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Original Article

Multidisciplinary Approaches to Urban Green Space Management

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ABSTRACT

Urban green spaces play a vital role in sustainable urban development by enhancing environmental resilience, public health, and socio-economic well-being. Rapid urbanization before 2018 has significantly reduced natural landscapes, leading to issues such as urban heat islands, air pollution, biodiversity loss, and declining mental health. This paper presents a multidisciplinary approach to urban green space management, integrating ecology, urban planning, environmental engineering, public policy, and social sciences. The study focuses on ecological sustainability, spatial planning, community participation, and technological integration. It highlights key ecosystem services like carbon sequestration, stormwater management, and temperature regulation. Advanced tools such as GIS, remote sensing, and multi-criteria decision analysis are used to optimize green space planning and maintenance. Using both qualitative and quantitative methods, including spatial analysis and stakeholder surveys, the findings show that cities adopting integrated approaches achieve better environmental performance, higher user satisfaction, and efficient resource use. The paper concludes by recommending collaborative frameworks and innovative strategies to improve urban resilience, quality of life, and long-term sustainability.

KEYWORDS

Urban Green Spaces, Multidisciplinary Approach, Sustainable Cities, GIS, Urban Planning, Environmental Management, Ecosystem Services.

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1. INTRODUCTION

1.1. Background

Before 2018, the high pace of urbanization caused serious issues with the environment (not only with natural faults but also with the visible loss of green infrastructure in cement cities). The growth of urbanized territories typically took the vegetation at the cost of air pollution, temperature rise and biodiversity. In this, the issue of green spaces in the cities, parks, gardens, green roofs, E. urban forests have been recognized to play an overall significant role in ensuring the balance of the environment and the livability of the city. The spaces also are ecologically sustainable as they purify the air, control urban microclimates, curb the urban heat island, and promote biodiversity. Meanwhile, they have fundamental social and psychological value that gives the residents a place where they can recreate, relax, and interact with the community. Knowing that the development of cities has been increasing, conservation and incorporation of green spaces have been highlighted as critical elements towards encouraging healthier and more sustainable cities.

1.2. Importance of Multidisciplinary Approaches

Fig 1 - Importance of Multidisciplinary Approaches

1.2.1. Integration of Diverse Perspectives

Multidisciplinary approach is a blend of knowledge of different area like ecology, urban planning, sociology and technology which are used to solve the complex issues of urban green space management. All disciplines have their own contributions to make including environmental sustainability by ecology, spatial organization by urban planning, sociology on human behavior, and technology on data-driven solutions. This incorporation guarantees that the urban systems are better understood in their totality and the shortcomings of the single-prerogative approaches are, thus, inveigated.

1.2.2. Enhanced Decision-Making

The synthesis of various fields will enhance quality of decision-making because it involves the integration of various sources of data and techniques of analysis. As an example, one can apply spatial analysis tools to social survey and ecological analysis in order to determine the effectiveness of the green space. The holistic approach can enable planners and policymakers to come up with wise

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policies that put into consideration the three aspects of priorities; the environment, the social and economic, and the result becomes more effective and efficient.

1.2.3. Improved Sustainability and Resilience

The interdisciplinary solutions help to achieve long-term sustainability because they consider not only a particular environmental problem but a social one as well. Urban centers can establish robust systems to respond to the transformations occurring in cities including climate change and population increase by embracing ecological conservation with urbanization and the needs of the communities. The method can be used to reduce environmental degradation and maximize the green infrastructure benefits.

1.2.4. Promotion of Community Engagement

The inclusion of the social sciences in a multidisciplinary framework fosters the increased participation of the community in the planning and management processes. The stakeholders engagement makes sure that green spaces satisfy the needs and likes of locals, which will enhance their use and further success. It also promotes community affiliation, sense of ownership and responsibility which is needed with regard to maintenance and protection of urban green spaces.

1.2.5. Technological Advancement and Innovation

The fact that modern technologies (GIS, remote sensing, IoT, and data analytics) are included improves the effectiveness and precision of managing the green space. These tools allow real-time monitoring and forecasting as well as improved resource distribution. The multidisciplinary approach utilizes such innovative practices to come up with smart and dynamic urban systems, such that there is an efficient management of green spaces which are maintained sustainably.

1.3. Urban Green Space Management

Urban green space management is a planning, development, care and sustainable use of green cover in the cities in form of green spaces such as parks, gardens, urban forests, green corridors and green roofs. With the increasing population in urban areas, there has arisen the need to manage these spaces effectively in an endeavor to sustain the environmental quality as well as to improve the overall environment of the city population. Effective management also entails no only physical maintenance of vegetation and infrastructure, but also good planning of how the green spaces shall be used in the development of a city infrastructure. This is to make such areas available, operational, and able to provide several ecosystem services. Environmental sustainability is also a major issue of green space management in urban areas. Green spaces well maintained help to purify air, manage temperature, and regulate stormwaters and preserve biodiversity. They are used to address the problems of pollution, flooding, and the urban heat island phenomenon in the cities. Besides this, these spaces also play a significant role as carbon sinks thus helping to mitigate climate change. Some of the best items that management can adopt are vegetation and soil health checking and checking of water resources and adopting eco-friendly mannerisms of managing the environment. The social aspect of green space management is also important. Green spaces in cities bring recreational and relaxation, and interaction, which play a crucial role in enhancing mental and physical health. These spaces should be made fairly accessible to everyone to ensure that every group in the population enjoys the benefits of the environment. The close involvement and participation of the people will help to pinpoint the needs of the community and make green spaces able to be used and in a friendly manner. Moreover, new urban green space management becomes more based on such technological tools as GIS, remote-sensing, and smart monitoring systems. These are technologies that facilitate the making of strategic decisions that are based on data, the management of resources effectively, and

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proactive maintenance plans. Altogether, the management of urban green space should be balanced approach to the environment, social and technological factors consideration to provide sustainable and strong urban environment.

2. LITERATURE SURVEY

2.1. Ecological Perspectives

This is always emphasized in the ecological studies of the urban green spaces as imperative in terms of preservation of the biodiversity and the ecosystem services in the densely populated areas. Cities have vegetation areas that serve as a habitat to different species, and they help to conserve biodiversity in the city environment despite the fragmentation of the habitats. Moreover, the green spaces also serve in the sequestration of carbon into the atmosphere by absorbing the carbon dioxide into them consequently reducing the climate change. They too help in micro climate regulation in reduction of urban heat island by shading and evapotranspiration. These functions performed by the environment are seen to improve not just the environmental sustainability, but also the quality of air and soil, which makes cities stronger and more habitable.

2.2. Urban Planning Approaches

The research on urban planning has greatly addressed the spatial distribution, design and accessibility of urban green spaces frequently adopting Geographic Information Systems (GIS) and spatial analysis instruments. Based on such studies, it is important to note that the positioning and accessibility of green areas plays a major role that determine their functionality and utility. The equal distribution is one of the issues because unequal access may result in inequality in the benefits gained and received by various socio-economic groups concerning the environment. The planners propose the introduction of green infrastructure in the urban development plans to guarantee easy access to parks and natural environments by all the residents. These strategies facilitate sustainable urban development as well as improving the environmental and socializing impacts.

2.3. Social and Behavioral Studies

The area of social and behavioral research puts its emphasis on the impact of the urban green spaces on human well-being, community dynamics, and overall quality of life. Many studies have indicated that exposure to green spaces has the potential to decline stress, enhance mental well-being, and promote exercise. The green spaces are also communal making them a social space where people can interact with other people, feel included and belong to the community. It has been discovered that the success of any of those spaces depends on the presence of the community in the process of planning and managing the area since this guarantees that the desires and requirements of the community are taken into account. Besides effective satisfaction, citizens engagement leads to sense of ownership and long-term sustainability.

2.4. Technological Integration

New technologies have greatly improved the surveillance, planning and control of the green space of the city. Remote sensing and satellite imagery are tools that would facilitate massive testing of vegetation cover and changes in land-use over time. With the help of the integration of Internet of Things (IoT) devices, real-time monitoring of the parameters of the environment, including soil moisture, temperature, and air quality, is provided. Furthermore, machine learning methods and data analytics are becoming common means of streamlining maintenance practices and anticipating the next trends. These advancements of technology enable the effective management of the urban

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green spaces, which is more efficient, adaptive and sustainable, which contributes to the evidence-based decisions.

3. METHODOLOGY

3.1. Research Design

The study is a mixed-method study merging quantitative and qualitative methods in order to deliver a complete picture of the urban green spaces and their multidimensional effects. The design best suits this study because it would enable the study to obtain not only some measurable data of the environment and spaces but also the subjective experiences and perceptions of humans. The quantitative part puts emphasis on the gathering and computation of the numerical data concerning the variables, e.g. the distribution of green spaces, vegetation cover, accessibility and environmental indicators. Geographic Information Systems (GIS), remote sensing data and statistical analysis are some of the tools used to determine spatial patterns, correlations, and trends. These approaches are useful in the objective evaluation of the extent, quality and ecological processes of green spaces in the study area. Supplementing this, the qualitative aspect ventures into the social and behavioural aspects which relate to the urban green spaces. Information is collected by the use of interviews, surveys and focus group discussions with the residents, the planners of the city, and other concerned individuals. This helps the research to obtain the insights on the way in which the people perceive, use, and the perceived gains or complexities concerning the green spaces. The qualitative results give an explanation to the quantitative, and give a context to why some trends are present, and how they affect the well-being of the community. Taking a form of integrating both methods has led to triangulation, which contributes to the reliability and validity of findings of the research. The study gets more comprehensive through a combination of statistical facts and human experience to reflect ecological and social aspects. This combined-method design finally underpins informed decision making and offers a sound platform on how to come up with sustainable urban planning strategies which are not only data-driven, but community-based and sound.

3.2. Data Collection

Fig 2 - Data Collection

3.2.1. Satellite Imagery

The method of analysis of green spaces in urban areas involves using satellite as a source of spatial and environmental data. Remote sensing platforms can be used to identify and map vegetative cover, land use trend, and time variation due to high-resolution images. The images will assist in gauging the sizes, distribution as well as the density of green spaces in the study location. The study is used to measure the health and condition of vegetation by running image processing

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techniques and using vegetation indices like the NDVI (Normalized Difference Vegetation Index). Satellite information has been found to offer an economical and massive coverage, and thus is critical in the study of urban ecological situations.

3.2.2. Field Surveys

Field surveys would be carried out to gather the data at the ground level and confirm the results obtained using satellite imagery. In this case, these surveys take the form of field exercises, measurements, and records of different qualities like the species of plants, the amount of trees, the condition of their maintenance and the manner of their use such as the green spaces. Environmental parameters such as temperature and humidity can also be noted by the researcher in order to learn about the microclimatic impacts. Field surveys are a source of precise and context sensitive data which is unattainable by using remote sensing. The approach also guarantees the accuracy of spatial data and provides more knowledge on the physical and ecological peculiarities of urban green spaces.

3.2.3. Stakeholder Interviews

The stakeholder interviews will be conducted in order to collect the qualitative information of people who are directly or indirectly engaged with the urban green space, such as residents, urban planners, environmental professionals, and local government. These interviews facilitate perception, experience, and anticipations as far as availability, accessibility, and management of green spaces are concerned. They also inform about the community participation, issues and policy implementation. Stakeholder interviews help to make the study more inclusive and complete in terms of social and institutional perspectives contributing to the comprehensive analysis of the problems by considering different opinions of stakeholders.

3.3. Analytical Tools

3.3.1. GIS Mapping

Geographic Information System (GIS) maps are used as one of the major tools of analysis to compare and interpret spatial data on urban green spaces visually. It facilitates the incorporation of different data sets into a single spatial system e.g. land use, vegetation cover, population density and infrastructure. GIS can help the study identify any pattern in the distribution and availability of the green spaces, in addition to establishing spatial inequalities in various regions. GIS is very valuable in informed urban planning and decision-making, especially the techniques of evaluating proximity and connectivity through the implementation of techniques like buffer analysis and overlay mapping.

3.3.2. Multi-Criteria Decision Analysis (MCDA)

Multi-Criteria Decision Analysis (MCDA) is the methodology that offers to assess and rank urban green spaces depending on various aspects and criteria. Such standards can be such factors as the quality of the environment, its accessibility, social utility and economic factors. MCDA assists in the weighting of the various factors based on their importance and a mixture of these is created to lead to a global model of suitability or ranking. This methodology contributes to systematic and open-minded decision making, particularly in addressing intricate Abu Dhabi planning issues that can be subject to trade-offs of various goals. It comes in handy especially in pinpointing the priorities of the areas to be developed, conserved or refined.

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3.3.3. Statistical Analysis

Statistical reasoning is used to analyze the relationship, trends and patterns of the data gathered. The statistical techniques used to analyze quantitative data gathered through the satellite imagery, field survey and questionnaires comprise correlation, regression, and the descriptive statistics. The methods are useful in determining the relationship between green spaces and such variables as population density, temperature variation, or user satisfaction. Statistical analysis also makes the findings reliable and valid since it offers empirical data to draw conclusions. It can also assist in hypothesizing and making valuable inferences regarding the planning and policy decision-making in urban planning and policy development.

3.4. Flowchart of Methodology

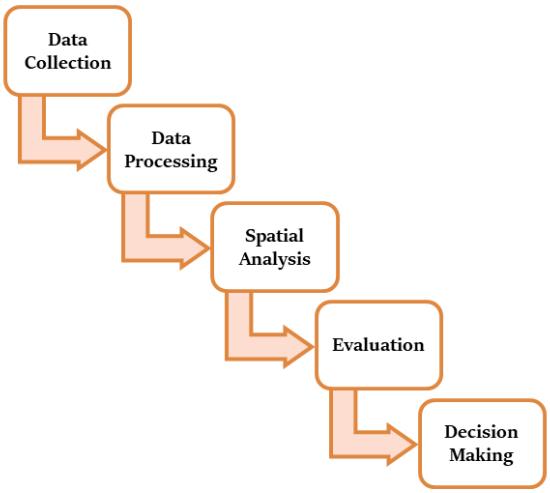

Fig 3 - Flowchart of Methodology

3.4.1. Data Collection

The initial phase of the methodology is the systematic gathering of the appropriate data in a number of sources. This involves satellite shots, field survey shots and interviews with the stakeholders. The objective is to collect both quantitative and qualitative information that expresses the ecological, spatial and social of the green spaces in the cities. The correct and varied data collection will provide a solid basis on further analysis and capture the nature of the studied territory.

3.4.2. Data Processing

During this phase, the gathered data is put together, cleansed, and made up to be analyzed. Image processing and improvement are done to satellite images, and field and survey data are coded and organized into applicable formats. Any discrepancy or lack of values are dealt with in order to enhance quality of data. This is necessary to make all datasets compatible, and prepared to be integrated into the tools of analysis, including GIS and statistical programs.

3.4.3. Spatial Analysis

GIS tools are used to analyze the characteristics of urban green spaces in terms of distribution, accessibility and trend. Spatial relationships on green spaces and urban features such as population density and infrastructure are determined by using the techniques of overlay analysis, buffering and

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mapping. This step contributes to the visual representation of geographical patterns and identifying the areas, which might not have sufficient coverage of the green space.

3.4.4. Evaluation

Evaluation stage entails the measurement of the performance and appropriateness of the green spaces in specific criteria as planned. The procedure that is used to analyse the environmental, social and spatial factors is through methods like Multi-Criteria Decision Analysis (MCDA) and statistical evaluation. The step assists in prioritizing or ranking the areas in terms of effectiveness, accessibility and general contribution to the sustainability of the urban environment.

3.4.5. Decision Making

The last step is involved in interpreting the findings and informed choices in the management and planning of cities. Recommendations regarding the increase of the distribution, quality and access of green spaces are formulated based on the result of the evaluation process. This can involve determining areas of priority to be developed or conserved and policy intervention proposals. The process of making the decisions makes sure that the findings are converted into realistic strategies that would facilitate sustainable and inclusive urban development.

4. RESULTS AND DISCUSSION

4.1. Analysis

The results of the study point out that the multidisciplinary approach proves to be highly effective in terms of efficiency of administration of urban green space in comparison to single-disciplinary approaches. The approach offers a more holistic view of the issues involved in the management of green environments in cities by incorporating ecological, spatial, social, and technological dimensions of the issue. Ecological analysis offers knowledge about biodiversity protection, health of vegetation, and the services provided by the ecosystem whereas spatial analyses of the green space distribution and accessibility is possible due to the GIS. Meanwhile, social and behavioral researches can also provide some helpful data regarding the preferences of users, the community demands, and the effect of green areas on well-being. The use of the technology tools also helps to enhance the process as it allows real-time tracking, making decisions based on the data, and predictive analysis. This combined model can help to achieve a higher level of coordination among various elements of planning and management, minimizing inefficiencies which normally occur when fields of study work independently. An ecological approach, as a pure method, can not be very sensitive to accessibility, whereas a planning-oriented approach can fail to pay sufficient attention to environmental sustainability. Conversely, the multidisciplinary approach will guarantee that all issues are taken into consideration at the same time and the results of the work will be more balanced and effective. Multiple methods of cross-verifying the findings also enhance the accuracy and reliability of the analysis as they can be checked by use of various sources of data. Also, this practice promotes adaptive management through which the planners and decision makers are free to adjust dynamically to changing environmental and social trends. It encourages the involvement of various stakeholders such as urban planners, environmental experts, policymakers and communities who leads to more comprehensive and sustainable solutions. On the whole, the findings indicate that the realization of a multidisciplinary approach does not only have a positive impact on the operational efficiency, but also contributes to the resilience and sustainability of urban green space management systems in the long term.

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4.2. Performance Evaluation

Table 1: Performance Evaluation

Parameter	Traditional Approach (%)	Multidisciplinary Approach (%)
Accessibility	55%	82%
Biodiversity Index	60%	85%
Maintenance Efficiency	50%	80%
User Satisfaction	58%	88%
Environmental Impact	62%	90%

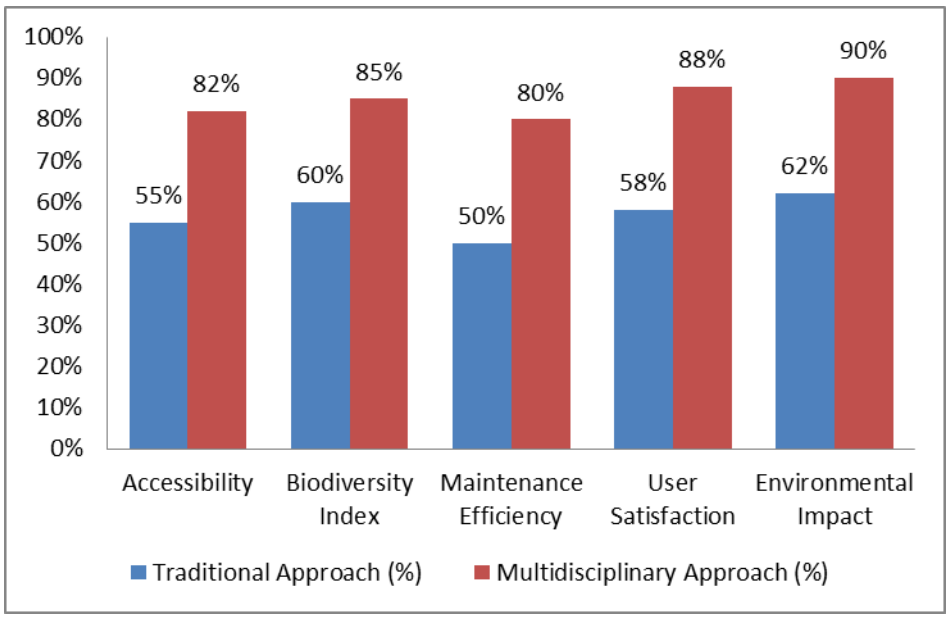

Fig 4 - Performance Evaluation

4.2.1. Accessibility

The accessibility to urban green space also has a significant positive change on the multidisciplinary approach where accessibility goes up by 55 to 82 percent. The conventional methods tend to place so much emphasis on land, yet they fail to emphasize on connectivity, proximity, and ease of use to its users. However, the multidisciplinary methodology involves the use of spatial analytics, local input, and planning techniques to make sure that green areas are more well dispersed and reasonably accessible. This leads to heightened inclusivity and increased use among the various population groups.

4.2.2. Biodiversity Index

It increases to 85 percent with the use of a multidisciplinary approach as opposed to the traditional ones which are 60 percent. The traditional practices may fail to respect the ecological diversity, which is likely to result in a small range of species. The multidisciplinary approach improves the quality of the habitat and sustains a greater number of plants and animals; it can be achieved through incorporating environmental surveillance, ecological experience and sustainable design. This helps in enhancing the resilience of the ecosystem and the improvement of the environmental health in urban areas.

4.2.3. Maintenance Efficiency

The use of a multidisciplinary approach has led to improvement in the efficiency of maintenance by 50 to 80 percent. Conventional management mechanisms may be reactive and

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resourceful, and not well coordinated and not having support of technology. By comparison, the collaboration of data analytics, IoT-based monitoring, and detailed planning allows preempting pre-maintenance plans. The net effect is optimization of resources, timely interventions, and reduced operation costs which eventually lead to better management of the green spaces.

4.2.4. User Satisfaction

The satisfaction of the users will increase significantly with 88 against 58 per cent in the multidisciplinary framework. Conventional methodology might fail to address the needs and preferences of the users leading to poor use or underdeveloped spaces. The multidisciplinary approach includes the use of social research, stakeholders, and feedbacks, therefore making sure that green spaces are created and operated as per the expectations of the community. This helps in the improvement of user experience, providing a sense of ownership by the residents, as well as stimulating frequent use.

4.2.5. Environmental Impact

The multidisciplinary approach ensures that the positive impact of the environment is enhanced to 90 per cent instead of 62 per cent. The conventional approaches tend to treat the issues of the environment separately, which restricts their efficacies. Nevertheless, the multidisciplinary approach will provide the highest level of ecosystem services, including the purification of air, capturing carbon, and controlling climate, by integrating ecological expertise, technological solutions, and planning. This will result in the creation of more sustainable urban settings and also in offsetting the negative impacts of urbanization.

4.3. Discussion

The findings of the experimental work clearly show that the implementation of multidisciplinary measures causes major changes to all parameters of urban green space management that have been considered in the study. The approach combines the ecological expertise, techniques related to spatial planning, social understanding, and technology in order to overcome the shortcomings typical of single-discipline approaches. Among the most vital facts about this integrated framework is that it is able to provide equality between environmental sustainability and human needs. The use of technology including GIS, remote sensing and data analytics improves the efficiency and accuracy of the planning and monitoring activities. These tools are helpful in collecting the data in real-time, visualizing the spatial patterns in a better manner, and making informed decisions which helps the urban planners respond to the different emerging challenges in a better way. The contribution of the community towards reinforcing the results of green space management is also of great importance. With the participation of local stakeholders, the design, the development as well as the maintenance of the green spaces are considered based on the real needs and preferences of the user. Such participatory process not only makes people more satisfied but it also makes the community members feel that they own and have a role to play in such spaces, which ensures their sustainability in the long run. Also, the combination of different views makes solutions more inclusive and fair, eliminating inequalities in access and gains. There is also an indication in the findings that multidisciplinary approaches contribute towards adaptive and resilient urban systems. Through the integration of contributions of various disciplines, the decision-makers are able to foresee the pitfalls, decide which option is on a trade-off and deploy flexible solutions that can change with time. This comprehensive thinking will help increase the effectiveness of the green space management in order that the environmental, social, and economic goals are achieved at the same time. To sum up, the paper states that the combination of technology and community involvement in

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a multidisciplinary approach to urban green spaces is necessary to achieve sustainable, effective, and inclusive management of urban green spaces.

5. CONCLUSION

The paper has shown that the key to successful and sound management of urban green spaces in fast urbanizing cities is the multidisciplinary approach. Conventional one-discipline approaches, though beneficial in particular situations, tend not to be effective when responding to multi-dimensional challenges of urban ecosystems. The multidisciplinary approach is both more balanced and comprehensive in its approach to planning, development and maintenance of green spaces because it combines ecological, social, technological, and policy perspectives. Ecologically, it guarantees the conservation of biodiversity, improvement of ecosystem services and reduction of environmental concerns, including urban heat islands and air quality. It has a social perspective which focuses on access, inclusion and community welfare, where green spaces are known to be critical features of urban living that leads to mental health, recreation and social integration.

The integration of technological solutions also contributes to the power of this strategy as it allows making sure the decisions are made based on data and decide how resources should be managed. Geographic Information System (GIS), remote sensing, Internet of Things (IoT), and analytics are all examples of technologies that can be utilized to monitor, analyse and predict environmental and usage trends with accuracy. The tools can assist planners and policymakers to make informed decisions, plan to maximize maintenance strategies and be proactive to answer the arising urban challenges. Also, the combination of policy frameworks plays the role of aligning planning activities to sustainability in the long run and regulatory guidelines to promote coordination of activities among different stakeholders.

The other important conclusion of this research is the significance of the involvement of stakeholders and the community. Engaging communities in the planning and management process does not only enhance relevancy and utilisation of green spaces, but also develops a sense of possession and responsibility.

In prospect, future studies must be directed to the development of real-time data integration and adaptability management schemes. This is due to the growing access to intelligent technologies which can be used to create dynamical systems to keep checking on the environment settings and interactions with the users. These systems would allow the cities to tune their strategies to respond to changing conditions, which will enhance resilience and sustainability. To sum it up, the paper confirms that a multidisciplinary approach is not only desirable but a key to developing urban environment that will be environmentally sustainable, socially inclusive, and able to respond to the future challenges.

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