Journal of Engineering Research

Volume 7
Issue 4 *4*

Article 11

2023

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Eman H Ayad, Sarah E. Abdel Rasheed

Erjeng, Tanta University, Egypt (ERJENG)
Vol. 7 – No. 4, 2023
©Tanta University, Faculty of Engineering
ISSN: 2356-9441 https://erjeng.journals.ekb.eg/ e ISSN: 2735-4873

Considering Green Corridors in Road Networks: An Integrated Gray-Green approach for Urban development in Cairo, Egypt.

Eman H Ayad[1], Sarah E. Abdel Rasheed[2]

[1] Assistant Professor, Architecture Department, Cairo Higher Institute for Engineering, Computer Science and Management. – email:emanayad79@gmail.com
[2] Assistant Professor, Architecture Department, Cairo Higher Institute for Engineering, Computer Science and Management. – email: sara_k2711@yahoo.com

***Abstract*- Green corridors are one of the main features for sustainability, they refer to ecological qualities and are basic elements for resilient cities. Many global cities are oriented towards green construction to protect their environments from rapid urbanization and its destructive impact on nature. However, in other cities, this is extremely challenging. In Cairo, contemporary developments are directed towards constructing the 'Gray' road networks, whereas the 'Green' is nearly disappearing. This study introduces an integrated 'Gray-Green' approach for urban development in Cairo, where green corridors are considered to achieve a livable sustainable urban environment. First, the study discusses characteristics, benefits and challenges for green corridor construction. Then, it presents three different visions and approaches for three international projects adopting green corridor concepts within their urban development. The study then depends on a comparative analysis between the three mentioned projects and the fourth case in Cairo. This analysis explores themes, objectives, challenges and actions for each project in order to conclude a proposed action plan for Cairo. This plan is considered an adaptive process for fostering environmental, social and economic sustainability in Cairo.**

***Keywords*- Green Corridors, Green-Gray Roads, Integrated Road Approach, Cairo Road Cross-Sections, Cairo Green-Gray Road Action plan.**

I. INTRODUCTION

Cities in developing countries are always struggling to cover continuous needs for economic growth, investments and improving quality of life. Traditional methods focusing on 'Gray infrastructure' including transport networks, roads and bridges, supply and sewage systems, etc. have been followed so as to provide basis for socioeconomic development. However, it eventually turned to put excessive cost on communities and challenging to meet their needs [1]. It became no longer able to face environmental changes and climatic resiliency. On the other hand, the globe is going towards the 'Green infrastructure' presented in parks, rivers, wetlands, green roofs, etc. considered as the sustainable approach that is able to support natural ecosystems maintaining communities' health and saving resources for next generations. Although sustainable, green approaches face challenges of uncertain investment return and unable to suit traditional construction models [2]. Recently, many studies have been proposing a new direction combining the two gray and green approaches. An integrated approach that is able to insert nature into mainstream systems to decrease cost and provide more resilient facilities. Relative studies have been focusing on decreasing costs and benefiting economically through the integration of mainstream infrastructure with nature looking forward to achieving resilient systems [1]. Furthermore, protecting communities from accumulative threats of climate change and economic deficiencies.

On this basis, the term 'Green corridors' aroused to emphasize the critical role and optimal use of green spaces [3]. It refers to the continuity and connectivity of green spaces or areas. They are urban lines of greenery that ensure the existence of nature along with the physical environment to meet sustainable goals. Thus, acting as a gray-green approach for city sustainability. This study explores the concept of "Green corridors" as a sustainable approach for urban design. It provides a theoretical study concerning gray-green design, in addition to characteristics, benefits and challenges for adopting such strategy in general, and specifically at a local level.

II. AN INTEGRATED GRAY-GREEN APPROACH

Urban studies had reported the obvious negative impact of rapid urbanization on nature although providing more facilities, technologies and life opportunities [4]. With population growth, the demand for urbanization increases with a continuous consumption of resources and negative consequences on natural ecosystems. two-opposite directional impacts where 'Gray' referring to urbanization versus 'Green' referring to nature. Green spaces play a major role of environmental purification and sustainability, however, usually separated or isolated from urban areas and hardly appear within buildings [5]. An integrated approach of green and gray seeks to achieve a continuous partnership of urban networks and green landscape networks. This combination and connection guarantee an urban ecological integrated network. This study explores the concept of "Green Corridors" as a tool for achieving an integrated gray-green approach for the sake of environmental restoration.

III. GREEN CORRIDORS: CHARACTERISTICS, BENEFITS AND CHALLENGES

As a concept, green corridors first appeared in the United States by the landscape architect, Olmsted, that introduced "Parkways" in urban design. In addition to the early twentieth century ideal "Garden City" of Howard, where proportional areas of residences, agriculture and industry integrate together [3]. Another resembling term expressed as the "ecological corridor" appeared in the 1990s relative to environmental protection and control researches [6]. Green

Doi: 10.21608/ERJENG.2023.323553

Journal of Engineering Research (ERJ)
Vol. 7 – No. 4, 2023
©Tanta University, Faculty of Engineering
ISSN: 2356-9441 https://erjeng.journals.ekb.eg/ e ISSN: 2735-4873

corridors are considered large linked portions of green land mingling within urban land and characterized by their linearity, connectivity and continuity. Their main goal is to preserve and strengthen biological diversity, to conserve an ecological environment through decentralization and participatory strategies for conservation [6]. They integrate and functionalize with urban networks as spaces for economic, social, ecological and cultural benefits. Thus, acting as a multi-functional tool for sustainability, communal welfare and quality of life.

Green corridors are green ways with great benefit on the community and the urban environment, this includes various aspects shown in the following:

- *Environmental benefits*: green corridors are addressed to sustainability [9], they are considered as habitats for many species functioning as wildlife parks, wetlands, long green flowing spaces improving the city's microclimate. Greenery provides shading that reduces the urban heat island (UHI) effect coming from hardscape surfaces and excessive heat [10]. Human survival depends mainly on his connection with nature, for example, birds perform pollination, seed dispersal, pest control, and waste management besides being impressive to be watched [11].
- *Urban benefits*: besides creating a visual aesthetic impact, green corridors encourage urban regeneration, offer routes for pedestrians and cycles contributing to transportation needs [8], and because of their linear configuration, they flow to connect urban and landscape elements of various functions unifying the urban image.
- *Social & Cultural benefits:* green corridors offer identity spaces for the community, extended spaces for pedestrians, recreational functions and community gatherings at different levels. They are appealing and resonate with human aesthetic standards [11]. They are also presented as cultural fields for gaining knowledge, and scientific exhibitions for research and various educational programs.
- *Economic benefits:* being sustainable supports the city's economic development through saving resources, providing job opportunities, increasing availability for natural food products and many other primary commodities.

On the other hand, green corridors face a great challenge in the continuous urban crawl breaking up its contiguous trait leaving small green patches unable to perform or give the required potentials. Furthermore, dealing with city urban structure is an extremely multi-faceted complex process with diverse agendas and programs [10]. This requires high levels of urban management and strategic planning.

IV. Approaches for Green Corridors Worldwide

The concept of Green Corridors has been widely approved and applied recently at a global scale with different objectives and properties, however sharing linearity and multi-functionality [12]. A remarkable project in Seattle aimed to create a "Pollinator pathway"; a green corridor for pollinators connecting the middle city to a small city park and designed with the ability to extend in the future [13]. The approach intended to connect fragmented green spots, support biodiversity and arousing the importance of natural world for human survival [13]. The project grabbed the community to interweave with all project phases, installing grass strips in front of houses, finding fundraisers, and many other crucial roles to provide technical, social and economic support. People did not only expertise the project benefits, but also gained knowledge about pollinators and their importance for human living and for nature.

Figure 1. Seattle Pollinator Pathway connecting fragmented landscapes [13]

Another approach, in Barcelona, aimed to develop a green urban network based on connectivity and re-naturalization concepts where urbanism and nature interact to strengthen one another. These two concepts are achieved through implementing functional robust urban green corridors, and tracking land areas of different sizes and kinds to undergo naturalization. Areas within urban condensed fabric include unused plots, green roofs, road islands and balconies …etc. [14]. This project deals with a set of main criteria for urban corridors implementation including continuity, creating rich and various layers of vegetation, biodiversity, increasing urban comfort, creating areas for human therapy, etc.

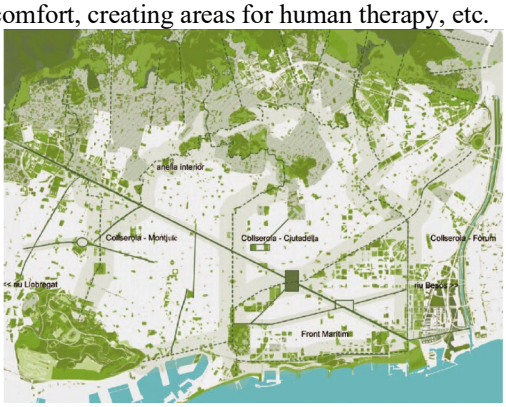

Figure 2. Barcelona continuous green corridors [14]

Doi: 10.21608/ERJENG.2023.323553

Journal of Engineering Research (ERJ)
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©Tanta University, Faculty of Engineering
ISSN: 2356-9441 https://erjeng.journals.ekb.eg/ e ISSN: 2735-4873

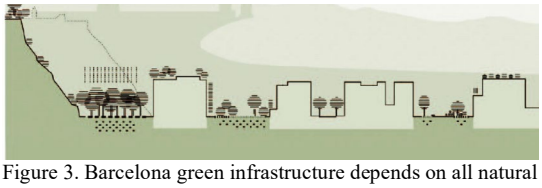

Figure 3. Barcelona green infrastructure depends on all natural & man-made green areas, both public & private [14]

Los Angeles, known for its various geographic entities, suffer from the existence of undeveloped neglected spaces within a densely heavy populated city. Regional reports predicted that temperature will terribly increase by mid-century causing extreme damage to the environment [15]. Depending on location, plans were set to adopt green corridors for environmental and social wellbeing, where one of the objectives were the development of "Green Alleys" within compacted urbanism. The social approach came to address dense communities and poverty, as green alleys facilitated resident's transportation and acted as gathering and recreational spaces, on the other hand promoted safety managing stormwater. Furthermore, alleys were adopted by permeable paving, water control networks and reservoirs to improve water quality and supports environmental sustainability [15].

Figure 4. Los Angeles green alleys storing storm water

Many other cases around the global, which can't be all mentioned in one study, had to consider green corridors as an only solution for recapturing the natural environment specially in existing sites. Each country had its own objectives, challenges and significant conditions, thus had its own solutions and strategies for implementation.

V. Key Concepts of Green Corridors

From the previous literature, it is obvious that incorporating green corridors in urban design depend on three key concepts shown as follows:

- Contiguity & Continuity: which is a prime characteristic that supports green infrastructure requirements for water harvesting processes. Connectivity occurs through various scales, along roads at different scales, pavements, gardens, green roofs…etc., all perceived as a broad network of green nodes with synergetic impacts.
- Functionality: which encompasses several compatible objectives and goals according to each application. Green Corridors must be safely usable and multi-functional. This involves achieving environmental, social, economic and cultural themes based on context and community conditions. Considering human-use as a prime goal, green corridors must offer safe, walkable and un-interrupted paths. Environmental functions may include reducing air pollution, preserving soil, moderating temperature…etc. Social functions may look for sensory enjoyment, social interaction, and many other social goals. Providing opportunities for economic investment may also be one of the main themes for design.
- Pleasure: this arouses through the connection with nature, increasing quality of living environment, elevating urban aesthetics and levels of enjoyment.

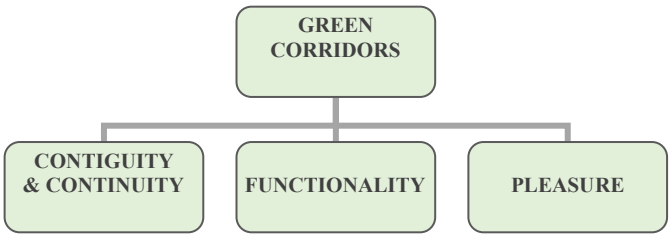

Figure 5. Key concepts for green corridors (Source: Authors)

VI. Gray versus Green Infrastructure in Cairo, Egypt.

One of the major challenges that Egypt is facing consistently is the rapid increase of population each year, along with the expansion of multi-economic projects which require efficient infrastructure networks that are backbones for any development. Since 2014, Egypt launched the National Roads Project and invested large sums in the roads system to ensure that it has the ability to deal with long-term increase in car trips, solve traffic congestion problems and improve overall safety. By 2019, 4,500 km were developed out of 7,000 km planned. This project was followed by additional investments in the land transport sector, and according to the World Bank, where 4,000 km long road projects were accomplished nationwide at the end of 2020 [16], most of these projects are in Cairo and Alexandria governorates, which constitutes about 15% of Egypt's total population (about 104,750,000 inhabits in 2023 according to The Central Agency for Public Mobilization and Statistics, CAPMAS) [16].

Cairo Governorate is witnessing the continuation of roads-construction projects to reduce congestion, most of which are concentrated in East Cairo [17]. Furthermore, 756 new bridges and tunnels at major road intersections and railway crossings have been successfully constructed over the past few years with a total cost of LE105 billion. Since 2020, 156 bridges and tunnels were built and inaugurated including 26 bridges in east Cairo [18]. Today, the government is working on the Monorail project which encompasses two axes; one connecting Cairo to the New Administrative Capital in the east, and the other connecting 6th of October City to Giza in the west. With more than 50 miles length in total, the Monorail is planned to be the world's longest route, with trains running up to 80 km/h, producing zero emissions and virtually no noise [19]. All development plans and actions on the land transport sector elevated the Egyptian road infrastructure quality rank order from 118 in 2014 to 28 by 2019 according to The World Economic Forum's

Doi: 10.21608/ERJENG.2023.323553

Journal of Engineering Research (ERJ)
Vol. 7 – No. 4, 2023
©Tanta University, Faculty of Engineering
ISSN: 2356-9441 https://erjeng.journals.ekb.eg/ e ISSN: 2735-4873

International Competitiveness Index for road quality. Moreover, the number of road accidents in Egypt fell by around 30% from 2014 to 2019 according to Egypt's CAPMAS report issued in June 2020 [18].

On the other hand, these expansions in constructing highways and bridges were accompanied by unplanned negative impact appearing in the sharp and continuous decline in green areas. Some areas were reduced, whereas others were completely removed as shown in Figure 6. For instance, between 2017 and 2020, Cairo lost about 9,000 m2 of its already limited green spaces. Each of Heliopolis and East Nasr City districts lost about 3,000 m2 of its greenery [20].

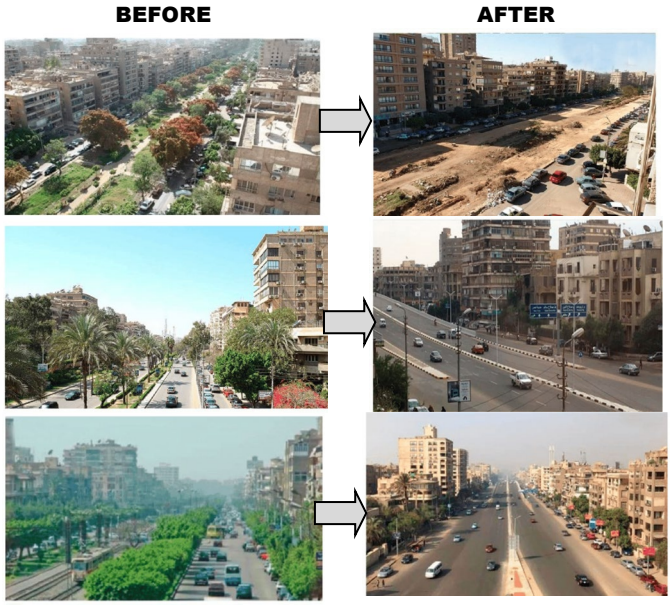

Figure 6. Cairo roads before and after expansion projects [21].

Cairo city includes various types of green spaces that differ in size and function. There is no official categorization or classification for all green areas. Some are private areas, public parks or green strips along streets. The city does not separate between amenities in statistics [27].

The per capita share of green spaces in Cairo is recorded under 0.74 m^2 per person in 2022; that is 0.3 m^2 less than the planned average for 2020, and 8.26 m^2 less than the minimum World Health Organization (WHO) standard. Looking back to 2017, the average green area per capita was 0.87 m^2 [20], while it was about 3 m^2 in 2012 [22].

Besides the severe decrease in the per capita share of green spaces in the heart of cities, the inequity of green space distribution across neighborhoods is considered another major problem. In 2020, 22 out of 37 districts in downtown Cairo (which encompass 66% of the population) had a very low percentage of green spaces recorded less than 0.50 m2 per person; while only 5 regions have an individual share of more than 3 m^2 and they are still losing their green spaces [23]. Above that, the obvious urban expansions in building gated residential communities that offer "green lifestyles" in greater Cairo region to those who can afford higher prices, causes a noticeable increase of the maldistribution problem.

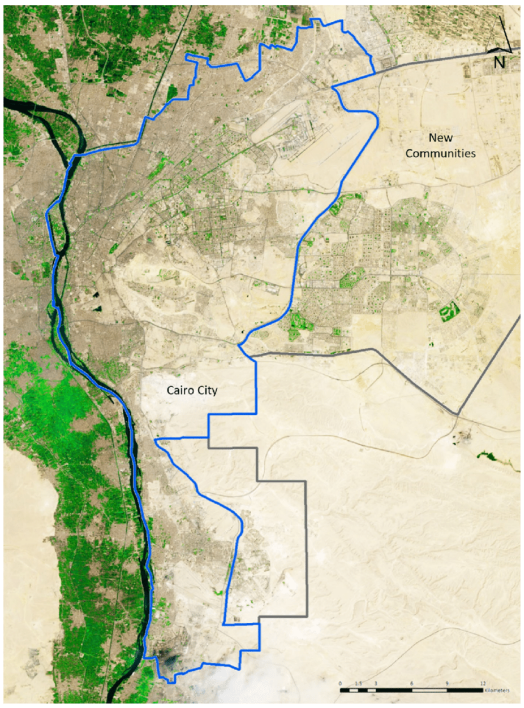

Figure 7. Cairo green spaces (Satellite Sept.2019). Green color intensity was changed for image clearance [27].

Since green areas play a fundamental role in mitigating climatic changes especially in highly urbanized and crowded cities, their apparent decrease result in the unprecedented rise in temperatures worldwide. Witnessing this in a crowded city like Cairo, in favor of road expansion projects and the establishment of new traffic networks, destroys nature's ability to keep emissions outside the atmosphere, affecting human health and raising the rate of heat-related deaths, in addition to decreasing quality of life standards. This contradicts with many important sustainable development goals of reducing global temperatures by 1.5°C. by 2030, achieve good health and wellbeing and making cities and communities sustainable according to Egypt's agreements of the COP21[24]. Thus, reducing the impact of transport on the climate, and increasing the per capita of green areas is considered a key policy objective to regain environmental balance and improve quality of life standards.

VII. Egyptian Roads Network Classification and Design Criteria

According to the 'Misr National Transport Study Report' published by the 'Transport Planning Authority' under the Ministry of Transport in 2012, the 'General Authority for Roads, Bridges and Land Transport (GARBLT) is the only one of several agencies in charge of designing and building intercity roads. Intercity roads under GARBLT jurisdiction are categorized into expressways, primary roads and secondary roads, but this classification is undefined and somehow vague regarding road characteristics and functions

Doi: 10.21608/ERJENG.2023.323553

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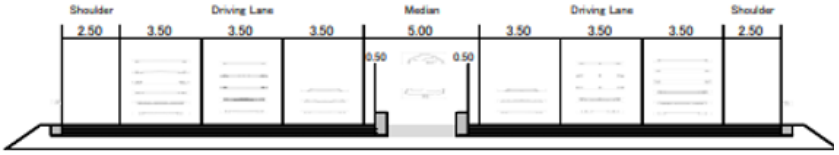
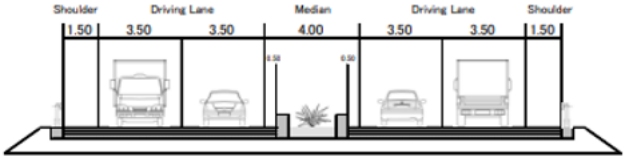
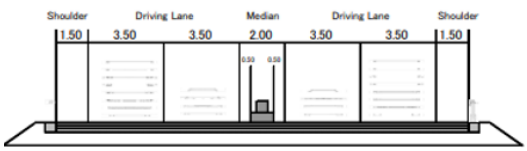
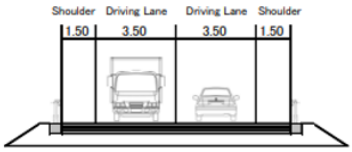
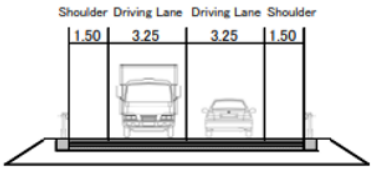
©Tanta University, Faculty of Engineering
ISSN: 2356-9441 https://erjeng.journals.ekb.eg/ e ISSN: 2735-4873

[25]. From another side, the GARBLT has its own design criteria based on the American Association of State Highway and Transportation Officials *(*AASHTO), an association that sets guidelines, specifications and protocols used in designing and constructing highways in the States, however not applied throughout Egypt. Other roadways in Egypt including city and town main roads are supervised through the governorates under the Ministry of Local Development.

Another more considered road classification is defined by the Ministry of Housing, Utilities and Urban Development (MOHUUD), this depends on a functional classification that reflects a pragmatic usage of roads, presented in table 1 as follows: [25].

Table 1: Definition of Functional Classification for Urban Roads

Expressway	These are highways connecting main cities and governorates, the width from 6 to 8 lanes, with maximum speed 120 km / h, as is the case in the Cairo-Alexandria desert axis or the Suez Road.  Expressway (6 lanes)
Main Arterial Roads	These often serve the important traffic in urban areas and regional routes of buses. Distances between main arterial roads depend on densities in urban areas. Although there are no distance rules between main arterial roads. In dense urban areas, distances between main arterial roads can reach 1.6 km while t ranges in less dense areas between 5 to 15 km. They range between 4 to 6 lanes, with minimum lane width 3.60 m and minimum median width from 3.60 – 15 m.  Main Arterial Road (4 lanes)
Secondary Arterial roads	These link the main arterial roads with each other. It carries shorter-distance trips and slower speeds. Secondary arterial roads distribute traffic on smaller geographical areas. Distances between secondary arterial roads varies from 0.1 – 0.2 km in urban centers and from 3 to 5 km in suburbs. It ranges from 2 to 4 lanes with minimum lane width 3.60 m and minimum median width 2 m.  Secondary Arterial (4 lanes)  (2 lanes)
Collector roads	Collector roads achieve the features of communication by land use and speedy traffic inside residence avenues, malls, and industrial centers. It differs from arterial roads as it can penetrate residence avenues to distribute traffic to the maximum end. Thus, collector roads collect traffic from local roads in populated areas heading it to arterial roads. Usually with 2 lanes, minimum lane width 3.30 m and minimum median width of 0.60 m.  Collector (2 lanes)
Local roads	Local roads include all road levels that are not included in any higher levels. Their main function is to make vehicles reach its destination. They are connected to higher level roads, characterized by lower speeds with minimum lane width of 2.70 m.
Source: Misr National Transport Study, 2012	

From the above classification and criteria, it is obvious that the followed methodology in road design and relevant urban development projects include hardly any consideration for green spaces in the city. Thus, the overall resultant is a severe drop in the individual green area share. Moreover, the existing green spaces under the management of the governorate suffer from serious decline and deterioration. Development projects target traffic and vehicle fluidity with

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ISSN: 2356-9441 https://erjeng.journals.ekb.eg/ e ISSN: 2735-4873

clear ignorance of green areas and its importance for the urban environment and human quality of life.

New visions for green areas recently have been oriented towards new cities in order to increase the greenery. For instance, a plan by the Ministry of Environment to plant 30,000 trees all around Great Cairo [28]. Even though, this trend deals with green areas as fragmented patches or central recreational and commercial hubs rather than being networks or part of an integrated infrastructure.

VIII. Comparative Analysis between different Urban development approaches

In this section, the study follows a comparative method of analysis to elaborate the differences and similarities between the previous studied international cases and the Egyptian case for urban development. The comparison shown in Table 2 depends on showing themes, objectives, challenges and the action plans for each case.

Table 2. Comparative analysis between Urban development projects

Location	Seattle, Washington, US	Barcelona, Spain	Los Angeles, California, US	Cairo, Egypt
Urban Development Project	**Pollinator Pathway**	**Barcelona green infrastructure and biodiversity plan**	**Green Alleys**	**National Roads Project**
Theme	Ensure the relation-ship with our planet Earth by designing comprehensively for long terms.	Secure a city model where nature & urbanity interact enhancing each another to enable citizens to benefit from the natural heritage & be actively engaged in improving all areas.	Converting underutilized alley paths into community assets & resources for environmental, economic & social benefits.	City development based on achieving traffic fluidity on planning scale.
Goals & Objectives	• Connect existing isolated green spaces. • Create a more hospitable urban environment for pollinators like bees through a system of ecological corridors • Using existing urban infrastructure such as curb space, pavements and rooftops for connecting pollinator pathways.	• City Natural & Cultural Heritage Preservation and preventing various species & habitats from extinction. • Capturing maximum spaces for green infrastructure & ensuring connectivity. • Maximizing social & environmental services obtained from green infrastructure & biodiversity. • Achieving progress in society awareness & education to provide higher value on project areas. • Making city more resilient to face future challenges.	• Converting alleys into recreational, walkable and bikeable spaces to supplement scarce public park resources through existing underused urban infrastructure • Encourage walkability & connectivity in the neighborhood • Improve water quality and supply • Greening the Urban matrix. • Addressing safety and reducing crime.	• Addressing Long term increase in freight, car trips. • Avoiding traffic congestion problems. • Improving overall safety
Challenges	• Decline of Pollinators • Funding • Maintenance	• Heritage Context • Urban Pressure	• Degraded Nature of Alleys • Design & Engineering • Funding & Maintenance • Managing community Involvement	• Increasing Population & High densities • Urban Pressure
Actions	1- Connect fragmented landscapes 2- Consider a Multi-generational plan and maintenance. 3- Meet native ecological requirements or standards 4- Ensure healthy relation between Urban & landscapes 5- Meet Urban standards of city aesthetics and civic efficient design 6- Create an Interdisciplinary squad. 7- Explore perspectives for problems from different fields to determine how to proceed.	1- Preserving the city's natural and cultural heritage 2- Planning green infrastructure to ensure connectivity and a balanced distribution 3- Designing green spaces considering environmental sustainability and integrating to ensure biodiversity 4- Creating new sauces for nature by increasing gardens, trees and quality for open spaces. 5- Supporting and upgrading knowledge for Management, conservation & maintenance 6- Fostering training in schools & community centers 7- Fostering green areas as places for health, wellness, & recreation with involving citizens in their creation 8- Empowering local leadership, social networks & commitment to goals.	1- Create a Green Alley Subcommittee 2- Addressing Environmental, economic and social issues through determined framework per alley. 3- Developing various scenarios for implementation according to alley sites. Each scenario is a new customized construction for a specific location. 4- Maintaining vehicular accessibility for services.	1- Enlarging Road widths by increasing number of lanes. 2- Constructing new bridges and tunnels at major road intersections and railway crossings. 3- Designing alternative methods for rapid transport with short time distance such as the Monorail.

Source: Authors from collective research [13], [14],[15],[17],[27]

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©Tanta University, Faculty of Engineering
ISSN: 2356-9441 https://erjeng.journals.ekb.eg/ e ISSN: 2735-4873

From the previous analysis, it is clear that all projects target existing urban contexts with several challenges, all projects are managed by city authorities and all attend to deal with roads and street networks for development.

Seattle, Barcelona and Los Angeles projects are oriented towards the environment seeking quality and improving the city and human relations with nature, while the Egyptian case neglects the essential role of green areas that are subjected to vanish. Despite challenges of urban heritage existence in Barcelona and the unusual approach of the pollinator pathway in Seattle, these projects managed to implement the key concept of contiguity and continuity for the previously existing fragmented green areas. On the other hand, Los Angeles used its roads and existing alleys as urban green corridors with a major challenge of managing storm water. The three approaches aimed to design and construct an integrated connected infrastructure where green and gray interact to achieve sustainability. In Cairo, green spots rarely exist as isolated very small areas located at road medians or at the 2 sides of the road, and are on their way to disappear.

In development projects, dealing with the community is crucial. When acting as vital players, citizens give synergetic support for activating the project, pushing it into track to reach goals, and are key actors for maintenance. Thus, projects with multi-phasing and complex issues such as the pollinator pathway, the Barcelona green infrastructure and the Los Angeles alleys had a prime strategy to educate all community levels and spread knowledge about the project to achieve higher goals. Projects captured public awareness, imagination and succeeded to create a long-term ecological environment.

IX. Action Plan for an Integrated Green-Gray Road Network in Cairo

Cairo city had recently gone through major rapid transformations, and is still considered the attractive core grabbing more population. This study tries to adapt the solution for the environmental decline affected by the National Roads project.

The proposal depends on a basic theme aiming to consider Green Corridors in Cairo Road networks to support a livable sustainable urban environment. Objectives are formulated to meet the above proposed key concepts for green corridors: contiguity and continuity, functionality, and pleasure. Objectives for developing an integrated approach could be determined as follows:

1- Implementing Principles of Green Infrastructure in Cairo Roads.
2- Improving environmental conditions to support Health & Wellbeing
3- Attaining Social & Economic benefits.
4- Involving the Community.
5- Spreading knowledge & understanding of green corridors benefits.
6- Ensuring Long-Term Development.

Planning for achieving objectives must be based on periodic phases, each phase is a progressing step to the final outcome. No phase could begin without going through the previous one. The study plan is identified within each phase and through its resources. It presents a set of necessary tasks and activities that are basis for achieving goals. Phases, resources and actions are explained as follows:

- Phase 1: Start-up:

This is the starting phase where all members of the project are identified. All stakeholders such as governors, authorized institutions, managers, etc. are in charge. Also, donors, project partners and private groups may be engaged. Furthermore, community groups are considered key stakeholders. All these parties have potentials, capabilities and presented as prime resources for upcoming phases.

- Phase 2: Out-reach

After identifying the road or group of roads (it is preferable to begin with one extended road rather than enlarging the scope), it is very important to announce for the project, spread intentions and advertise for benefits. This depends on the power of social media in motivating citizens, encouraging knowledge and escalating outreach. Other methods for dispersion are marketing and public gathering announcements.

The second step in this phase is focusing on creating a team, establishing subcommittees, each concerned with a specific site (partial area). These committees meet within a regular schedule to discuss, exchange knowledge, attend workshops, listen and learn about the project. Committees are considered the main source for information and the starting point for the planning phase.

- Phase 3: Data & Planning

In this phase, committees start to operate to gather data about the site. Environmental information is crucial for supporting green infrastructure. Social and economic surveys are resources for determining needs, problems, challenges and threats. In this stage, people with influence presenting local leadership could be identified, so as volunteering. In addition, local community skills, capabilities are being fetched and explored. Human resources are encouraged and rewarded through benefits to activate and engage other community groups and private or non-profit organizations.

All Stakeholders contribute to set programs, plans and project schedules at different scales and for all previously determined issues.

- Phase 4: Design & Implementation

At this phase, designing for an integrated approach begins. Finding solutions and overcoming obstacles and challenges of the site through new creative applicable ideas is a prime need. Assets are presented in the road side pavements, parking areas, buildings' setbacks, cul-de-sacs and road medians if existing. If not, an alternative design for the whole road is required. Spotting areas of existing or proposed greenery in site is the starting point, followed by determining water sources for growing green. Besides existing irrigation water, other sources could be from waste water of surrounding buildings, car wash and gardening water. From

Doi: 10.21608/ERJENG.2023.323553

Journal of Engineering Research (ERJ)
Vol. 7 – No. 4, 2023
©Tanta University, Faculty of Engineering
ISSN: 2356-9441 https://erjeng.journals.ekb.eg/ e ISSN: 2735-4873

another side, winter rain is considered a major resource for harvesting.

Designs depend on connecting the spots and maximizing the green, it also determines porous layers for pavements and car areas to support green infrastructure. For functionalization, designed green areas should be planted for the community to benefit. Fruitful, large canopy trees are recommended.

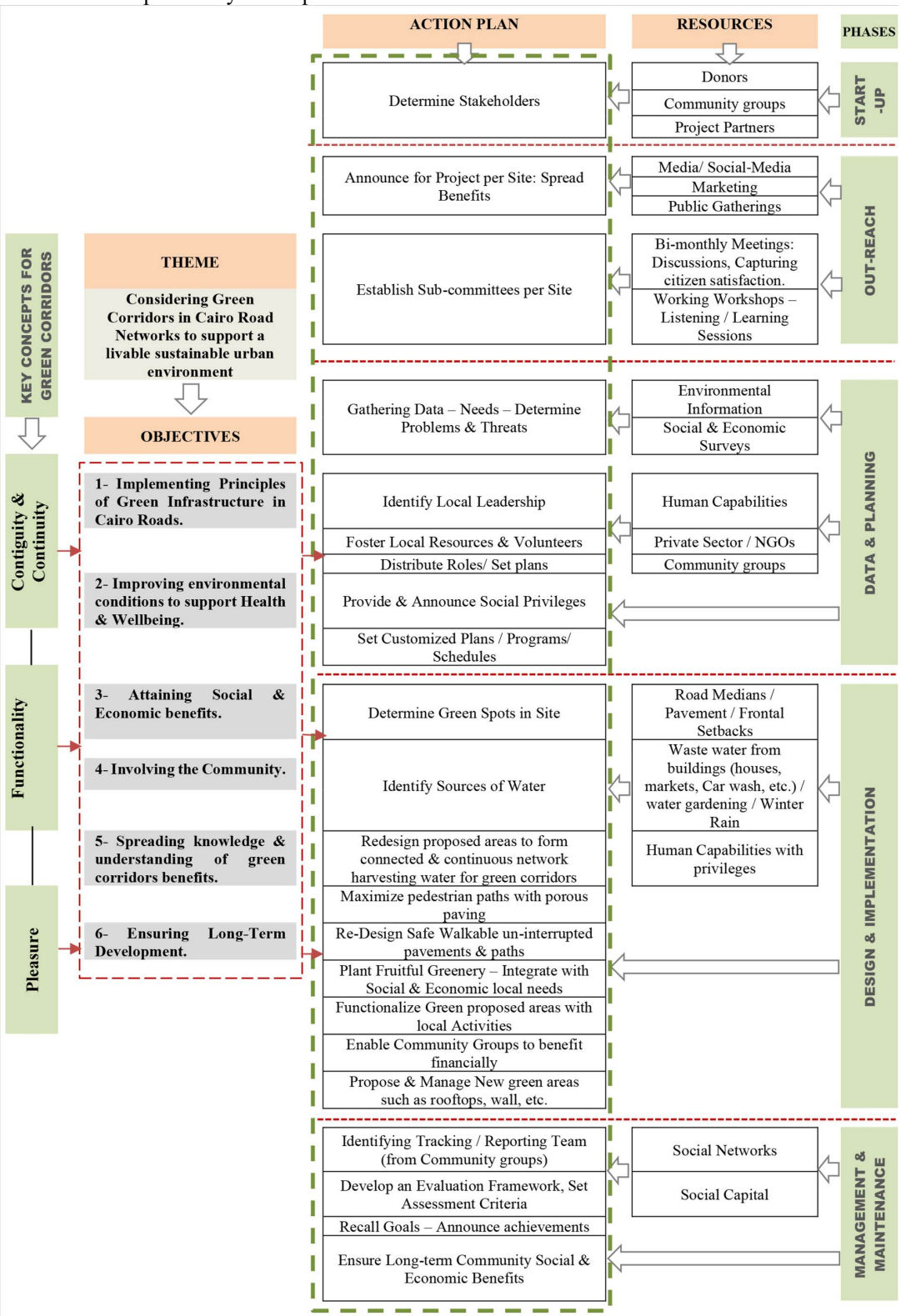

Figure 8. Theme, Objectives & Action plan for engaging Green Corridors in Cairo Road Networks.

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Designed green corridors could offer places for social activities, small compatible projects and other social and economic development pivots. Participating and engaged citizens should be rewarded several facilitations. Furthermore, new designs for maximizing the green could be introduced, such as roof-tops, converting some internal roads into pedestrian paths, etc.

- Phase 5: Management and Maintenance:

Since this phasing process is dependent on each other, thus a fixed management and assessment framework must be followed. Each step in each phase is a milestone. A tracking and reporting team from the local themselves is required. This team must be accredited, announced and rewarded. On the other hand, a continuous recall for goals, objectives, benefits and acquired potentials is necessary to elevate project reputation and guarantee a long-term development.

Finally, the whole plan tracks the path giving steps to achieve objectives with the hands of the community. This methodology successfully captures satisfaction and produces pleasure in being safe, fulfilling needs and having an influential role in reaching goals. Social capital through community interaction and participation is a vital factor and a main support for economic benefit. This accelerates progress and creates an integrated vibrant urban environment.

X. CONCLUSION

Fostering environmental sustainability within urban existing fabrics is featured as a great challenge. On the other hand, rapid environmental changes and impacts have been experienced in the last decades due to the obvious denial of nature and its role in affecting the lives of communities. Thus, the need to find innovative, scalable and applicable solutions to retrieve environmental qualities of nature is extremely necessary. Green corridors are one of the flexible manageable solutions that contributes to ecological restoration and delivers resilience for climatic changes. In Cairo, with its dense urban context, exploring an integrated gray-green approach is considered an optimal solution. This study proposes an action plan as an adaptive solution to merge green corridors within Cairo's Road networks in order to support a sustainable restoration for the city's urban life that has been greatly affected by the recent road projects and enlargements. The action plan aims to achieve the main qualities for green corridors and put a start for green infrastructure in Cairo. It depends mainly on local community groups being active players for achieving change. An integrated approach activates the community, adapts benefits and escalates urban quality of life.

Funding: No funding.

Conflicts of Interest: No conflicts of interest.

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