



Management of Urban Greenery System in Vietnam in the Era of Industry 4.0

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Abstract: Application of computer software and exploitation database systems bring great benefits and integrate many features in different fields of science and life for urban management including urban greenery management in cities. In Vietnam, they have been being more concerned due to the Vietnamese Government policies in development of e-Government and smart cities. This paper firstly focuses on discussion about the reality of urban greenery management in Vietnam to reveal the problems in management as well as opportunities of this field in application new technology in cities, such as artificial intelligent, information technology, internet of things, ... Secondly, it reviews the current application of science and technology in urban greenery management in the world as well as cities in Vietnam to evaluate the effectiveness, understand a broader context and eventually draw lessons, which can be learned for this field in Vietnamese circumstance. Finally, it discusses the potential to apply the management software and suggests some suitable solutions for the smart urban greenery management that can provide effective tools and become components to develop and organize smart cities in Vietnam in the era of Industry 4.0.

Keywords: Internet of things, open-source, science and technological application, smart city, urban greenery management

1. Introduction

In Vietnam, management of urban greenery system began to be concerned strongly by the French in the late 19th century. It was beginning a period of sharp development of this field in Vietnam. Presently, in order to contribution of improving the quality of urban greenery management and development, the Vietnamese Government has issued many legal documents on this field, such as: Circular No. 20/2005/TT-BXD, Circular No. 20/2009/TT-BXD, Decree No. 64/2010 / ND-CP, related to management of urban greenery. However, these guidelines are incomplete and overlapping; the terminologies used in these documents are still inconsistent, which lead to many difficult for the local governments to implement. (Ministry of Construction, 2005; Ministry of Construction, 2009; Prime Minister of Vietnam, 2010) Otherwise, these legal documents have not any articles mentioned about application of science and technology, a very important approach in the postmodernism era, in this field. However, the strategies to develop e-Government and smart city in Vietnam require a new approach in urban management, which can help Vietnamese Government at different levels to manage synchronously and exploit effectively the local and national database. It reveals a need of research and development in applying the digital, information technology (IT), internet of things (IoT), and artificial intelligent (AI) for urban greenery management in Vietnam.

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Additionally, in the whole Vietnam, according to the characteristics of each region, only a few provinces and cities have legal documents, that regulate the list of trees and restricted trees for planting in the urban areas. However, they are still lack of coherence and logic related to the criteria of choosing plant species in each Regulation as well as the consistence between Regulations of the cities, such as: Ho Chi Minh City, Da Nang, Lang Son, Phu Tho, Binh Phuoc, and Vinh Long... According to these legal documents, individuals and groups can grow some plant species on streets that are not on the list of prohibited or restricted species. However, in fact, they are not suitable for urban road's conditions. Moreover, despite the same ecological characteristics, some species on the list of plant species in a city are not on the list in the other ones. Typically, the *Dipterocarpus altatus* **Roxb.ex G. Don.** and *Pterocarpus macrocarpus* **Kurz.** are on the list of street tree species in Da Nang and Binh Phuoc province, but they are on the list of banned street tree species in Phu Tho province. The eucalyptus trees (*Eucalyptus citriodora* **Hook.f.**, *Eucalyptus camaldulensis* **Dehnhart**, *Eucalyptus robusta* **Smith.**), *Terminalia catappa* **L.**, *Ceiba pentandra*,... are some species on the list of common urban plants in Thanh Hoa province (including for streetscape, garden, park and other green spaces), but these are banned plant species grown on streets in most of other provinces and cities. (Binh Phuoc People's Committee, 2013; Da Nang People's Committee, 2016; Hanoi People's Committee, 2010; Ho Chi Minh City People's Committee, 2004; Lang Son People's Committee, 2011; Phu Tho People's Committee, 2014; Thanh Hoa People's Committee, 2010; Vinh Long People's Committee, 2014] It shows a lack of linkage in urban greenery management between provinces and cities. Nonetheless, this issue can be improved and fixed by application of the information technology as well as internet of things, which can support provinces and cities to use and share their database and help the local governments to manage urban greenery system synchronously and fluently.

Currently, the urban greenery management bases mostly on the human labor in Vietnam. The application of Microsoft Excel to manage and exploit the information database of this field is popular in almost cities, which are not completely suitable to the present development of technical basement and computer science in Vietnam. As a result, the capacity in storage of the information is limited. It is very difficult to apply new techniques to improve the ability of the agencies in management and to connect stakeholders via new protocols and modern applications. Moreover, in the digital era, application of information technology and exploitation database systems bring great benefits and integrate many features in different fields of science and life for urban management in cities. They support effectively and richly the management, storage, development, and exploitation of resources.

To apply new technologies is suitable and correct orientation for the current Vietnamese Government's strategies. Consequently, computer science and its applications have been being more concerned in Vietnam. In terms of urban greenery management and development, there are many information fields, such as: plant species, trees' health, planting time, tending, irrigation, and maintenance, etc. It needs to be managed systematically and effectively in an integrated system to improve a convenience for exploitation and use as well as updating the database system. Apparently, in Vietnam, it needs to be researched carefully to find abilities to apply IT, IoT and AI to facilitate the governmental management at different levels which are suitable to not only the present conditions of each city, as well as national infrastructure system but also the national development strategies. Therefore, this research is required in order to propose several suitable solutions to improve the effectiveness of urban greenery management, which works hand-in-hand with urban development to address simultaneously growth, innovation, economy and ecology in the era of the 4th industrial revolution.

2. Research Methods

In order to fulfill the research objective, some methods are applied into this research. Firstly, the author collected and analyzed documents related to the urban greenery management in Vietnam. Various types of documents both in theory and policy on urban greenery management in Vietnam are collected, synthesized, analyzed, and evaluated to reveal the existing problems in management and highlight opportunities to apply new science and technology in this field. This method also was applied to investigate, evaluate international theoretical research to understand methodologies and to find suitable solutions using achievements in science and technology related to smart management including automatization, IoT, cloud computing, and AI. Secondary, interviewing IT experts was applied to understanding the current orientation as well as innovation in smart management. It suggested the author some ideas how to apply new progressive science and technology in urban greenery management. Thirdly, the author chose some practices and projects in terms of urban greenery management researched and implemented in the cities, both in the world and Vietnam, to analyze, evaluate and find lessons, which can be learned to suggest solutions for Vietnam. Finally, combining theories and practical works was applied to propose several solutions for smart urban greenery management in Vietnam. These proposals can help to improve the effectiveness of urban greenery management in Vietnam's context in the era of the Industry 4.0.

3. Application of Science and Technology in Urban Greenery Management in the World and in Vietnam

3.1 In the World

To apply the computer science for information management of urban greenery system has been popular in big cities around the world. The software has been built and applied, which are based on the survey results to create different layers of information and various digital maps (Pham, A. T., 2018). In Zurich, Switzerland, to manage the social potential for urban green spaces, the city has used geographic information system (GIS) software to zone the responsibilities for individual citizen. As its policy is socialization of urban greenery management, the city's government encourage residents to commit to the responsibility of managing green areas (Kuchelmeister, G., 2000).

In Barcelona, Spain, urban greenery management uses a software that interacts with the community through the website. This software called GAVI integrates a variety of information layers to facilitate urban greenery management in the categories of pruning, maintenance, and removal management as well as replacement and risk management (Fig. 1) (Barcelona City Council, 2011).

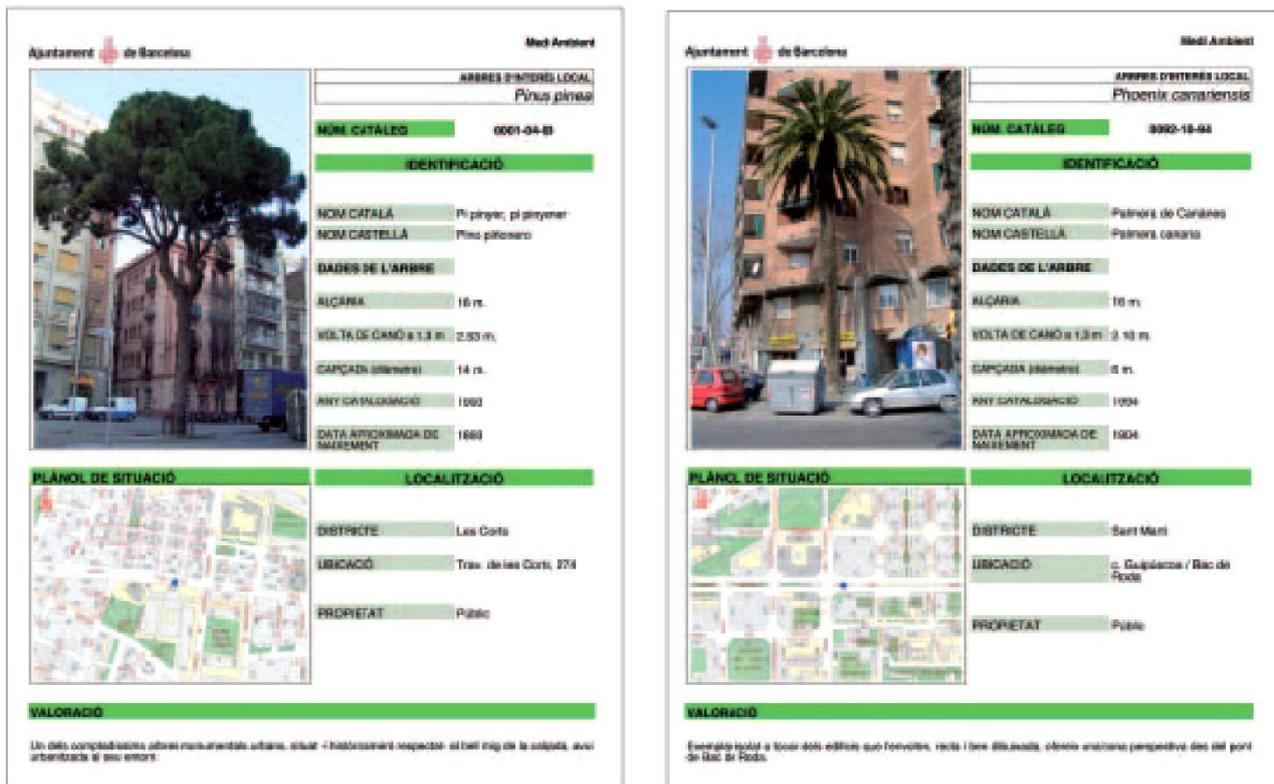


Fig. 1 - Information about the street trees are updated by GAVi software which can interact with the urban community via a website (Barcelona City Council, 2011)

In Minnesota, United State, a GIS software has been used to create zoning maps of different risk levels created by trees to manage. The management of these digital maps is implemented and controlled by all departments in the city. (Fig.2) For example, the transportation and public works departments manage the road systems, traffic volumes and congestion levels by using related information maps or data layer files. Planning and zoning department control the public buildings such as hospitals, fire stations, police and other emergency medical facilities; schools; library; administration building and community center; and public areas such as golf courses, parks and swimming areas. Parks and recreation department controls the location and function of public parks' model and other recreational areas. Information layers are shared to create an integrated map of identify factors, which need to be concerned; particularly, the information to identify vulnerable areas created by trees in the community. (Pokorny, J.D., 1992)

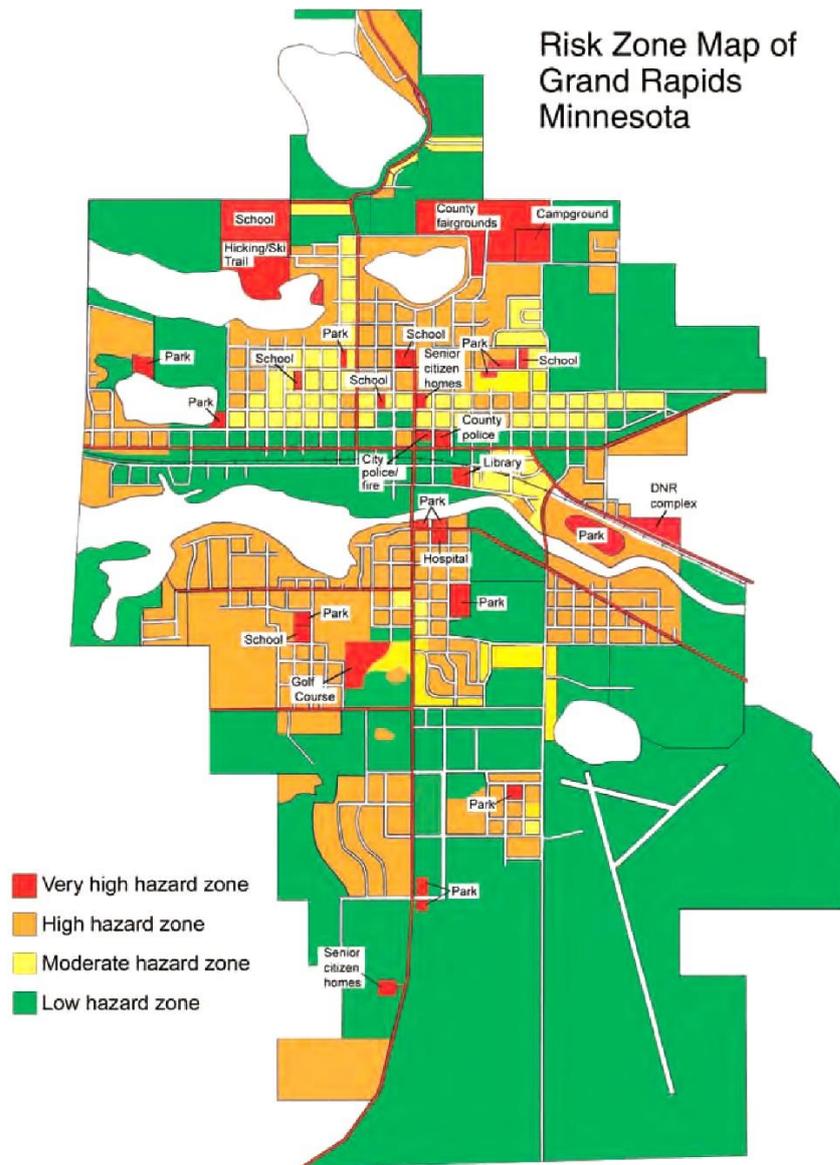


Fig. 2 - Application of GIS software to create digital maps for risk management in Minnesota, United State (Pokorny, J.D., 1992)

In San Jose-California, United State, the urban greenery management office set up an interactive website with residents to manage legal policy issues in urban greenery management. (Dorothy, A., Abeyta, E., Lanham, R. and Ralph, M., no date) In the city, all pruning, replacement, and maintenance activities require a permit. It means that this office manages licensing and complaints from people through this website. (Pham, A. T., 2018)

In London, England, there are more than 3,000 parks and 1,600 areas for nature conservation, 4 national nature reserves and 3.8 million large and small flower gardens. To effectively maintain the green areas and to avoid wasting water for irrigation, the city has applied the model of automatic watering and intelligent control through the flow sensor system at the pump stations. Thereby, the city control effectively the amount of water and save costs related to labor, tank trucks, and maintenance fees for specialized vehicles. (David, M.W. and Nguyen, N.T., 2019)

In the United State, every day, there are more than 34 million cubic meters of water consumed to irrigate the outdoor landscape, mainly for the residential areas. In the traditional irrigation, more than 50% of water will be wasted according to the actual needs of this greenery system (American Society of Landscape Architects, 2020). Therefore, the trend of using automatic irrigation systems has been widely applied in this country. In addition to irrigation to maintain the greenery system, automatic irrigation technology is also combined with a nutritional supplement system for plants. For public greenery systems, beside the annual routine care, the sensor system applied in the smart irrigation system will assess the level and nutritional needs to be supplemented in unusual cases, collected information will be connected to the software system to automatically replenish nutrients according to needs in order to best maintain the health of the green tree system and quality of urban landscapes. (Pham, A.T., 2019).

Nowadays, application of software, IoT, AI and automation of one or more stages in the urban greenery management and development become more and more important and meet to requirement of human society in the era of the Industry 4.0. There are several experiment and publication about the Science and technological application for smart irrigation management. (Tanu, S. and Ashok, V., August 2017; VnExpress electronic newspaper, 2015) A new approach has been applied. It is Message Queuing Telemetry Transport (MQTT) protocol. It is a lightweight, open and simple to control a smart irrigation system that link to all its components such as: sensors systems, operating units, cloud, services... (Waleed, A., et al, 2018) Nevertheless, most of experiment focus much on smart irrigation for agricultural management. However, the methodology has a potential to be applied for urban greenery management when it must develop with some related specific inputs. Then, the application will contribute to free the human labor, increase the storage capacity as well as enhance the integrated information processing between urban greenery and related fields. This is also one of significant steps to develop the smart cities.

3.2 In Vietnam

Department of Construction to apply the GIS software, initially set up a database of public greenery on central roads. When completed, the GIS software will be very useful in managing, developing trees which can display detail Hanoi is the leading city in applying science and technology for urban greenery management. However, so far there is not any complete tool for this work in Hanoi. In 1999, Hanoi Green Park Company conducted a software to manage the street trees' data based on the surveyed existing system. This software is written in FoxPro language running on Windows. The software met the requirements of searching for green information and partly renders the information as required. However, it has not got a professional data entry interface yet, which is a very important activity for requirements of management, resulting in slow data entry, and many errors when entering the new data. Besides, the database is quite sketchy and has no binding relationship to ensure a unified information system. Otherwise, this software was only suitable to setup on one computer, not compatible with modern information connection (internet) in nowadays.

By 2017, Pham Anh Tuan has written a new software for urban greenery management in Hanoi. Currently, this software is being transferred by Hanoi Department of Science and Technology to the Hanoi Department of Construction to research, update and apply it in practice. The software has been built on the basis of application of open sources and global GIS software to standardize the information system of street trees, gardens and parks and other interactive interfaces between participating stakeholders. Therefore, it can increase the utility for greenery management, conservation, and development activities with the participation of the community. Decentralization was applied in the software to allow different groups can access, supplement information, even requirements on pruning... to minimize information processing time. Indirectly, it helped to minimize risks due to trees which can affect extremely urban community. The system of information layers and data fields has been built based on a goal of meeting the ability to serve and support the urban greenery planning, planting, and maintaining as well as serve management records for each tree in the city. (Fig.3) Presently, the database of the software has just been piloted for Ba Dinh and Thanh Xuan districts on a base map on scale 1:2000. When the database is fully developed, it will be a high opportunity to manage, preserve and develop efficiency the urban greenery system, which can contribute to reduce the workload for this field later, and to complete the interface for building e-Government in the future. The next phase is only for updating and supplementing the system of trees replacement in the existing urban areas, new planting and new greenery areas for new urban development in Hanoi (Pham, A.T., 2017).

The screenshot shows a web application interface. At the top, there is a navigation bar with tabs: Home, 1. System, 2. Planning management, 3. Tree Management (selected), 4. Report, 5. Document, 6. Information, and Site Actions. Below the navigation bar, there is a breadcrumb trail: Home > 3. Tree Management > 3.3. Tree according to Species. The main heading is 'Tree according to Species'. Below this, there is a search bar with 'Fast Find' and a search icon, and buttons for 'Add new' and 'Activities'. A dropdown menu shows 'See: Tree'. The main content is a table with the following columns: ID, Name, Family, Other Name, Distric, Commune, Street, Height m, and Latitude. The table contains 10 rows of data.

ID	Name	Family	Other Name	Distric	Commune	Street	Height m	Latitude
5.3	Muong	Fabaceae	-	Ba Dinh	-	Van Bao	9	21.03181
8.2	Muong	Fabaceae	-	Ba Dinh	-	Van Bao	9.2	21.0317
9.2	sp.	-	-	Ba Dinh	-	Van Bao	-	-
9.5	Nhoi	Euphorbiaceae	-	Ba Dinh	-	Quan Thanh	13	21.04056
10.4	da	Moraceae	-	Ba Dinh	-	Nguyen Thai Hoc	9.3	21.03197
12.4	Sua	Fabaceae	-	Ba Dinh	-	Quan Thanh	15.5	21.04035
13.3	Muong	Fabaceae	-	Ba Dinh	-	Van Bao	12.5	21.03137
13.8	Nhoi	Euphorbiaceae	-	Ba Dinh	-	Quan Thanh	5.8	21.04057
14.5	Muong	Fabaceae	-	Ba Dinh	-	Quan Thanh	7	21.04036

Fig. 3 - Main interface of the information website for management, preservation, and development of urban greenery system in Hanoi. (Pham, A.T., 2017)

Danang has spent a lot of interest in applying of science and technology for greenery management. In 2005, Danang Park and Tree Company had a contract with Danang Softech Software Technology Center to build a management tool called "Green Management Software". The software has interface which can be yearly added, editable, stored data and allow access to aggregate results depending on each request. However, when put into practical implementation, the software had difficulty updating the database and effective due to the number of symbols on the tree is marked with a building's number; therefore, trees planted in places without houses will not be able to update the location (Interview Nguyen, T.D., 2015 March 27th). In 2015, the People's Committee of Da Nang City assigned the information of the marked tree (Da Nang electronic newspaper, 2015). However, up to now, the software is not complete yet.

Ho Chi Minh City is also one of the pioneering cities in the application of science and technology for urban greenery management. There have been many researches and applications of information technology in this field in Ho Chi Minh City. In 2000, Dinh Quang Diep, a lecturer at Ho Chi Minh University of Agriculture and Forestry, built an urban tree database in Ho Chi Minh City which was written on Visual FoxPro software. However, due to the software's limitations in connecting to the internet, the software is no longer in use. (Interview Dinh, Q.D., 2015 August 07) In addition, to meet the more complex requirements in urban greenery management as well as in accordance with modern science and technology, there have been studies on the application of open source and GIS software for urban greenery management in Ho Chi Minh City. For example: Nguyen Quoc Tuan (2011) has built the databases in Ward 6, District 3. (Fig. 4) (Nguyen, Q.T., 2011) Do Minh Canh (2014) has just studied on the campus of Ho Chi Minh City University of Agriculture and Forestry. (Fig. 5) (Do, M.C., 2014) These projects have been completed by using the open source developed by the gvSIG Association on Java fundament. The shapefile and property data were managed by the open-source DBMS to support spatial data management such as PostgreSQL/PostGIS, and eclipse programming environment in Java. The data include name of the trees, building's number, street name, year of planting, origin of trees, geographical location, characteristics of growth and development of trees... The fact that completing the software with full information data requires a lot of time, effort and financial issues. Therefore, these studies have just stopped as the pilot project.

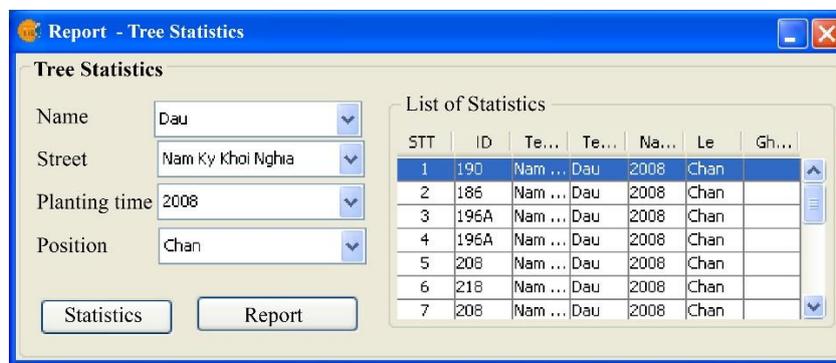


Fig. 4 - Interface for report and statistics of trees (Nguyen, Q.T., 2011)

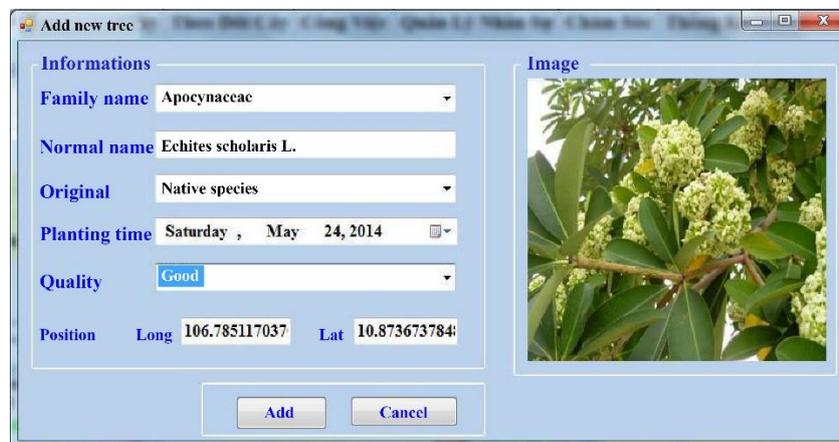


Fig. 5 - Interface for adding new trees (Do, M.C., 2014)

Besides of building urban greenery management software, Ho Chi Minh City has studied to install the automatic irrigation systems combined with irrigation flow sensor systems from advanced countries such as the United State,

France, and Germany. Thereby, the irrigation organization can proactively control and regulate the amount of irrigation water in each area of greenery and for each tree species in the urban areas. This irrigation system is managed and operated by software via the Internet which help modernize the maintenance and management step by step, and contribute to reduce the watering cost by 80% compared to watering by normal irrigation trucks. (David, M.W. and Nguyen, N.T., 2019)



Fig. 6 - The application of automatic irrigation contributes an improvement of landscape quality and limitation of impact on traffic participants on the urban roads system. (Nguyen, T., 2017)

Other smaller cities across the country also have had certain interests in the urban greenery management and development, such as Hue and Hai Phong... In 2012-2013, Phan Duy Thuc, working at Hai Phong Park and Tree Co., Ltd., had implemented a pilot project on building a street tree database for Le Chan and Hai An districts, Hai Phong Province. The database system is built on Excel program which contains 16 information fields, specifically; number order, district, street, survey time, species, scientific name, tree number, situation, diameter at 1.3m, tree height, canopy diameter, X and Y Coordinates, year of planting, trees' status. The Excel database system has been linked to ArcGIS version 10.0 to set up a database system which can be displayed on ArcGIS platform and shown several layers on base map on scale 1: 2,000. (Fig. 7) (Hai Phong Park and Tree Co., Ltd., 2013) However, for many different reasons (finance, labor, and mechanism...), it has stopped and has not been completed for the whole city.

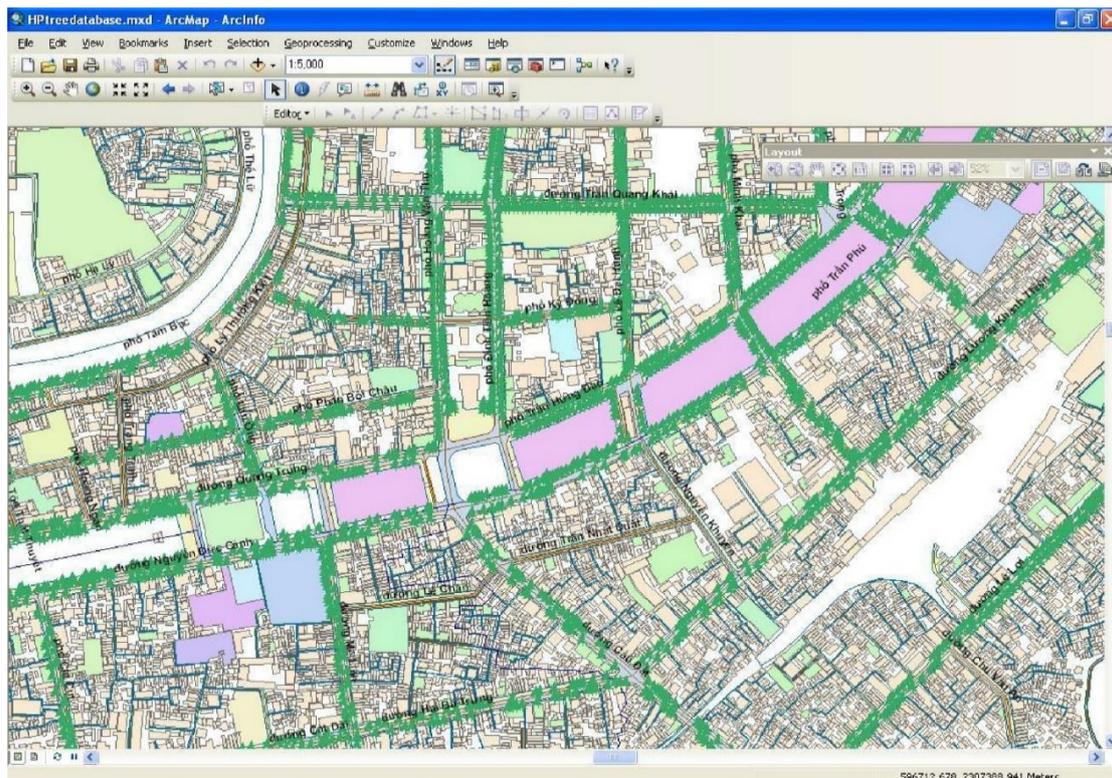


Fig. 7 - System of trees' database on the GIS software in Hai Phong city (Hai Phong Park and Tree Co., Ltd., 2013)

In Hue, in 2006, a group of students from Hue University of Science and Technology developed a GIS system to manage greenery system in the ancient citadel to create a useful tool, which can support tree management and planning as well as preserving the ecological environment. The project was carried out on four roads around the citadel (23/8, Doan Thi Diem, Dang Thai Than and Le Huan) and the Forbidden City area. This group has implemented the following steps: baseline mapping, digitizing information, updating thematic information. To compare to manual methods, tree management by GIS technology is more systematic and detail. To look overall map, the viewer can see the distribution of the trees, and find the detail information of each tree, such as: tree height, distance between trees, tree name (common, local and scientific name), family, and quality of trees... (VnExpress electronic newspaper, 2015).

Application of science and technology in the urban greenery management has been interested and spent a lot of concerned by local governments in Vietnam. However, most of researches and practices are far behind the achievements of applied science and technology. They are individual and have different approaches without any general national strategies. Therefore, it is very difficult to create a linkage between cities to share database. They need to be rethought about the cities' approaches and researched to find how can improve the effectiveness in management as well as encourage the participant of community, which can apply new progressive technologies, to develop sustainable urban ecological system in the era of the 4th industrial revolution.

4. Potential to Apply the Smart Urban Greenery Management in Vietnam

First of all, in terms of the policy, Resolution 36a/NQ-CP stated: “Accelerating the development of e-government, improving the quality and performance of state agencies, serving the people and businesses better and better. To enhance Vietnam's position on e-Government according to UN ranking. Publicity and transparency of activities of state agencies on the network environment.”, (Prime Minister of Vietnam, 2015) which shows one of the specific goals to highlight the goal of simplifying and increasing the efficiency of administrative procedures. Therefore, the development of urban green management in the direction of e-Government based on the principle of building application software is indispensable and needs to be accelerated. Thereby, it helps state agencies to work effectively, improve efficiency and more transparency for every daily management. Otherwise, it provides better information to citizen, businesses and organizations; and create favorable conditions for people to exercise their democratic rights, management participation, conservation and development about the urban greenery.

The research also suggests several solutions to improve the urban greenery system management. Firstly, to build effectively the e-Government, database system and information on urban greenery system needs to be examined closely and updated regularly. Updating and interacting between the three subjects (Government, Businesses and Citizen) in the urban greenery management system via digital means are motivation for the development of application software. Building software based on global GIS software platform aiming to standardize the information system of trees, gardens and parks and other interactive interfaces among participating entities is necessity. (Fig. 8) The sooner the database is developed, the sooner the opportunity to manage, protect and develop the sustainable urban greenery system will be effective. Software integrated with open-source systems, google earth, and GIS mapping technologies will increase the utility in the management, conservation and development of urban greenery with the participation of the community.

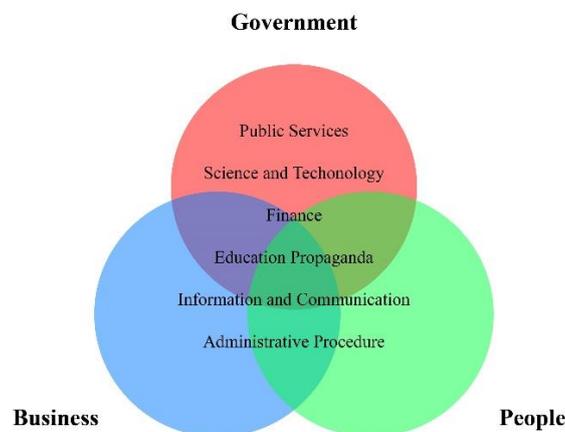


Fig. 8 - Proposal for an interactive relationship between the three subjects in state management

Secondly, with the high speed of development and application of computerized electronics such as computers, laptops and other portable smart devices such as smartphone, tablet, etc., the utility of operations when being connection with this system of electronic devices, it will contribute to simplifying the communication process among

groups involved in urban greenery management, conservation and development. (Fig. 9) This is a specific channel of communication between state management agencies and other individuals, collectives and social organizations in order to promote quickly collective spirit aiming to achieve optimal and timely results. Moreover, the development of software needs to be studied in an integrated manner. Cities need to build an overall architecture of urban greenery management system, which includes a cluster of servers, such as databases servers, application servers, website servers, SMS sending servers, of which:

S1: The database server will have the function to store all data of the urban greenery management system including textual and digital map data.

S2: Application server will be used to run application software that support calculations for map data processing.

S3: Website server used to run website services and information management page of urban plants in a city.

S4: The server is responsible for sending and receiving SMS messages via mobile phone network.

These servers can be physical machines or virtual machines running on a single physical server while still remaining the features of each server.

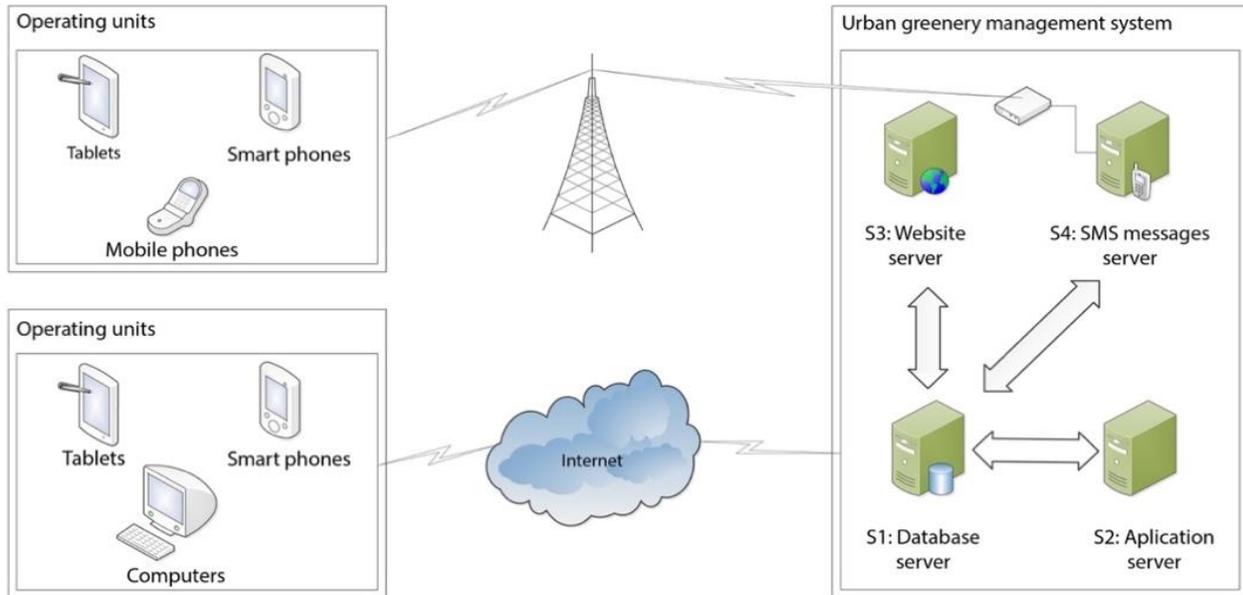


Fig. 9 - A proposal for general physical structure of urban greenery management software

The logic model of urban greenery management system is designed with a database system and a software system (software for the system of urban greenery management and standard software on the terminal devices). (Fig.10)

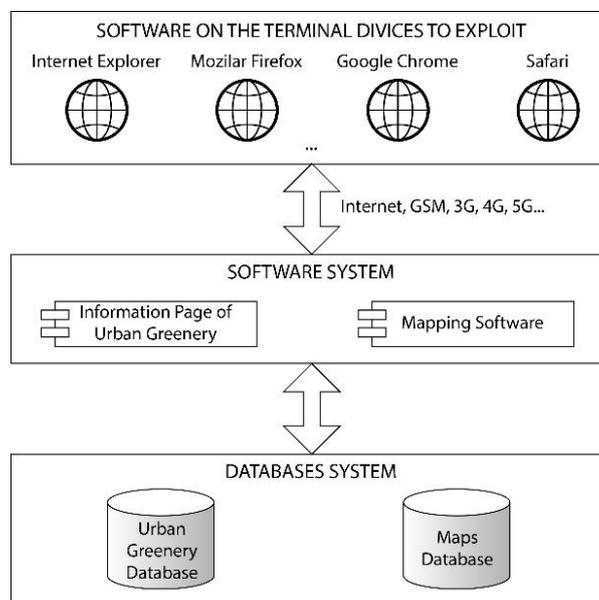


Fig. 10 - Logic model of urban greenery management system

This database system is designed to be able to store a full range of diverse and complex data of the system. However, the above figure only shows the components of the database system. When it is actually run, the system operates daily. So updating, calculating, and displaying the results must be separated to ensure the system stability and safety. The whole data is designed into three database systems, including Input Database, Processing Database, Results and Syntheses Database (Fig.11).

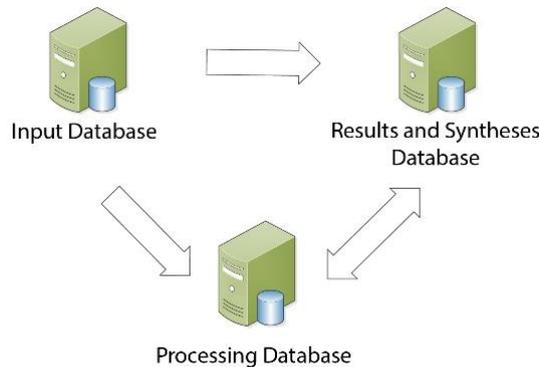


Fig. 11 - Proposal design for the database system

The construction of these database systems ensures that during the updating process, the data does not affect the processing of the calculation model, and the processing of the calculation model does not affect the operation of urban greenery information pages in cities. These database systems are self-synchronous to ensure that the data is unified, accurate and safe.

Finally, to enhance the effectiveness of urban greenery management and development as well as reduce operating costs, smart irrigations system should be applied as pilot projects firstly for public greenery areas in the big cities in Vietnam, such as Hanoi, Ho Chi Minh, Da Nang... The model of automatic watering and intelligent control through the sensor system should be applied in the system. The sensors applied in the system include soil moisture sensors, weather sensors (rain, temperature, and humidity), and fertile sensors. A smart irrigation system allows an automatic control of the electronic valves which not only close or open the volume of water flow, but also assess and control the levels and nutritional supplemented needs in order to best maintain the health of the greenery system, the quality of urban landscapes, and effective operating costs. Furthermore, an implementation of the Internet of Things (IoT) has to be the best solution for establishment a smart irrigation system to develop a smart city (Waleed, A., et al, 2018). Additionally, to optimize the IoT in operation, a client server publish/subscribe messaging transport protocol should be applied. It is MQTT protocol. (Fig. 12) Once these pilot projects have been evaluated for the effectiveness and withdraw the lessons, they will be adjusted before being applied on larger scales. Otherwise, this approach can be developed and applied for the other aspects in smart urban management, such as urban agriculture, productive landscape...

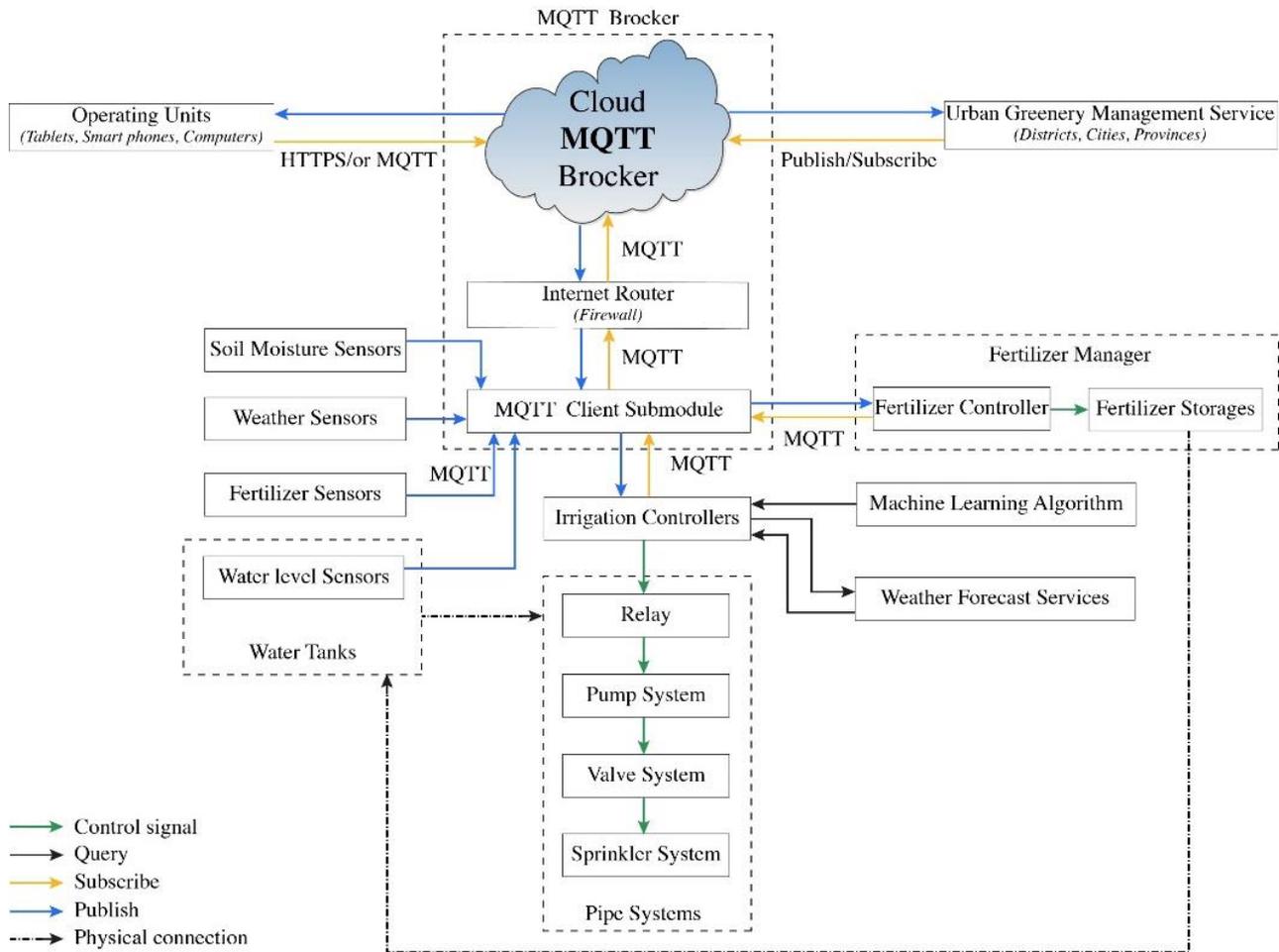


Fig. 12 - A proposal for smart irrigation system using IoT and MQTT protocol in IoT

5. Conclusion

This paper has investigated the problems and potentials as well as proposed three solutions, which can apply the achievements in science and technology for urban greenery management in Vietnam. Based on the obtain results, the following conclusions are derived:

- The applications of IT software, AI and automation of one or more stages in the urban greenery management and development contributes to freeing human labor, increasing the storage capacity and the ability to enhance the integrated information processing between urban greenery and related fields. They are indispensable trends in Vietnam and in line with the orientation of building smart cities and e-Government, as well as meet requirements for activities of human society in the 4th industrial revolution.
- To use open-source systems integrated with google earth and GIS mapping technologies to build smart urban greenery management can enhance the ability to link and integrate with the system of electronic devices, as well as increase interoperability between state management agencies and social sectors. At the same time, it contributes to the publicity, transparency, timely processing of relevant information and improves the performance of urban greenery management in Vietnam.
- Implementation of IoT and MQTT protocol is one of suitable solutions to install a smart irrigation system for urban greenery. It becomes one of important components to develop the smart urban greenery management and other fields to construct smart cities in Vietnam, which works hand-in-hand with urban development to simultaneously address growth, innovation, economy and ecology in the era of the Industry 4.0.

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