DISCUSSION ON THE CURRENT APPLICATION STATE OF DIGITAL TRANSFORMATION IN URBAN GREEN TREE MANAGEMENT IN VIETNAM

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Tóm tắt:

Ứng dụng chuyển đổi số trong quản lý cây xanh đô thị là một bước đột phá quan trọng trong việc tối ưu hóa và cải thiện quản lý cây xanh trong các khu đô thị hiện đại. Trong thời đại số hóa ngày nay, việc áp dụng công nghệ và ứng dụng số để quản lý cây xanh đã mang lại nhiều lợi ích lớn cho cả thành phố và môi trường. Ứng dụng chuyển đổi số trong quản lý cây xanh đô thị không chỉ giúp tối ưu hóa hiệu suất và hiệu quả của việc quản lý cây xanh mà còn góp phần quan trọng vào việc bảo vệ môi trường và tạo ra môi trường sống tốt hơn cho cư dân đô thị. Trong bài viết này đề cập đến một số vấn đề trong ứng dụng chuyển đổi số, từ đó tổng hợp, đề xuất một số giải pháp phù hợp với tình hình phát triển và ứng dụng chuyển đổi số trong quản lý cây xanh đô thị ở Việt Nam hiện nay.

Từ khóa: *Chuyển đổi số, quản lý cây xanh đô thị.*

Abstract:

The application of digital transformation in urban greenery management is a significant breakthrough in optimizing and enhancing greenery management in modern urban areas. In today's digital age, utilizing technology and digital applications for greenery management has brought numerous benefits to cities and the environment. The digital transformation in urban greenery management improves efficiency and effectiveness and plays a crucial role in environmental conservation and creating a better living environment for urban residents. This article discusses various issues related to digital transformation and proposes suitable solutions in line with the current development context of applying digital transformation in Vietnam urban greenery management.

Keywords: *Digital transformation, urban green management, GIS, SWOT.*

1. Introduction

Nowadays, applying digital transformation to urban green management in Vietnam is becoming an essential part of sustainable and intelligent urban development. The arrival of the 4.0 Industrial Revolution has brought new opportunities and problems for urban tree management and protection. Using scientific terminology, this article outlines digital transformation applications in urban green management in Vietnam.

The critical turning point in applying digital transformation to urban green management marks a strong transition from traditional tree management to using digital technology to improve efficiency and effectiveness. This allows cities to manage trees more effectively by using sensors and data collection systems to monitor the condition and health of trees so that conservation plans can be made. Maintain and care for plants more accurately. In addition, digital transformation applications also help predict and prevent incidents using artificial intelligence, facilitate better interaction with the community, and improve environmental protection. This requires integrating tree management systems into urban management systems to make more intelligent and sustainable decisions. Specifically, optimizing management and maintenance, predicting and preventing incidents, enhancing community interaction, improving environmental protection, and integrating with overall urban management.

Applying digital transformation to urban green management in Vietnam brings many great benefits. First, it facilitates the efficient collection of tree-related data, including resistance, condition, and other environmental factors. Managers can make more accurate tree care and protection decisions through this data. In addition, digital transformation applications help optimize planning for planting new

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trees and maintaining existing trees. Predictive models based on digital data allow managers to determine the optimal location, type of tree, and planting time.

The 4.0 Industrial Revolution has significantly impacted many fields, and the urban management industry is no exception. Breakthrough technologies in the 4.0 era have entirely changed how the management industry operates, opening up new opportunities and improving work efficiency. More specifically, the application of digital transformation in urban green management in Vietnam is currently developing and has great potential to improve management and protect the environment. Below is an overview of the situation and progress of this application in Vietnam.

- Smart data collection tools: Large cities such as Hanoi and Ho Chi Minh City have begun deploying intelligent data collection systems, including sensors to monitor the condition of trees. These data help improve tree monitoring and management [11, 13, 17].

- Mobile applications and public websites: Many mobile applications and public websites have been launched, allowing residents to participate in tree management. They allow people to report problem trees, request maintenance or suggest planting more trees from the research of the author groups. [13, 15, 8, 14].

- 3D modeling and GIS: Geographic information systems (GIS) and 3D modeling are applied to manage trees on a larger scale and display information visually. This helps urban managers have a panoramic view of the trees in their area.

- Tree planting and smart crop programs: Using smart technology to plan and manage the tree planting process has become essential to urban green management. Innovative tree-planting programs help optimize the use of space and resources. [8, 15, 19].

- Education and awareness creation: education and awareness creation on urban green management have been regulated Quynh [19] and promoted through digital transformation applications, websites, and campaigns in online communication. Also from the research of the author group Hue, Lam [8, 17] have come up with comments that help the whole community better understand the importance of trees in improving the quality of life and protecting the environment.

Digital transformation applications have enormous potential, but certain obstacles still exist. Aspects such as initial investment expenses, training for human resources, and data security concerns must be carefully considered. Furthermore, several obstacles must be overcome before digital transformation technologies can be used in urban green management. These obstacles include data security concerns as well as technical and financial difficulties. Vietnam has great potential to manage trees better and

have greener living environments thanks to the fast advancement of technology and the efforts of associated cities and organizations. On the other hand, there is a tremendous chance to enhance urban green management, establish green urban gardens, and enhance living circumstances for city dwellers. This report focuses on an overview and analysis of intelligent data collection tools, 3D models, and GIS.

2. Content

2.1 Overview of research on Digital Transformation applications in tree management in the world and Vietnam

According to Hue [8] the "Tree Equity" initiative was created to ensure that urban areas and cities in the United States have enough green trees to provide significant advantages to the entire community. This is accomplished by developing a fair tree evaluation system and implementing it on a nationwide scale in urban areas with a population of at least 50,000 people or more. This method assesses a region's ability to produce adequate greenery to protect health, encourage economic development, and reap social advantages. The benefits to society and the environment that trees provide. The American Forest Foundation created the Tree Equity Score Analysis (TESA) to help folks who live in cities and wish to dig further into their methods. TESA not only helps them evaluate each requirement for each unique plot of land, but it also enables the integration of local data to construct tree planting plans adapted to climate conditions, public health, and economic objectives. Distinct local conditions. This tool identifies tree-planting opportunities, develops plans for tree-planting projects, and provides various scenarios to stimulate tree development in the region [2].

Drone tree planting technology is a crucial step advance in the tree planting sector. The approach was created by BioCarbon Engineering, a UK firm financed by Parrot. The drone scans the ground and generates a 3D map before employing an algorithm to determine the most successful tree-planting model. In Edmond [9] researcg, it was said that: The plane transports tree seeds and can plant over 100,000 trees every day. Each year, up to 1 billion trees might be planted by 60 drone crews. This quick and inexpensive approach can be used in difficult-to-reach regions. Furthermore, the "Plant for the Planet" application provides users an extensive list of beneficial functions. Users can set marks on a map to track the growth of their sponsored trees worldwide, including where they were planted, who did it, and how many trees they had. And it was pointed out in the study by Arcnews [3] that the ranking in the app shows that most of the trees have been grown concentrated in countries such as China, India, Ethiopia, Pakistan and Mexico.

The combination of intelligent data collection techniques and 3D and GIS

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models in tree management is being studied extensively worldwide. For example, the evaluation of biological byproducts from urban tree maintenance from an energy standpoint [10]. Due to lacking information, tree pruning is frequently not managed with comprehensive planning. The study established and tested a new method based on GIS after measuring the amount of wood byproducts from trees using geophysical equations and having knowledge about present tree management in Milan, Italy. The result is an estimation of potential in terms of available wood byproducts displayed on an urban map. The author also mentioned management support to increase the use of tree waste materials and incorporate them into local renewable energy supplies, thereby producing a cost-effective renewable resource and promoting a circular economy on a local scale.

Cimburova and Blumentrath [5] analyzed the quantity of byproducts produced by maintaining urban greenery from an energy standpoint. Due to lacking information, tree pruning is typically not structured according to a defined strategy. A new GIS-based system was created and evaluated in Milan, northern Italy. After predicting the number of byproducts from tree trimming using densitometric equations and having available information on present tree management. The primary result is estimating energy potential in the form of bioavailable feedstock from trees, displayed on a spatially connected metropolitan map. Furthermore, the study's findings can help regulatory authorities improve the management of these materials, thereby converting public expenditures for maintenance into public income for future investment. A GIS database can support local matching of available renewable energy sources and active energy supply systems (e.g., district heating systems), providing low-cost and efficient renewable resources while enhancing the circular economy at the local scale.

An efficient GIS technique for predicting tree visibility in metropolitan environments [6]. This approach, implemented in GRASS GIS, can be used to evaluate tree display, contributing to tree valuation and related ecosystem services. This approach has been tested and confirmed to be accurate, and it can handle huge and high-resolution data sets. By incorporating tree display metrics, this strategy has the potential for widespread application in tree management, urban ecosystem accounting, and tree-related conflict resolution.

Yanzhi [12] conducted an overview study on urban green tree assessment by data collection from a street perspective. The authors analyzed 135 scientific papers published between 2010 and 2022 that stressed using Street View (SV) photos to evaluate urban vegetation. The most

well-known area of this research is the extraction of the green visibility index, which focuses on analyzing the impact of roadside trees on the health, activities, and psychology of people (referred to as cultural service). However, few other studies have examined the various ecological services urban trees provide. Overall, this research demonstrates that using SV photography to evaluate applications of urban greenery confronts numerous problems, including restrictions in the spatial and temporal breadth of the images, low data collection accuracy, and the immaturity of deep learning approaches in detecting items. Despite these challenges, there is considerable potential for these methodologies to be developed to facilitate more diverse urban greenery research and applied to evaluating other ecosystem services and/or specific types of green infrastructure, such as roadside trees.

In Vietnam, Anh [1] researched the administration of Urban Greenery Systems of Industrial Revolution 4.0 by computer software and database systems. The material provides numerous benefits and incorporates numerous aspects in numerous domains of research and life, including urban green management. Because of the government's initiatives to create e-government and intelligent cities, interest in this sector is growing in Vietnam. This research begins by investigating the current state of urban green management in Vietnam to identify existing management challenges and the field's potential in implementing new technology in urban areas, such as artificial intelligence, information technology, and the Internet of Things. Following that, the author examined the uses of science and technology in urban green management worldwide and in cities in Vietnam to evaluate performance and better understand the setting. Propose lessons that can be applied to the situation in Vietnam. Finally, the paper explores the potential for using management software and suggests appropriate solutions for intelligent urban green management, thereby giving effective tools that may help develop and organize smart cities in Vietnam during the Industrial Revolution 4.0.

Diep [7] used Google Earth images collected by combining the use of Elshayal Smart GIS software with the altitude parameter set to 263 m in their study of building a map of the distribution of urban greenery and estimating greenhouse locations in Can Tho city. Objects in the image can now be seen clearly with the naked eye. Create a map of the current state of trees in Ninh Kieu district. The results suggest that the district's green space is 621.62 hectares, with an overall accuracy of 85.71% (K = 0.71). However, the density of trees in the Ninh Kieu area is only 50–60% of the Ministry of Construction's criteria. This green space can only absorb more than 60% of the district's greenhouse gas emissions, or

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226,891.30 tons of CO_2.

Meanwhile, the greenhouse gas emissions from the three sectors are 734,740.48 tons of CO_2 equivalent from energy, agriculture, and waste. These findings indicate that the Ninh Kieu area should expand tree planting and implement green solutions to reduce greenhouse gas emissions. Green resource management and protection can substantially decrease urban greenhouse gas emissions and foster sustainable green urban development [4] researched using GIS technology to build a tree management system in Tra Vinh by using WEBGIS (GIS) to manage trees in Tra Vinh city. This study has a significant meaning, giving managers a more realistic overview of the city's green tree situation. At the same time, it aids in adjusting management methods and improving the urban environment. Furthermore, GIS applications have the potential to reduce geographic data collection costs.

It is clear that digital transformation research and applications in urban green management have yielded numerous substantial benefits, both globally and in Vietnam. Drones, mobile apps, and intelligent data collection technologies have boosted the speed and efficiency of planting and maintaining urban trees. This not only grows more trees but also aids in managing tree resources. Furthermore, GIS and digital technology have made monitoring and analyzing tree growth simple by providing specific information on where trees were planted, who planted them, and how many trees were planted. This improves tree management efficiency and allows for global tracking of tree initiatives.

2.2 Discussion and evaluation of Digital Transformation applications in Vietnam

Digital transformation applications in tree management are currently being targeted and developed in Vietnam. Vietnam is witnessing fast urbanization growth, and urban tree management is becoming increasingly crucial. The digital shift has created numerous potentials to improve tree management while posing several obstacles. To ensure the most successful use of digital transformation in tree management in Vietnam, the current situation's strengths and limitations must be thoroughly considered. The SWOT (Strengths, Weaknesses, Opportunities, Threats) study of digital transformation applications in tree management in this article will help us better understand the construction industry's strengths, weaknesses, opportunities, and difficulties. When using modern materials in construction, Vietnam faces challenges. Here are some discussion points of a fundamental SWOT analysis:

a. Strength

The strengths of applying digital transformation in urban greenery management in Vietnam may include increased awareness, technological receptiveness in major metropolitan

areas, opportunities for international collaboration, urban economic development, and the environmental and social benefits of enhanced urban forestry administration.

- Raised awareness: In Vietnam, there is a considerable increase in understanding of the importance of tree management and using digital transformation technologies. This lays a firm platform for future growth.

- Digital transformation applications in large cities: In Vietnam, certain large cities have successfully used digital transformation apps for tree management. This indicates the technology's feasibility and potential in tree management.

- International organization support: Vietnam has the chance to collaborate with international organizations to learn and get technological and financial assistance in building digital transformation applications.

- Economic development and urbanization: Vietnam's economic development and urbanization present chances for better tree management and the application of digital technology.

- Environmental and social advantages: Concern for the environment and community health opens up chances to employ trees to reduce greenhouse gas emissions and improve quality of life.

b. Weaknesses

The weaknesses of the current state of digital transformation in urban greenery management in Vietnam may include a lack of widespread geographic information systems, insufficient geographic data sources, uneven development, shortage of specialized personnel, limitations in greenhouse gas estimation and management, as well as constraints in evaluating urban forest productivity.

- Limitations of geographic information systems: In Vietnam, using GIS (Geographic Information System) in tree management is relatively uncommon. As a result, there is a lack of access to and distribution of high-quality, consistent geographic data.

- Geographic data source limitations: In order to execute digital transformation applications in tree management, precise and detailed geographical data sources are required. Many communities continue to lack geographical data on trees.

- Uneven development: In Vietnam, the growth of digital transformation applications in tree management is uneven between large urban and rural areas. Rural communities and small cities are still in the early stages of development and do not yet have access to digital technologies.

- Lack of skilled human resources: Deploying and maintaining digital transformation systems requires GIS and information technology knowledge. A problem in this industry is a lack of expert human resources.

- Limited greenhouse gas estimation and management: The use of digital transformation in evaluating and

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managing greenhouse gas emissions from trees remains limited. This may result in the ineffective use of trees to minimize greenhouse gas emissions.

- Limited estimation of tree performance: In the future, estimating tree performance, such as its ability to absorb CO_2 and offer ecological services, would require a mix of geographic data and modeling science progress.

c. Opportunities

The perceptible opportunities include increasingly heightened environmental awareness, advancement in information technology and GIS, data sharing and collaboration potential, assistance from governmental and non-governmental entities, incremental project deployment, and ameliorated capabilities for appraising urban greenery performance.

- Raising environmental awareness and conserving trees: Both the world and Vietnam focus on environmental and tree protection. This increased understanding provides an opportunity to encourage the use of digital transformation in tree management.

- Information technology and GIS development: Information technology and GIS are rapidly evolving. Using digital technologies to manage trees has become more convenient and efficient.

- Data sharing and collaboration: possibilities for geographical data exchange and collaboration in large-scale tree management. This can help increase efficiency and save costs.

- Government and non-governmental organization (NGO) support: Governments and non-governmental organizations (NGOs) can provide financial and political support for programs utilizing digital transformation in tree management.

- Develop projects in phases: the ability to deploy digital transformation applications in tree management in stages, beginning with large urban regions and then moving to rural areas and small cities.

- Improved estimation of tree performance: Improved estimation of tree performance, such as its ability to absorb CO_2 and offer ecological services, can help optimize tree care and use.

d. Threats

The proposed challenges to consider and discuss include a lack of investment resources, uneven distribution, personnel training capabilities, geographic data constraints, information security and privacy, technological competition, and change.

- Lack of technical infrastructure and investment resources: deploying a digital transformation system necessitates significant investments in technical infrastructure, software, and professional human resource training. A lack of resources and investment can hinder the implementation of digital transformation apps for tree management.

- Uneven distribution: the development of digital transformation applications may be uneven across different areas and

cities. Large cities can go further in digital transformation than rural areas and small cities.

- Ability to train and provide professional human resources: It is currently difficult to attract and train human resources with experience in GIS and information technology. A lack of informed and qualified individuals can hamper implementation.

- Geographic data's spatial and temporal scope: Geographic data frequently has a limited spatial and temporal scope. Collecting and maintaining geographic data necessitates constant investment and change, which can be difficult.

- Data security and privacy: Geographic data management necessitates specific consideration for data security and user privacy. Data security and privacy can present extra issues.

- Competition and technological change: Businesses and organizations may compete in the development of digital transformation applications for tree management. Rapid technological advancements can render present solutions obsolete.

In conclusion, while digital transformation use in tree management is growing in Vietnam, numerous restrictions and hurdles remain to be addressed. Raising awareness, investing in information technology, and educating human resources with knowledge in this field are all necessary for more effective tree management that contributes to environmental protection and sustainability in urban areas.

3. Proposed Solution

Based on a SWOT analysis of the current state of digital transformation applications in Vietnam. To more successfully use digital transformation in tree management in Vietnam, it is required to prioritize investments in technical infrastructure, the collection and updating of geographical data, the training of human resources, uniform distribution, and environmental protection, monitor and analyze tree performance, as well as preserve information security and privacy. The following solutions are proposed in the report:

3.1 Regarding solutions for increasing investment and technical infrastructure

The government and other organizations must boost their investment in the technical infrastructure, software, and equipment required for digital transformation applications in tree management. This includes providing governments and organizations with financial resources and technical support to guarantee that the application is deployed properly. Specifically, for example, the Workshop on Research on Public Green Space Management System held on October 3rd, 2023 in Can Tho (Fig. 1).

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Fig. 1. *Can Tho Workshop on Research on the Management of the City's Public Greenery System.*

3.2 Regarding solutions for geospatial data collection and updating

Through geographic information systems (GIS), the government can facilitate the collection and update of geographic data about trees. Organizations can work together to share data and maintain information consistency. Building and sustaining digitally converted tree management systems requires accurate and up-to-date geographic data.

3.3 Regarding solutions for professional human resource training and recruitment

Human resources with knowledge and abilities in GIS and related information technology are required to deploy and manage digital transformation systems successfully. Governments and universities can work together to offer specialized training and education in this subject. Simultaneously, investments in attracting and maintaining talented human resources are required to ensure the stability and durability of digital transformation programs.

3.4 Regarding solutions for regional development and distribution

The government might set up reward and support programs in both urban and rural areas to encourage the development of digital transformation applications for tree management. A plan connecting large cities and rural areas can ensure that tree management efforts are not hampered by geography.

3.5 Regarding solutions for protecting data security and privacy

Proper policies and regulations must be established to secure geographic data and user privacy. Information security procedures must be established to ensure that sensitive data is safeguarded and used properly.

3.6 Regarding solutions for monitoring and evaluating tree performance

Methods and instruments for monitoring and evaluating the performance of trees in absorbing greenhouse gases and providing ecological services are needed. Estimate tree performance and discover opportunities for improved management using geographic data and modeling.

4. Conclusions

In the global context, and more specifically in Vietnam, empirical observations have demonstrated that applying digital technologies in urban greenery management has yielded

appreciable efficacies. Scientific research and practical implementation of digital transformation have catalyzed this progression. Advanced technologies like uncrewed aerial vehicles (drones), mobile applications, and intelligent data collection systems have markedly enhanced the velocity and productivity of urban vegetation's new planting and maintenance operations. The impact of these advancements is not limited to increasing the quantity of greenery but also optimizing the management of associated resources.

Remarkably, the robust integration of Geographic Information Systems (GIS) and other digitization tools has streamlined the processes of monitoring and evaluating urban forest growth, furnishing detailed and evidence-based data on planting locations, executing agencies, and specific tree counts. This digital transition has contributed to more effective urban forestry administration, alongside elevating the capabilities for supervising greening projects on a global scale.

According to scientific research reports and proposed SWOT analyses, digital transformation applications in tree management in Vietnam are in the early stages of development and are making significant progress. Alongside the facilitations, numerous challenges still exist for the progression of digital transformation in urban greenery management in Vietnam in the current period. We must persist in investigating, expanding, and effectively implementing fundamental solutions to thoroughly and extensively integrate technology and digitization into urban forestry administration in Vietnam.

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