34], education field [33], [35], and so on. In view of this, based on historical decision-making data under emergencies, considering various subjective and objective factors that affect the decision-making behavior of traffic emergency response, the attributes of emergency decision-making activities are analyzed and determined, emergency rescue measures are summarized, and decision trees are trained through data mining algorithm, thus establishing an auxiliary decision-making model and solving the key problems of emergency auxiliary decision support system [36].

The establishment of the decision tree includes two processes: the growth of the decision tree and the pruning of the

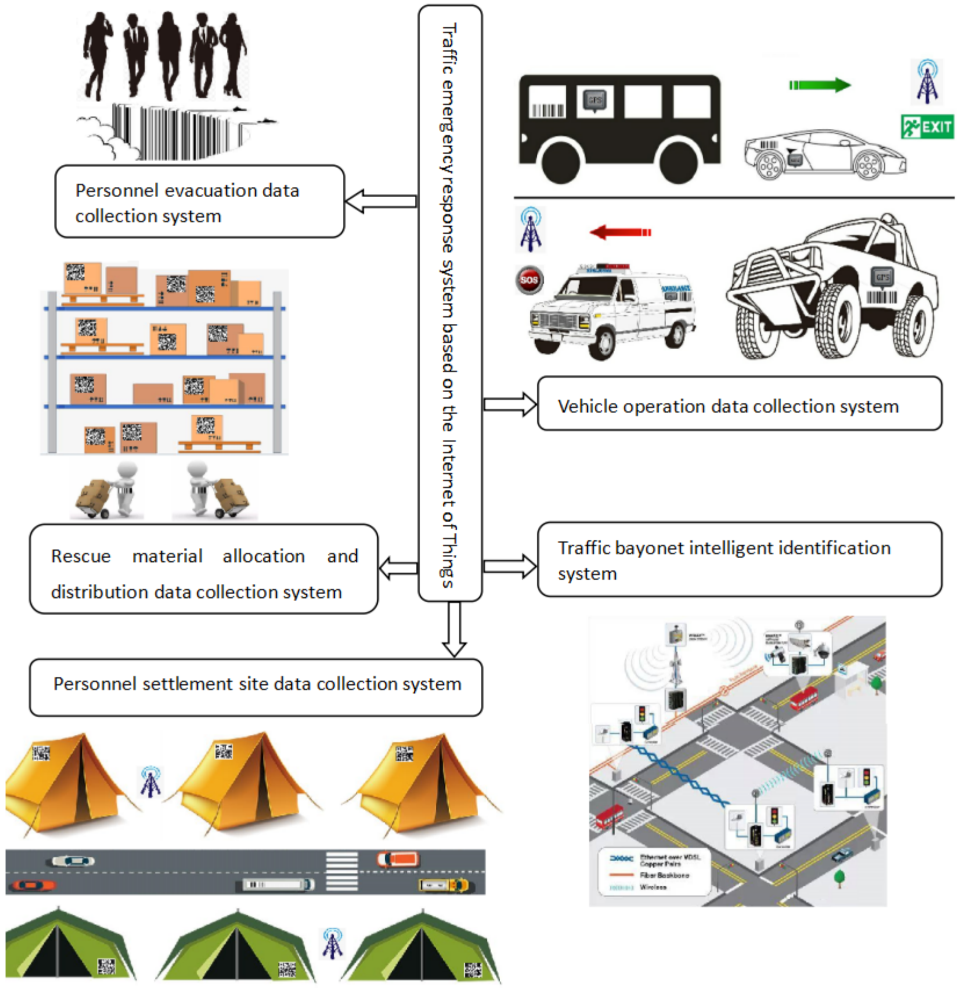

FIGURE 2. **Traffic emergency response system based on internet of things.**

decision tree. Different decision tree algorithms have different ways to deal with the problem. The differences between the commonly used C5.0, CART and CHAID algorithms are shown in Table 1. Considering that C5.0 adds Boosting algorithm in the classification process to make the results more accurate, it is proposed to use C5.0 decision tree algorithm to solve the problem of emergency auxiliary decision.

Historical decision data under emergencies is very important for data mining, but in reality, there are very few such data. The introduction of advanced technologies, such as Internet of Things, big data and cloud computing, in emergency response and rescue activities makes it possible to obtain such data. Through summarizing historical data, such as personnel evacuation, vehicle operation, allocation and distribution of rescue materials, personnel settlement sites, traffic bayonet, decision-making measures, etc., and classifying them by attributes, a structured database is formed.

In the process of rescue decision-making, the influencing factors of rescue decision-making can be divided into objective factors and subjective factors according to the source. The objective factors include personnel, vehicles, rescue materials, resettlement sites, etc. the subjective factors include expected targets, rescue priorities, protection of important targets, information release, etc., as shown in Fig. 3.

According to historical decision data, input data of the decision tree is trained, and C5.0 decision tree algorithm is implemented by using the data mining software Clementine. Firstly, through the sample set segmentation function of Clementine software, the data source with a specified proportion is taken as the training set, the confidence level of pruning purity is set, and the global pruning method is adopted to finally generate the target decision tree.

Compared with the traditional decision tree, the emergency rescue response decision tree established by data mining has more branches, which is more suitable for complex decision problems, and can realize the decision process by means of computers. However, the decision tree is completely generated based on empirical training, and its shape depends on the characteristics of sample data. Therefore, there will be some branches with obvious errors, which need to be corrected by the organizer of rescue activities according to

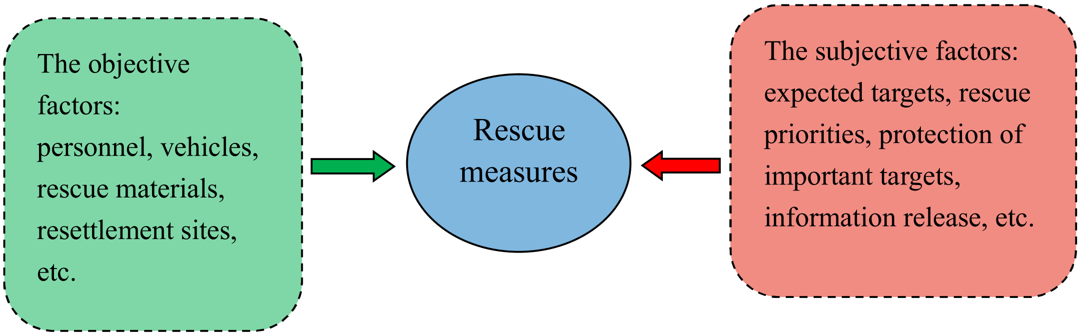

FIGURE 3. Main influencing factors of rescue decision.

TABLE 1. Main differences of decision tree algorithms.

	C5.0	CART	CHAID
Output variables	Classification type	Classification type and numerical type	Classification type and numerical type
Input variables	Classification type and numerical type	Classification type and numerical type	Classification type and numerical type
Select the best grouping variable and the best segmentation point	Information gain rate	Gini coefficient and variance	From the perspective of statistical significance
Pruning	According to the training set, post-pruning	According to the test set, pre-pruning and post-pruning	Pre-pruning
Tree	Multi-fork number	Binary number	Multi-fork number

the actual situation. It is not a completely executable program as an important emergency auxiliary decision support.

V. APPLICATION OF INTERNET OF THINGS TECHNOLOGY IN QINGDAO TRAFFIC EMERGENCY RESPONSE SYSTEM

In order to further improve the traffic emergency response system under emergencies based on Internet of Things technology, the author takes Zhongshan Road Business District in Qingdao as an example to construct a specific traffic emergency response mode and corresponding operation steps. As a city under separate state planning and a sub-provincial city, Qingdao is an economic center of Shandong Province, an important national coastal city, a coastal resort city and an international port city, as well as a major node city and a strategic supporting for maritime cooperation of "one belt, one road" new Eurasian continental bridge economic corridor. Its development momentum is rapid and it is moving towards an international city. The impact and harm brought by emergencies can be said to be beyond estimation. Opportunities and challenges coexist, and the rapid development of the city puts forward higher requirements for the city's emergency management level. Zhongshan Road Business District of Qingdao was founded in 1897 during the German occupation period. It is a famous business center in Qingdao with a length of 1500m and is connected to Trestle Bridge in the south and Dayaogou in the north.

Through the research on the road setting, building type, pedestrian flow and traffic flow characteristics of Zhongshan Road Business District, it is found that the surrounding environment is complex, non-main roads are narrow, pedestrian flow density is high, etc. In this area, the evacuation and resettlement of personnel should be considered emphatically. Second, consider the problems of rescue personnel arriving at the incident site quickly and transporting rescue materials. In the face of unexpected events, the data on the flow of people, vehicles and materials can be uploaded quickly, analyzed in timely manner and delivered accurately to form a traffic emergency response system for Zhongshan Road Business District based on Internet of Things technology to improve the ability to deal with emergencies.

A. COLLECTION AND ANALYSIS OF EVACUATION DATA

After an emergency occurs, the flow of personnel should be grasped in a timely manner, mainly including the number of people evacuated, evacuation methods, evacuation routes and other information. Timely and accurate collection of the above information is conducive to the orderly evacuation of personnel and the further development of reasonable

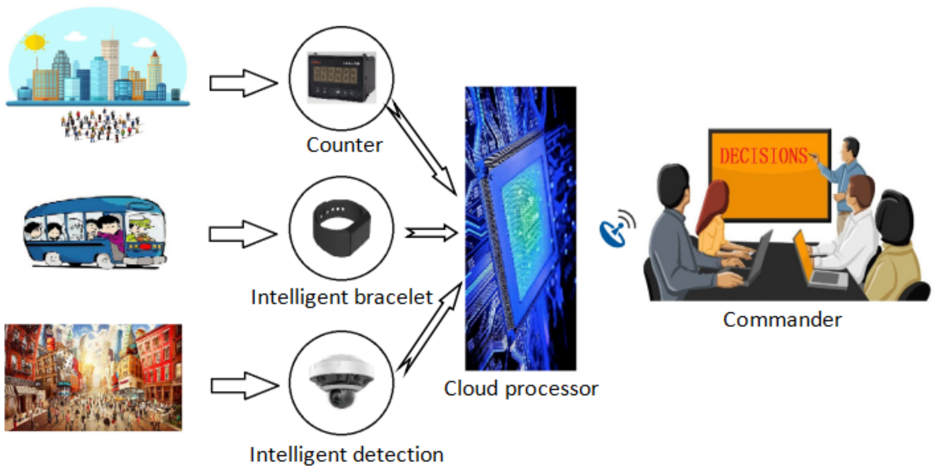

FIGURE 4. Data collection and analysis process of evacuation.

resettlement [37]–[39]. The number of evacuees is counted through the number counting system installed at the exits of major buildings in Zhongshan Road Business District. Statistics can be made by distributing radio frequency identification bracelets to the personnel evacuated by public transportation. Through large-scale commercial facilities and existing public safety monitoring systems on main roads, the status of personnel in public areas and evacuation paths for personnel can be grasped in a timely manner. The information collected by the sense layer of the Internet of Things is submitted to the back-end cloud processing system for analysis and processing, and the processing results are supplied to the organizers of emergency disposal. The process of collecting and analyzing evacuation data is shown in Fig. 4.

B. DATA COLLECTION AND ANALYSIS OF VEHICLE OPERATION

Based on the Internet of Things technologies, such as RFID technology, sensor technology, ubiquitous communication and network, the vehicle operation data is connected to the Internet to realize the interconnection and intercommunication among various elements of the traffic emergency response system, such as personnel, vehicles, materials and the like. Collect real-time vehicle operation state data, carry out real-time simulation and decision-making through the central processing system, provide decision support for emergency response organizers, realize the intelligent and optimal operation of the entire emergency traffic management system, thus effectively improving the road congestion problem in the evacuation process and improving the rescue efficiency. Vehicle operation data collection mainly includes data collection of evacuated vehicles and data collection of vehicles participating in rescue.

1) DATA COLLECTION AND ANALYSIS OF EVACUATED VEHICLES

Evacuated vehicles generally refer to all social vehicles within the site affected by emergencies. On the one hand, the detention of these vehicles has potential safety hazards, on the other hand, it will also have adverse effects on rescue work. As the roads around Zhongshan Road Business District are relatively narrow, the sharp increase in traffic flow in a short period of time will easily lead to road congestion, thus affecting the evacuation efficiency. In order to master the operation data of this part of traffic flow and guide its evacuation in a reasonable and orderly way, it is necessary to collect, analyze and transmit information, such as the position, speed, inside and outside images of the vehicle in real time through Internet of Things technology [41]–[43], [53]–[55]. Since most of the evacuated vehicles are social vehicles, they generally do not have automatic vehicle identification conditions. To solve this problem, the following measures are mainly taken. First of all, emergency volunteers will temporarily install portable on-board radio frequency identification tags on the evacuated vehicles according to the principle of lump sum. Secondly, give full play to the function of the traffic bayonet and collect the operation data of the evacuated vehicles through the intelligent equipment of the traffic bayonet. The data collection and analysis process of evacuated vehicles is shown in Fig. 5.

2) DATA COLLECTION AND ANALYSIS OF RESCUE VEHICLES

Vehicles involved in rescue refer to vehicles involved in incident handling, rescue, first aid and evacuation. These vehicles mainly include fire engines, ambulances, police cars, engineering vehicles, etc. Rescue vehicles arrive at the scene quickly, rescue forces are rationally allocated, and work can effectively improve rescue efficiency. Although rescue vehicles are equipped with GPS and other equipment, they belong to different departments and are difficult to cooperate with each other with poor coordination. Therefore, the conventional rescue vehicles in the whole city should be equipped with Internet of Things equipment. In case of emergency, the operation data of all vehicles will be transmitted to the traffic emergency response system through the dedicated frequency band. The traffic emergency response system will

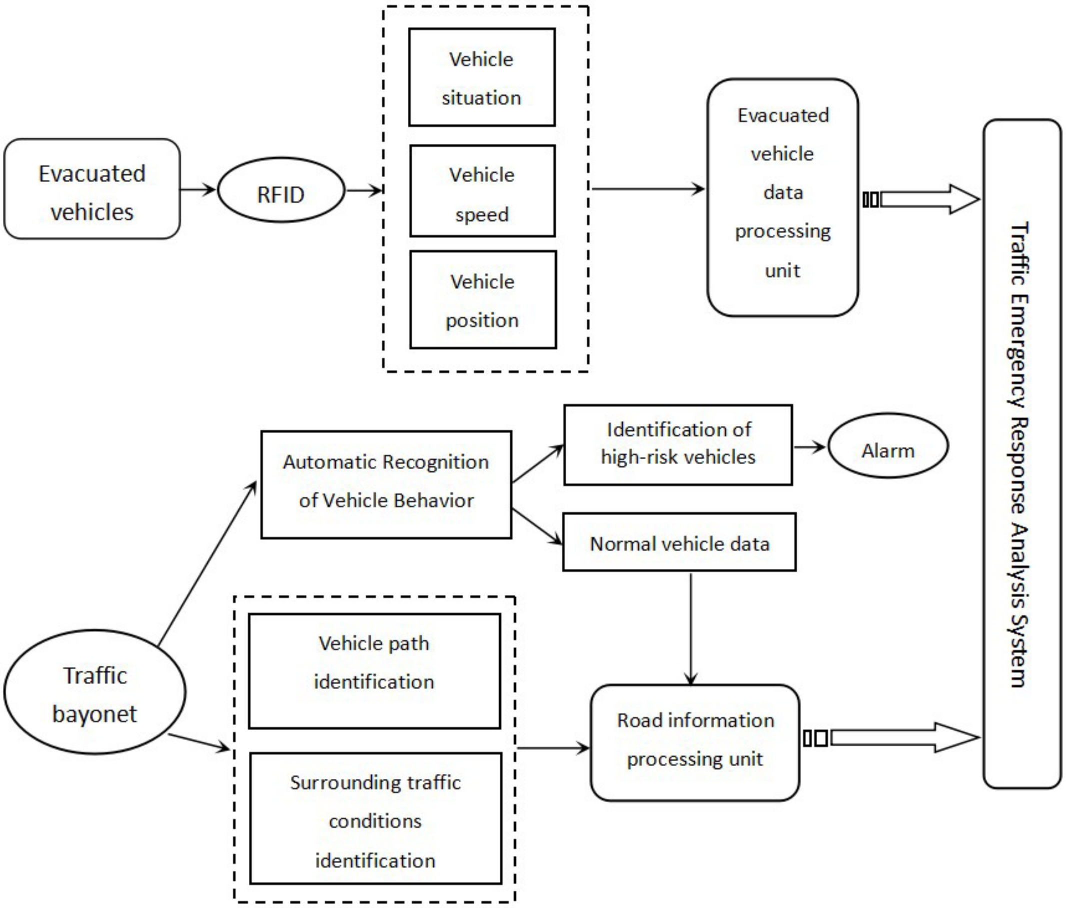

FIGURE 5. Data collection and analysis process for evacuated vehicles.

reasonably allocate nearby vehicles to participate in the rescue according to the emergency situation and provide the best path selection for rescue vehicles. Take Zhongshan Road Business District as an example, the locations of the surrounding hospitals, fire stations and police stations are shown in Fig. 6.

By analyzing the location of rescue stations around Zhongshan Road Business District, it is found that rescue forces need to pass through some narrow streets to reach the emergency site. These streets are very easy to become very congested due to the occupation of evacuated vehicles, thus causing rescue vehicles to be unable to work in a timely manner. Therefore, the traffic situation in this area should be analyzed in real time, the traveling paths of the rescue vehicles involved should be dynamically planned [44], [45], and green rescue paths should be opened when necessary. Based on the Internet of Things technology, an emergency rescue path guidance system is established. First, basic information, such as the locations of rescue vehicles, the location of rescue, and the dynamic situation of roads is obtained, and the above information is transmitted to the rescue path guidance processing unit. Through big data analysis [46], information fusion [47], [48], optimization methods [49] and other technologies, the best dynamic path is optimized, and rescue vehicles are guided to the incident site. When the optimization result cannot effectively improve the traveling speed of rescue vehicles, the system will interfere with the traffic signals in the above areas and propose how to open a green rescue path to the organizers of emergency response. The emergency rescue path guiding system is shown in Fig. 7.

3) PROCESSING OF VEHICLE DATA INFORMATION

Under the condition of emergency, traffic congestions can easily occur. Thus, how to determine the best evacuation and rescue route online based on the collected vehicle data information is very important. Through comparing the common path planning algorithms such as A* algorithm, ant colony algorithm, Dijkstra algorithm and Floyd algorithm, it is found that these algorithms can hardly meet the requirements of traffic emergency response system under emergencies. It is found that the variable structure discrete dynamic Bayesian network model developed on the basis of variable structure dynamic Bayesian network has a good effect on processing discrete data. The tool with variable structure discrete dynamic Bayesian network will help to complete real-time dynamic path planning, so that the evacuated vehicles

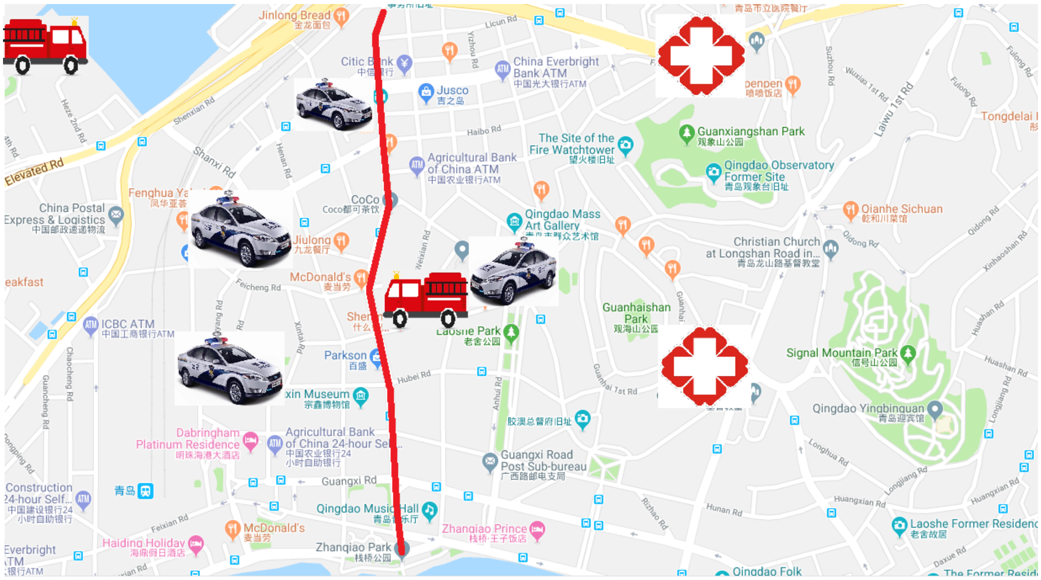

FIGURE 6. Location map of rescue stations around zhongshan road business district.

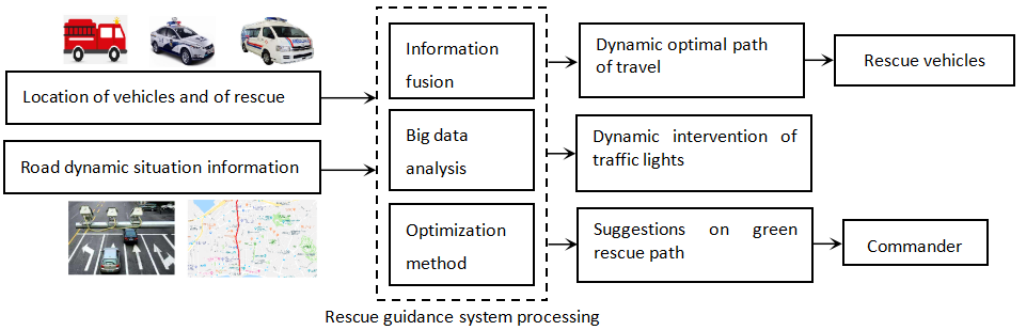

FIGURE 7. Emergency rescue path guidance system.

can quickly leave the incident area. At the same time, this can guide the vehicles involved in the rescue work to quickly arrive at the designated location to carry out work.

C. DATA COLLECTION AND ANALYSIS OF PERSONNEL SETTLEMENT AND RESCUE MATERIAL DISTRIBUTION

The application of Internet of Things technology to the traffic emergency response system in the bustling commercial districts of the city is helpful to guide the emergency evacuation and organization and management of personnel in case of emergencies, to avoid unnecessary congestion, and to scientifically allocate rescue materials at the same time. Important personnel resettlement sites near Zhongshan Road Business District include Zhongshan Mall, Guanxiangshan Park, Guanhaishan Park, Trestle Bridge Scenic Spot, etc., as shown in Fig. 8.

1) DATA COLLECTION OF PERSONNEL SETTLEMENT SITES

When the evacuated personnel enter the resettlement sites under the guidance of the staff, they receive the intelligent bracelet with radio frequency identification tags, read the data of the number, distribution and activity of the crowd through the reader-writer, and submit it to the background for storage analysis, record the basic situation and relevant distribution of the evacuated personnel, which is helpful to better understand the working progress of the resettlement site. The sorted information is then sent to the organizer of the emergency response and transmitted to the mobile equipment of the evacuated personnel. The information processing is shown in Fig. 9.

2) DATA COLLECTION FOR ALLOCATION AND DISTRIBUTION OF RESCUE MATERIALS

The distribution of rescue materials is an important part of the rescue work, and it is necessary to timely grasp the location, quantity and status information of rescue materials. The Internet of Things technology is used to establish a data collection system for the allocation and distribution of rescue materials. When the rescue materials are allocated and collected, automatic recording and self-service collection can be realized, and the collection records and material balance records will be updated in real time. The application of Internet of Things technology can effectively reduce the occurrence of errors and omissions due to complicated or incomplete registration, which is more conducive to the rational

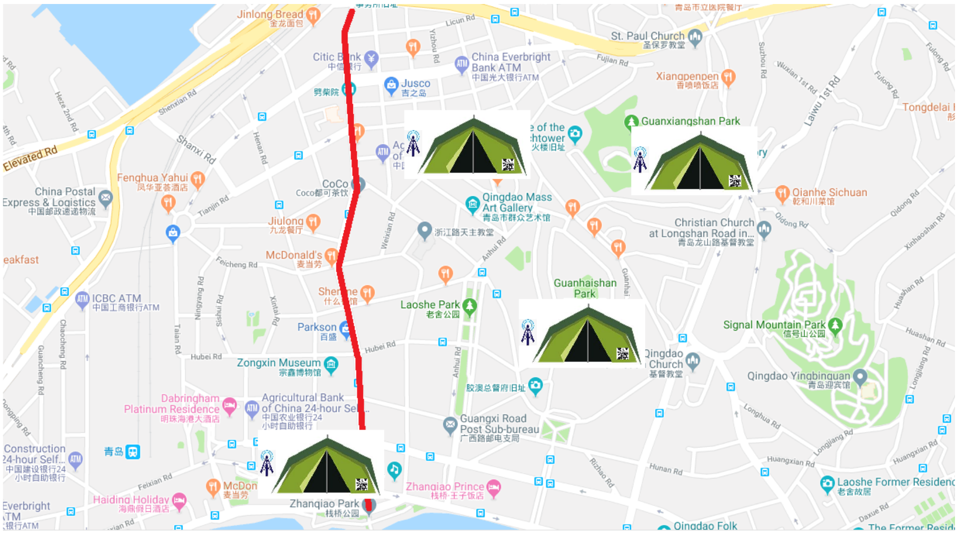

FIGURE 8. Location map of personnel settlement sites around zhongshan road business district.

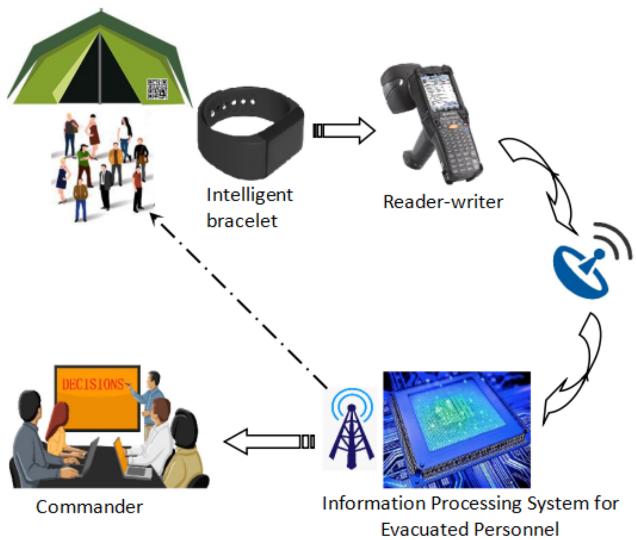

FIGURE 9. Information processing of evacuated personnel under internet of things technology.

allocation of resources by emergency organizers and improves the rescue quality [50]–[52]. The hierarchical structure of the rescue material allocation and distribution management system based on the Internet of Things technology is shown in Fig. 10.

D. COLLECTION AND ANALYSIS OF EMERGENCY DATA IN TRAFFIC BAYONET

The traffic bayonet system adopts advanced photoelectric technology, image processing technology and pattern recognition technology to take clear images of every passing car and automatically recognize the license plate and driver characteristics. The collected vehicle information data are stored in the server database in real time. The high-definition traffic bayonet system can also quickly capture the vehicles causing the incident, vehicles violating regulations, blacklisted vehicles, etc. Under normal circumstances, the traffic bayonet system is mainly used for the management of vehicles. It can simultaneously record the close-up image of the front part of the vehicle and the panoramic image of the vehicle, with a resolution of 768×576, which can meet the general requirements. However, for the data collection of the traffic emergency response system under emergencies, the resolution is relatively low because the facial features of drivers and as many vehicle details as possible need to be clearly seen. For this reason, scientific research institutions have developed a high-definition traffic bayonet system that can record vehicle images up to 2 million pixels or more. The resolution of vehicle images can reach 1600*1200 pixels or more. Taking a photo at the same time cannot only clearly see the facial features of drivers and passengers, but also can distinguish the license plates of vehicles with high quality. It has a very high automatic license plate recognition rate which can actually reach over 98%. When an emergency occurs, the system can immediately switch to the emergency data collection program to provide data support for the evacuation of personnel and vehicles, the arrival of rescue vehicles at the site, and the distribution of rescue materials. At the same time, relate to drug-related, involved, fugitive, key personnel information database, warn the vehicles under his name, intelligently warn the high-risk vehicles, such as entering the city for the first time, drivers covering their faces, and passing cards. The emergency data information of the traffic bayonet is uploaded to the ‘‘traffic bayonet information processing system’’ for analysis, then transmitted to the organizer of emergency disposal and sent to the mobile police system of the police personnel on site.

VI. WORKING FLOW OF TRAFFIC EMERGENCY RESPONSE AND DISPOSAL

After the occurrence of an emergency, the organizer of the emergency response shall dispatch relevant personnel to the

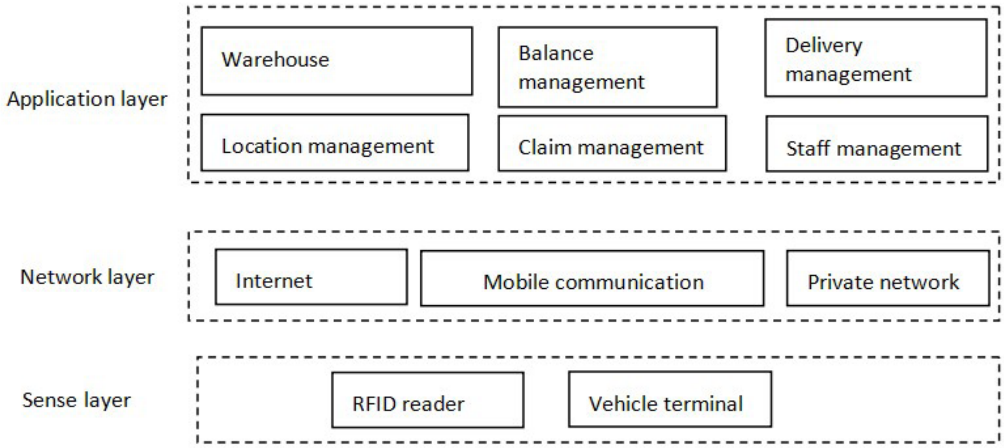

FIGURE 10. Hierarchical structure of material allocation and distribution system based on internet of things technology.

site at the first time, cooperate with each other and jointly implement the emergency response in accordance with the pre-plan and disposal procedures to fully control the incident situation and prevent the incident from expanding.

A. ON-SITE RESCUE

Before the medical staff arrive at the site, the emergency rescue force who arrive in advance shall, in accordance with the first aid procedures, carry out on-site classification and examination of the injured in the incident, and carry out on-site first aid for the critically ill; Organizers equip evacuated personnel and vehicles with Internet of Things signs and guide them to evacuate according to the emergency response plan; After the traffic police rush to the site, they should immediately take effective measures to divert vehicles, divert traffic, protect the site trace evidence and fix the relevant evidence; The fire department is responsible for dismantling vehicles and rescuing people trapped in the vehicles due to overturning and deformation of the vehicles; Other police personnel are responsible for the maintenance of public order in the site; In case of special incidents, the organizer of emergency response shall be responsible for mobilizing professionals and tools for rescue.

B. DATA COLLECTION, UPLOADING AND ANALYSIS

Using various Internet of Things sensing technologies, relevant data are collected and uploaded to the emergency response system. The organizer of emergency disposal shall, according to the data obtained, quickly and comprehensively grasp the specific situation of the incident, define the necessary measures for personnel safety protection, determine the scope, methods and procedures for evacuation of personnel and vehicles under emergencies, and organize their implementation. The organizer shall also coordinate medical, police and rescue personnel to quickly arrive at the site for rescue to prevent the incident from spreading or causing secondary injuries.

C. OPENING OF EMERGENCY RESETTLEMENT SITES AND DISTRIBUTION OF RESCUE MATERIALS

At the same time of on-site rescue, it is decided whether to use the resettlement site according to the severity of the incident. When the organizer of emergency response decides to use these places, it should immediately do a good job in rescue work, such as personnel receiving and resettlement. In particular, it is necessary to do a good job in the digital management of personnel and materials, and submit the specific resettlement situation to organizers of emergency disposal.

D. INCIDENT RECOVERY

After an emergency occurs, the organizer of the emergency response shall, according to the needs of the response, issue prevention and response tips to the public through radio, television, newspapers, websites, outdoor display screens, short messages, etc., and mobilize all social forces to assist in the rescue and response work. After the rescue on site is completed, the site shall be cleaned up in time to repair the damaged traffic facilities and restore normal traffic order. After the emergency respond is completed and the elimination of hazardous factors is confirmed, the graded response initiating unit shall decide and announce the end of the emergency disposal. Relevant departments carry out post-disaster recovery and reconstruction, such as allocating rescue funds and materials, investigating the causes of the incident, and resuming production and living plans.

VII. EVALUATION OF TRAFFIC EMERGENCY RESPONSE SYSTEM DESIGN SCHEME

In order to verify the effectiveness and feasibility of the traffic emergency response system design scheme designed in this paper, this paper designs a comprehensive evaluation index system from five aspects: personnel evacuation subsystem, vehicle operation subsystem, rescue material allocation and distribution subsystem, resettlement site subsystem, and

TABLE 2. Comprehensive evaluation index of traffic emergency response system.

Target Layer	Criteria Layer	Index Layer
Comprehensive evaluation of traffic emergency response system	Personnel evacuation subsystem	Evacuation efficiency
		Evacuation path rationality
		Data collection accuracy
		Data collection convenience
	Vehicle operating subsystem	Evacuated vehicle data collection
		Rescue vehicle data collection
		Data collection accuracy
		Data collection convenience
	Relief material allocation and distribution subsystem	Material distribution accuracy
		Resource allocation rationality
		Data collection accuracy
		Data collection convenience
	Placement subsystem	Comprehensive data collection
		Data collection accuracy
		Data collection convenience
		Data feedback timeliness
	Intelligent identification subsystem of traffic bayonet	Recognition accuracy
		Switching timeliness
		Comprehensive data collection
		Data collection accuracy

traffic bayonet intelligent recognition subsystem. Based on the Critic-G1 combination method, the criterion layer and index layer in the traditional fuzzy comprehensive evaluation model are modified to establish a fuzzy comprehensive evaluation model for the system.

According to the impact degree and safety assessment content of the traffic emergency response system, a comprehensive evaluation index system of traffic emergency response system is constructed. The specific evaluation indicators are shown in Table 2.

In order to make the evaluation results reflect the subjective experience of the experts, and reflect the objective information of the actual indicator data, as well as the degree of mutual influence and relative importance of the indicators, this paper combines the subjective and objective weighting methods. Firstly, according to the experience of experts, give the order of importance of each evaluation index, and then calculate the critic information C_k, $k = 1, 2, \cdots, m$ of all evaluation indicators, and the calculation formula is:

$$C_k = \delta_k \sum_{i=1}^{m} (1 - r_{ik})$$

Herein, δ_k is the standard error of the k evaluation index, and r_{ik} is the correlation coefficient of the i index and the k index.

The ratio of the importance of the subjective given in the conventional G1 method is replaced by the ratio of the Critic information of each evaluation index X_{ik} to the least important index X_{mk}. Its calculation formula is:

$$r_{km} = \begin{cases} C_k/C_m, & C_k > C_m \\ 1, & C_k \leq C_m \end{cases}$$

Then calculate the weight of the kth evaluation index W_k based on the Critic-G1 combination method.

$$W_k = r_{km} / \sum_{i=1}^{m} r_{im}, \quad k = 1, 2, \cdots, m$$

Because the fuzzy comprehensive evaluation is directly used by experts to score the index weights, subjective randomness is greater. Therefore, the weights of the criterion layer and the index layer are determined by the Critic-G1 combination method. After the data is cleaned and dimensionless, the weights of each criterion layer to the target layer and each indicator layer to the criterion layer are calculated by MATLAB programming. The index weight matrix of the construction criteria layer is $A = \{0.3 \ 0.4 \ 0.1 \ 0.1 \ 0.1\}$, and the indicator weight matrix of the indicator layer is:

$$A_1 = \{0.72 \quad 0.18 \quad 0.06 \quad 0.04\}$$

$$A_2 = \{0.81 \quad 0.07 \quad 0.05 \quad 0.07\}$$
$$A_3 = \{0.70 \quad 0.19 \quad 0.04 \quad 0.07\}$$
$$A_4 = \{0.64 \quad 0.25 \quad 0.05 \quad 0.06\}$$
$$A_5 = \{0.75 \quad 0.18 \quad 0.07 \quad 0\}$$

Then follow the calculation steps of the fuzzy comprehensive evaluation for subsequent calculation. Firstly, according to the evaluation index data and the positive and negative index scoring formula, each index data is scored to construct a single factor evaluation matrix R_i; Second, build a review set of evaluation objects $M = \{M_1, M_2, M_3, M_4\} = \{excellent, good, \text{mod}erate, poor\}$ and the index set $U = \{X_{11}, X_{12}, \cdots, X_{54}\}$; and multiply the single factor matrix and the corresponding index layer matrix again to obtain the first-level fuzzy comprehensive evaluation result $B_i = A_i \times R_i$; finally, establish a first-level fuzzy comprehensive evaluation matrix $L = (B_i, \cdots B_m)^T$, conduct a two-level comprehensive evaluation and obtain a judgment vector $B = A \times L$; a given score level is substituted, the results of the system are as follows:

$$W = B \times T = \begin{pmatrix} 0.1902 & 0.5423 & 0.2716 & 0.1521 \end{pmatrix} \times \begin{pmatrix} 100 \\ 75 \\ 50 \\ 25 \end{pmatrix} = 77.075$$

From the final evaluation results, it can be concluded that the traffic emergency response system designed in this paper is rated as "excellent". The establishment of this system has a significant effect on improving the efficiency of emergency rescue and the quality of rescue.

VIII. CONCLUSION

Internet of Things technology has many advantages, such as high efficiency, large capacity, accuracy and efficiency, saving manpower, etc. It has been widely used in various fields. The author comprehensively analyzed the demand for traffic emergency response in emergencies, discussed the data collection methods under specific circumstances, introduced the Internet of Things technology in a targeted way, constructed a traffic emergency response system under urban emergencies based on the Internet of Things technology, including subsystems, such as personnel evacuation data collection system, vehicle operation data collection system, rescue material allocation and distribution data collection system, resettlement site data collection system, traffic bayonet intelligent identification system, etc. Taking Zhongshan Road Business District in Qingdao as an example, the specific implementation steps and operation procedures were discussed.The system design scheme has good data coordination ability and emergency response capability, and can effectively solve the problem that the rescue organization in the traditional rescue system cannot obtain the accurate information of the accident scene in time. At the same time, this can also solve the problem of un-coordination between various rescue information from different information channels. The implementation of this program will greatly improve the traffic emergency response speed under emergencies, thus substantially improving rescue efficiency and rescue quality.

Using Internet of Things data collection technology to comprehensively obtain on-site emergency information and organizing rescue work is the first application at the level of urban emergency management, which can provide some reference for the intelligent management of modern large cities. However, the system still has problems such as complicated data acquisition, huge errors, and insufficient optimization of the system analysis algorithm, causing obstacles to the system implementation to a certain extent.With the progress of Internet of Things sensing technology, communication technology, network technology and other application support technologies. In future research, data collection accuracy will be further improved and system analysis capability will be enhanced to comprehensively improve the efficiency of emergency response. In addition, the method can also be applied to other types of disaster prevention and avoidance management function design in order to establish a more intelligent and safer urban disaster prevention and avoidance management system.

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