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The Role of Unmanned Aerial Vehicles in Future Smart Cities

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ABSTRACT

The idea of expanding smart cities in the future has come to the minds of advanced societies as an efficient solution to solve current and future problems, which will play a very vital role in urban planning. The current research was conducted to identify the role of unmanned aerial vehicles in future smart cities. The present research was conducted in a mixed (qualitative-quantitative) method. The participants of the qualitative part, which was implemented based on the method of thematic analysis, were 14 experts, including specialized and experienced managers in the fields of urban security, urban and interurban transportation, road and urban development, aviation organization and aviation industries, and The Information and Communication Technology Organization of Greater Tehran cities until reaching theoretical saturation and in the quantitative part, all the expert experts of the relevant devices, numbering 134 people, using Cochran's formula and targeted sampling method, the number of 99 people They were selected as sample members. The reliability coefficient of the qualitative part was recorded by the method of two coders with the final result (83%) and the reliability of the quantitative part was recorded with Cronbach's alpha coefficient with the final result (0.91). MAXQDA software was used for qualitative data analysis and SPSS software was used for quantitative data analysis. The findings showed that in the process of explaining the role of unmanned aerial vehicles in future smart cities; There are 5 inclusive themes, 16 organizing themes and 58 basic themes. The results showed that unmanned aerial vehicles can play a significant role in creating future smart cities through 1- intelligent air transportation, 2- agile monitoring and inspection, 3- smart urban and citizen services, and 4- smart law enforcement. The validation of the findings in the quantitative section also showed that all the identified motifs are valid and the relevant tools will be effective in the management of smart cities in the future.

Introduction

Urbanization and reduction of resources, population growth, demographic changes, challenges of climate change, etc. have drawn the attention of city planners and city managers to the

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necessity of a smart city as an alternative solution to urban problems [1] . Managing urban affairs, especially in the current situation where cities are facing rapid growth and the continuous creation of new problems, is a very difficult task that cannot be imagined end. City administrators are so struggling to solve acute problems such as environmental pollution, poor housing, urban traffic, urban security, infrastructure saturation, lack of services per capita, and huge population flooding there is little opportunity or even the ability to find solutions. Such problems have their roots in the movement towards a desirable perspective [2] . Hence, the importance of creating and managing future smart cities is formed. According to Ahmed Pour et al. (2017), the smart city has been proposed as the center of transformation and development of the millennium and means the opening of new concepts in urban planning that combine the capabilities of the real and virtual worlds to solve urban problems. They also believe that a smart city is a city that uses information and communication technology to increase operational efficiency, improve the quality of government services provided, and as a result, raise the level of well-being of people in the society. Smart environment, smart transportation, smart economy, smart governance, smart life, smart people, and smart energy are some of the features that smart cities should use and benefit from in improving the welfare of society. Forecasting and future research of changes in the management of smart cities, through resource management and providing services to city dwellers, research, development and production in various fields of relevant technology is gaining momentum [3] . Smart cities can take advantage of recent developments and innovations in information and communication technology, robotics and software; Optimize the use of resources and improve operations in health services, transportation, energy and water, as well as increase the comfort level of residents. The effective and efficient use of information and communication technology in smart cities, in addition to more effective and active interaction with citizens, leads to a reduction in costs and resource consumption [4]. One of these technologies is unmanned aerial vehicles, which can provide many applications for future smart cities and have a positive impact on society. For example, UAVs can be used for environmental monitoring, traffic management, pollution monitoring, civil security control, and delivery of goods. Unmanned aerial vehicles can provide cost-effective services to help achieve the goals of smart cities [5]. The use of unmanned aerial vehicles in various fields has many advantages, and with a general look at how to use this device, it is clear that the future is unmanned aerial vehicles. In addition, the coronavirus pandemic has helped to accelerate the general adoption of drones in the air fleet. Currently, the use of drones is very high and it is natural that in the coming years, the use of these devices in everyday life will become much more prominent. These new tools use the latest developments. Today, unmanned aircraft systems are autonomously modified remotely controlled, or managed by a remote control or ground station [6]. In the modern era, artificial intelligence and the Internet of Things have been implemented in unmanned aerial vehicles, and such technologies in integrated urban management systems can have positive aspects for citizens. These multitasking technologies have proven to be both accurate and timely and can meet the needs of urban dwellers at the right time and place [7]. Since cities inherently face complex and extensive challenges that are related to each other and the rapid growth of cities is not proportional to the expansion capacity of their infrastructures and increasing pressure is imposed on urban infrastructures, therefore cities always suffer from adverse consequences. Therefore, old institutions and methods of management and governance are at odds with the complex and rapidly changing world of the information society. Therefore, one of the new concepts to deal with the current challenges of cities in the field of urban planning is the development of smart cities, where drones can be used as one of the dimensions of future city management. Therefore, by looking at the capabilities of these devices that integrate physical and virtual capabilities, the current research aims to answer the question of what role unmanned aerial vehicles play in the management of future smart cities.

Background Research

Akhawan [8], in a research entitled “Investigating and identifying the components of a smart city”, extracted the components of a smart city. The results showed that urban management specialists should use the components of information technology, smart governance, smart security, and

smart transportation in the development of a smart city. Frouzesh [8], studied the indicators of the smart city of Bishdar for the city of Shiraz. According to him, the main characteristics of a smart city are smart governance and then smart mobility, which is possible through various methods, including the use of drones. Qaddawi and Tabataba [9] investigated drones and their use in the security of smart cities. The results showed that drones play an important role in providing timely and necessary wireless communication services for the recovery of services immediately after a disaster and the applications of public security, smart cities, and smart police. Collaboration between drones and communication infrastructure can support public safety requirements such as real-time analytics, real-time monitoring, and advanced decision-making to help smart cities meet their public safety needs. Therefore, the deployment of UAV-based wireless communications can save people and ecosystems by helping public security organizations in efficiently facing threats and crisis management. Saber, Abedini, and Saadat Sarasht [10] investigated the use of UAVs in traffic management using photogrammetry. Considering the ever-increasing expansion of photogrammetry science and a new supply of drones using new technology, they found the use of these tools very useful in urban traffic management control. The results showed that unmanned aerial vehicles have more importance and advantages than traditional methods due to their low cost and high flexibility, the ability to move and carry a variety of sensors to measure a variety of environmental parameters, as well as their high response speed. Manju and colleagues [6] investigated the way drones work and are used in smart cities. According to them, drones can provide a lot of help in improving life in future smart cities by providing high-speed internet and also the Internet of Things. Mohammad and colleagues [4] studied the use of unmanned aerial vehicles in future smart cities. They concluded that drones can be used for environmental monitoring, traffic management, pollution monitoring, civil security control, and delivery of goods. Silva et al. [11] considered smart cities to have many challenges to reach a stable state. They considered the existence of suitable urban architecture that can easily connect different parts of the city as the most important component of a smart city. On the other hand, with drones, different parts of the smart city can be easily connected by using geometry in the smart city. Kim and colleagues [12] designed a model for smart city monitoring using heterogeneous drones. They suggested the use of three types of drones for the integrated monitoring of smart cities.

In recent years, various researches have been carried out regarding the creation and management of future smart cities and the factors affecting smart cities. However, what role unmanned aerial vehicles will play in future smart cities has not been discussed in such a way that it can include the innovation aspect of the present research.

Literature and theoretical foundations

Urbanization is a phenomenon of the new century. Although this phenomenon dates back to about seven thousand years BC, its new and increasing meaning comes back to the current century, which indicates a revolution in the field of city development and urbanization. So at the end of the 20th century, more than two-thirds of the world's population lived in cities. The expansion of urbanization in the current century has caused the preoccupation of many elites and experts with the issues related to the issues and its consequences [13]. In developing countries, unlike developed countries, the stages of population transfer from rural to urban areas have gone very fast. The arrival of new technologies has improved the standard of human life and the ease of living in cities. Also, the study of urbanization developments in different countries shows that cities have attracted many of the country's material and spiritual facilities due to the lack of infrastructure, including smart buildings, which has imposed many social and security consequences on the country [14]. The concept of smart city was formed in the early 1990s. The concept of a smart city, states that urban development is increasingly dependent on technology, innovation, and globalization, especially from an economic perspective. The concept of a smart city is becoming an important research area worldwide. The amount of data collected and the number of fixed sensors, surveillance cameras, and other devices that must be placed in a smart city are so large that using a small platform to replace them can reduce energy and resource costs. This smart platform should enable the implementation of various smart city services such as smart homes, smart unmanned aerial vehicles, smart energy networks, smart

transportation systems, and other possible future services [15]. From the point of view of thinkers, various theories have been presented about the smart city. The smart city has been proposed as the axis of transformation and development of the third millennium and it means the opening of new concepts in urban planning that combines the capabilities of the real and virtual worlds to solve urban problems. One of the basic foundations of a smart city is access to real-time information on citizens' actions and [3]. A city can be called smart if it has smart life, smart people, smart environment, smart mobility, smart government, and smart economy [16]. Meanwhile, citizens are a key part of the development of a smart city, because they are the creators and users of services and technologies, who present their ideas and opinions about the city. The concept of a smart city includes solutions for optimizing the use and management of tangible assets such as transportation networks, natural resources, and energy distribution networks, and intangible assets such as intellectual capital in the business sector. Money is public organizations. Smart city has the characteristics of "smart people, smart government, smart mobility, smart life, and smart economy". The passage into the 21st century and the expansion of urbanization, have created a golden opportunity for city managers to quickly move towards smartness and the use of technology. This intelligentization should be based on economy and economic development, and all tools should be used to move towards the intelligentization of cities [17].

Unmanned aerial vehicles are remotely controlled flying devices, also known as drones. Drones are capable of remote control and are designed and built for various purposes. Unmanned vehicles are used wherever human presence is a problem or an obstacle. These birds can either be guided and controlled remotely or fly automatically according to a predetermined program or intelligent complex dynamic systems [18]. The first unmanned aircraft was the Ariel Target plane, which was built in 1916. During the First World War, two countries, the United States of America and the United Kingdom, took measures to research and produce an unmanned aircraft so that it could carry a warhead; Finally, in 1927, this research concluded in the form of an air-to-ground ball with a propeller engine called Larynx. The design of this device was such that it reached a maximum speed of 200 miles per hour (320 kilometers per hour) and was able to carry a The warhead weighs 250 pounds (113.5 kg) and has a range of 300 miles (480 km). This device was launched from land or a warship, and thus the first unmanned aircraft or drones were produced in 1930 in the form of ground-to-ground radio-guided bombs [8]. Currently, unmanned aerial vehicles are mostly used for transportation and have other capabilities such as [9]. Reducing human casualties in creating security is one of the goals of drones. Other advantages of these birds include greater maneuverability, lack of physiological pressure on the pilot due to altitude or acceleration, etc. [19].Today, many countries spend a lot of money on designing and building drones to perform various missions [5].

Currently, drones have developed rapidly and more than ever play a key role in a range of smart city applications and services, including photography, surveillance, disaster relief and management, security and surveillance, civil infrastructure inspection, and delivery of goods. Some of these applications may require the collection and processing of large amounts of data, which can be challenging given the resource-constrained nature of these aerial vehicles. In addition, for some applications, high-precision positioning and navigation in UAVs is critical, which may require solving complex UAV routing problems [20]. Countries such as England, Spain, America, Singapore, Norway, and the Netherlands use drones to plan green spaces, analyze traffic patterns, and identify areas that need improvement. Monitoring the development work, tracking the progress of projects and assessing the environmental effects, monitoring air pollution, identifying areas that need attention, as well as tracking energy consumption, and identifying new construction projects are other tasks of drones that in the future Not so far, they will be used and exploited by many countries [21]. The rapid increase in the use of unmanned aerial vehicles (UAVs) and the development of smart cities opens up new opportunities and challenges in providing and using up-to-date information about various spatial features and phenomena that shape our world. Such information must be provided from variable locations, sometimes with a short time delay or with a high update rate, and practically always at the lowest possible cost. In all these factors, drones can excel as they have proven to be an effective tool for various mapping and surveillance purposes. In addition, many UAV applications that do not target spatial data

collection are currently in operational use or under development [12].

Research Method

The present research was conducted in a mixed (qualitative-quantitative) method. The library method was used to collect theoretical information and the interview method was used to collect field results. The data collection tool in the qualitative part was an open questionnaire and in the quantitative part a researcher-made closed questionnaire with a Likert scale including 58 items and 16 components. The participants of the qualitative part, which was implemented based on the method of thematic analysis, were 14 experts who are knowledgeable about the subject, including specialized and experienced managers in the fields of urban security, urban and intercity transportation, University of Medical Sciences, Road and Urban Development Organization, Aviation and Aviation Industries and Organization of Information and Communication Technology of Greater Tehran until reaching the theoretical saturation and in the quantitative part, all the expert experts of the relevant devices and in the number of 134 people, using Cochran's formula and purposeful sampling method. 99 people were selected as sample members. In the qualitative part, through open interviews that were conducted for 65 to 85 minutes, after conducting 14 interviews, the relevant factors in the interviews were repeated and the researcher reached saturation. In the analysis, the total number of basic themes identified was in the form of 58 titles, which were finally reduced to 16 organizing themes in the coding process and categorized into 5 overarching themes. In the second stage, the questionnaire was adjusted based on the results of the first stage (qualitative part). To ensure the validity of the qualitative part of the research and to ensure the accuracy of the findings from the researcher's point of view, valuable opinions of professors familiar with the field were used and to calculate the validity of the quantitative part, face validity was used. To calculate the reliability of the qualitative part of the questionnaire, the reliability method between two coders was used, and the reliability obtained from the two coders according to the calculations was 0.83, which indicated the appropriate reliability of the questionnaire. The reliability of the quantitative part was also calculated through Cronbach's alpha coefficient, and Cronbach's alpha coefficient for the research questionnaire was 0.91. MAXQDA software was used for qualitative data analysis and SPSS software was used for quantitative data analysis.

Discussion and findings

After conducting the interview and receiving the comments and answers of the interviewees, the thematic analysis process was carried out in 3 stages and the basic themes related to the role of unmanned aerial vehicles in future smart cities were extracted in the form of 52 themes as follows.

Table 1: Basic themes of the role of unmanned aerial vehicles in future smart cities.

1	Moving postal packages (postal birds)
2	Transporting medicines and medical equipment during the pandemic of epidemic viruses
3	Transportation of urban residents by small and large public flying vehicles (flying taxis and buses)
4	Inspection of vital and sensitive urban and suburban places and reporting possible damage
5	Inspecting the normal state of the city and reporting any unusual events to the competent authorities
6	Inspection of people's reports about urban violations and its reflection to the responsible organizations
7	Mapping of natural resources and intercity transportation axes
8	News coverage of street riots and marches
9	Aerial mapping of urban areas and reporting to the requesting authorities (carrier birds)
10	Aerial mapping of urban transportation routes for urban planning (geometer birds)
11	Moving a large volume of citizens by aerial subways (monorails)
12	Speeding up the movement of passengers with a small number (flying motorcycles)
13	Using drones by restaurants, shopping centers, etc. (Flying couriers)
14	Supervision of authorized urban projects and project progress report (watching birds)
15	Implementation of operations to disperse gatherings by birds equipped with tear gas tools, throwing nets, shotguns, etc.
16	Monitoring parks and public places and reporting the situation

17	Monitoring and reporting urban violations, including roadblocks
18	Informational and operational support for police missions
19	Monitoring the points that need relief and sending information to relief sources
20	Transportation of police equipment needed in times of conflict
21	Preparing and reporting hot news about natural and unnatural events
22	Monitoring unauthorized urban projects and reporting violations
23	Flying reporter birds over the population of cities and preparing news about the current situation
24	Rapid movement of relief forces by rescue birds
25	Detecting the amount of snow on public buildings and preventing the sudden fall of snow
26	Provision of internet for various urban equipments to launch internet of things
27	Observing and describing the traffic situation of cities in the direction of systematic planning
28	People helping and moving traffic injured people
29	Monitoring and measuring traffic and providing live reports to people and citizens through the media
30	Locating urban traffic and helping traffic officials to direct traffic to low-traffic routes
31	Real estate business and sharing attractive and spectacular pictures and videos from the outside and inside of the property
32	Protection of wildlife and forest parks against animal smugglers (forester birds)
33	Inspection and protection of vulnerable points of urban and suburban nature (environmental birds)
34	Inconspicuous examination of the health of migratory animals and travel to places that are too far or dangerous for humans
35	Providing internet in different parts of the city where it is not possible to build a telecommunication tower
36	Identifying activities and movements related to committing crimes to prevent crime
37	Rapid transfer of sick injured by emergency birds
38	The presence of unmanned aerial vehicles during firefighting operations
39	Sending first aid equipment to rescuers stationed in needy places
40	Directing and carrying out armed operations by armed birds
41	Rejecting and intercepting activities related to terrorist groups and smuggling groups
42	Statistics of the climate of cities
43	Measuring the air quality of polluted cities and submitting reports to regulatory bodies
44	Statistics of weather conditions in remote places that do not have a meteorological base
45	Implementation of air crime prevention patrols
46	Managing the amount of destruction and estimating costs caused by natural disasters
47	Flying at low altitude over the accident areas and looking for signs of life
48	Identifying and drawing possible and traversable routes that disrupt urban security
49	Supervision of public places under police supervision and prevention of possible crimes
50	Pursuing and monitoring and reporting the routes of fugitives from the clutches of the law and those who disrupt urban security
51	Identification and destruction of crime tools and instruments in crime-prone areas
52	Entering tight spaces to find missing persons due to various incidents

In the following and after continuous matching of the received information based on their similarities, differences and semantic stability, a label was considered for each of these parts or components during a process, and in this way,

organizing themes emerged in the form of 16 themes. The results are presented in Table 2.

Table 2: Themes organizing the role of unmanned aerial vehicles in future smart cities.

Basic themes	Organizer themes
Transportation of urban residents by small and large public flying vehicles (flying taxis and buses)	Transportation of city dwellers
Moving a large volume of citizens by aerial subways (monorails)	
Speeding up the movement of passengers with a small number (flying motorcycles)	
Transporting medicines and medical equipment during the pandemic of epidemic viruses	Transportation of objects and objects
Moving postal packages (postal birds)	
Using drones by restaurants, shopping centers, etc. (Flying couriers)	
Supervision of authorized urban projects and project progress report (watching birds)	Supervision
Monitoring unauthorized urban projects and reporting violations	
Monitoring of parks and public places and status report	
Monitoring and reporting urban violations, including roadblocks	
Inspection of people's reports about urban violations and its reflection to the responsible organizations	Inspection
Inspection of vital and sensitive urban and suburban places and reporting of possible damage	
Inspecting the normal state of the city and reporting any unusual events to the competent authorities	
Aerial mapping of urban areas and reporting to the requesting authorities (carrier birds)	Mapping and geometry
Aerial mapping of urban transportation routes for urban planning (geometer birds)	
Mapping of natural resources and intercity transportation axes	
News coverage of street riots and marches	Preparing and reporting news
Flying reporter birds over the population of cities and preparing news about the current situation	
Preparation and reporting of hot news from natural and unnatural events	
Observing and describing the traffic situation of cities in the direction of systematic planning	Traffic management
People helping and moving traffic injured people	
Monitoring and measuring traffic and providing live reports to people and citizens through the media	
Locating urban traffic and helping traffic officials direct traffic to low-traffic routes	
Real estate business and sharing attractive and spectacular video images from outside and inside the property	Real estate management
Detecting the amount of snow on public buildings and preventing the sudden fall of snow	
Managing the amount of destruction and estimating costs caused by natural disasters	
Flying at low altitude over the affected areas and searching for signs of life	Relief
Monitoring the points that need assistance and sending information to the aid agencies	
Entering tight spaces to find missing people due to various incidents	

Sending first aid equipment to rescuers stationed in needy places	
Rapid movement of relief forces by rescue birds	
Rapid transfer of sick people by emergency birds	
The presence of unmanned aerial vehicles in firefighting operations	
Protection of wildlife and forest parks against animal smugglers (forester birds)	Nature protection
Inspection and protection of vulnerable points of urban and suburban nature (environmental birds)	
Inconspicuous examination of the health of migratory animals and travel to places that are too far or dangerous for humans	
Providing internet in different parts of the city where it is not possible to build a telecommunication tower	Internet of Things
Provision of the Internet for various urban equipment to launch the Internet of Things	
Statistics of the weather conditions of cities	Meteorology
Measuring the air quality of polluted cities and submitting reports to regulatory authorities	
Statistics of weather conditions in remote places that do not have a meteorological base	
Carrying out air crime prevention patrols	Positive measures to prevent crime
Identifying activities and movements related to committing crimes to prevent crime	
Identifying and drawing potential and traversable routes of urban security threats	
Monitoring of public places under police supervision and prevention of possible crimes	
Pursuing and monitoring and reporting the routes of fugitives from the clutches of the law and those who disrupt urban security	Negative measures against crimes
Transportation of police equipment needed in times of conflict	
Rejecting and intercepting activities related to terrorist groups and smuggling groups	
Carrying out operations to disperse gatherings by birds equipped with tear gas tools, throwing nets, shotguns, etc.	
Informational and operational support for police missions	
Directing and carrying out armed operations by armed birds	
Identification and destruction of crime tools and instruments in crime-prone areas	

After comparing and matching the similarities and differences between the organizing themes, the phrases that were conceptually similar to each other were placed in the same category and formed the overarching themes. In this way, the network of themes related to the role of unmanned aerial vehicles in future smart cities was formed. The results are presented in table number 3.

Table 3: Theme network of the role of unmanned aerial vehicles in future smart cities.

Organizer themes	Overarching themes
Transportation of city dwellers	Smart air transportation
Transportation of objects and objects	
Supervision	Agile monitoring and inspection
Inspection	
Mapping and geometry	
Preparing and reporting news	
traffic management	Smart Urban and Citizen Services
Real estate management	
Relief	
Nature protection	
Internet of Things	
Meteorology	
Positive measures to prevent crime	Smart enforcement of the law
Negative measures against crimes	

In the implementation of quantitative data analysis, data description indicators are given in two groups central indicators and dispersion indicators. In this section, the distribution of research variables based on the most important central indicators (mean and median) and dispersion indicators (variance and standard deviation) were investigated. The findings of Table 4 (mean value) show that unmanned aerial vehicles with an average of (4.03) which is higher than the middle of the measurement range of the questionnaire (3) and shows the high level of this variable in the opinion of the respondents. will be effective in creating and operating smart cities of the future. However, the average of all dimensions is more than 3 and indicates the high level of these variables. Also, according to the results of Table 5, because the value of the significance level for all components is smaller than the error value (0.050), as a result, these variables have a non-normal distribution and are non-parametric tests in the direction of data analysis. Used. The results of the chi-square test and the level of significance obtained show that all dimensions will play an effective role in future smart cities. The resulting data in table number 6 shows this fact.

Table 4: Central indicators, dispersion, and distribution of factors

Variance	standard deviation	Middle	Average	Components	dimension
0.478	0.524	95/3	09/4	Transportation of city dwellers	Smart air transportation
0.469	0.500	91/3	4/00	Transportation of objects and objects	
0.388	0.520	98/3	94/3	Supervision	Agile monitoring and inspection
0.366	0.570	4/00	05/4	Inspection	
0.399	0.541	91/3	09/4	Mapping and geometry	
0.375	0.501	18/4	52/4	Preparing and reporting news	
0.364	0.538	10/4	01/4	traffic management	Smart Urban and Citizen Services
0.401	0.590	14/4	24/4	Real estate management	
0.389	0.524	10/4	22/4	Relief	
0.440	0.572	4/06	18/4	Nature protection	
0.385	0.550	81/3	98/3	Internet of Things	
0.349	0.595	61/3	85/3	Meteorology	
0.402	0.504	05/4	25/4	Positive measures to prevent crime	Smart enforcement of the law
0.395	0.535	4/30	4/46	Negative measures against crimes	
0.073	0.251	08/4	03/4	Final results	

Table 5: The significance level of the Kolmogorov-Smirnov test of the indicators.

The result of the k-s test	The value of the test statistic	Significance level	Components
abnormal	1.214	0.007	Smart air transportation
abnormal	1.324	0.000	Agile monitoring and inspection
abnormal	1.268	0.001	Smart Urban and Citizen services
abnormal	2.198	0.000	Smart enforcement of the law

Table 6: Comparison of observed and expected frequencies.

Smart enforcement of the law	Smart Urban and Citizen Services	Agile monitoring and inspection	Smart air transportation	total
73.650	78.591	74.109	76.491	Chi-square measure
0.000	0.000	0.000	0.000	Significant level
4	4	4	4	Degrees of freedom

Friedman's test was used to prioritize dimensions from the respondents' point of view. The SPSS output including the average ranks of each index and the chi-square statistic of the relevant variables is given in Table 7. The results showed that the priority related to the role of flying vehicles in future smart cities will be 1- smart city and citizen services, 2- smart law enforcement, 3- smart air transportation, and 4- agile monitoring and inspection.

Table 7: Ranking of research variables.

Priority	Average ratings	Dimensions	Variable
Third	4.29	Smart air transportation	Drones and its role in future smart cities
Fourth	4.08	Agile monitoring and inspection	
First	4.75	Smart urban and citizen services	
Second	4.51	Smart enforcement of the law	
Square root = 187.429 degrees of freedom = 4, significance level = 0.000			

Conclusion and Suggestions

Currently, smart cities are no longer a dream, but thanks to innovative solutions, many of them are already active or expanding rapidly. So far, smart city managers have used new technologies to communicate and improve infrastructure, productivity, comfort, and quality of life for residents and visitors. The current research was conducted to investigate the role of unmanned aerial vehicles in future smart cities. The results of the interview with experts led to the identification of 52 basic themes, 14 organizing themes, and 4 comprehensive themes to understand the role of unmanned aerial vehicles in future smart cities. The results showed that in recent years, with the advancement of technology and the expansion of aviation science, especially in the field of unmanned aerial vehicles, these devices will be used in the field of smart cities in different countries. The results of the analysis of the interviews and the final classification showed that unmanned aerial vehicles will play an important role in the management of future cities through smart air transportation, agile monitoring and inspection, smart urban services, and smart law enforcement. Transportation of urban residents, transportation of objects and objects, monitoring and inspection, mapping and geometry, preparation and reporting of news, traffic management, real estate management, relief, nature protection, Internet of Things, meteorology, positive measures to prevent Crime and negative

measures to deal with crimes will be considered as functions of flying devices in future smart cities. In explaining the validity of the findings in the quantitative section, the results showed that all the components identified at the error level of 0.05% are suitable predictors to confirm the role of unmanned aerial vehicles in future smart cities. The average value obtained, which was higher than the average of the measurement range of the researcher-made questionnaire and indicated the high level of variability from the respondents' point of view, showed that unmanned aerial vehicles will be effective in creating and operating smart cities of the future. Was. The ranking of the dimensions also showed that the priority related to the role of flying vehicles in future smart cities will be 1- smart city and citizen services, 2- smart law enforcement, 3- smart air transportation, and 4- agile monitoring and inspection. By examining the previous research, it was found that no research directly studied the topic of the current research, but the results of the current research can be compared with the findings of Akhawan [8] Urban management specialists should consider the components of information technology, smart governance, smart security, and smart transportation in the development of a smart city. Frouzesh also stated [9] that the main characteristics of a smart city are smart governance and then smart relocation, which confirms the findings of the present research. The results of Qadawi and Tabataba's research also stated that drones play an important role in providing timely and necessary wireless communication services for the recovery of services immediately after a disaster and the public security applications of smart cities and smart police. do, is in line with the findings of the present research. Manju et al. [6], Mohammad et al. [4] and Silva et al. [11] also talk about the applications of unmanned aerial vehicles in human life and the creation of future smart cities and how they enter the field of intelligence. They mentioned that it was largely in line with the findings of this research. However, according to the themes identified and the importance of addressing the role of unmanned aerial vehicles in future smart cities, he has a suggestion: • According to the results of the research, it is suggested to generalize and improve the level of awareness of different sections of the society regarding the abilities and capabilities of unmanned birds, and the capacities to attract the participation of people and knowledge-based organizations in the implementation of smart cities. provided the future. Considering that unmanned aerial vehicles can prevent and deal with crimes, it is suggested by Faraja, the army, the Ministry of Intelligence, and the Islamic Revolutionary Guard Corps to take necessary measures in the field of designing and implementing relevant projects by carefully studying the functions of these pieces of equipment. put in their work plan. • It is suggested to make use of the experiences of different countries that have provided smart city infrastructures, and build a small smart city as a pilot inside the country, and use the things calculated in this study as much as possible. • It is suggested that all the organizations that can use unmanned birds in making their actions more intelligent, start designing and operating the relevant systems from now on. For example, by preparing and using firefighting drones, the firefighting organization will use them on a trial basis to provide the necessary ground for making this organization smart.

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