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RESEARCH ARTICLE

URBAN GREEN INFRASTRUCTURE AND COMPETITIVENESS OF CITIES IN INDIA

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ABSTRACT

In high density areas in India, where demand for housing and basic infrastructure provisions take priority over conservation and creation of green spaces, urban green infrastructure analysis with a focus on economic development and place competitiveness, can help quantify the benefits of green and blue space. Based on the premise that the urban green infrastructure principle of multi-functionality can enhance competitiveness by performing multiple ecological environmental functions and providing multiple social benefits, we identify strategies and approaches to urban green infrastructure which support urban competitiveness. These strategies also align with the current policies in India which focus on place-based economic development. A conceptual framework is proposed which links functions and benefits of multi-functional urban green infrastructure urban competitiveness at the area-based level. Green infrastructure investment and green infrastructure strategies in the context of India cities have been discussed.

INTRODUCTION

The rapid pace of urbanization in many cities around the world is raising concerns about the environmental, social and economic sustainability and liveability of these cities. The problem is more acute in developing countries, particularly in BRICS countries, where spatial fragmentation and poor quality of life does not compliment the level of economic growth, investment flow and the desired level of competitiveness (Figueiredo, 2013; UN-Habitat, 2012). Characterized by high population density and high real estate value, cities in developing nations experience increased pressure on existing infrastructure and natural resources, resulting in fragmentation and loss of urban green space (Chaudhry and Tewari, 2010; Singh, Pandey, and Chaudhry, 2010). The World Health Organization recommends a minimum of 9 m² green open space per city dweller as an international standard. In India, Delhi with a per capita green space of 21 m²/ inhabitant, Chandigarh with 55 m²/inhabitant and Gandhinagar with 164 m²/ inhabitant are the greenest cities in the country and Jaipur with 2.3 m²/inhabitant has one of the lowest per capita green space availability (Chaudhry, Bagra, and Singh, 2011). In such a scenario, when there are no universally accepted standards for green space creation, development through urban green infrastructure may provide an alternative outcome to balance economic growth and urban development.

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Urban green infrastructure is a planning and design strategy which improves urban green space systems to be multifunctional green and blue networks (Shi, 2008; Tzoulas *et al*., 2007). Multi-functionality as a key guiding principle of green infrastructure focuses on the planning and management of the multiple functions (biotic and abiotic environmental functions, such as, air quality, storm-water management, micro-climatic conditions etc.), benefits (social benefits such as cohesion, accessibility and health and well-being) and values (aesthetic value) derived from green and blue spaces (Ahern, 2007; Austin, 2014; Benedict and Mcmahon, 2002; Kambites and Owen, 2006; I. C. Mell, 2010; Pickett, Cadenasso, and Grove, 2004; Sandström, 2009). Multi-functionality of urban green infrastructure can address multiple urban problems and provide associated benefits, within a financially viable framework (Commission, 2012; Jaffe, 2010). GI can therefore be a highly valuable policy tool to promote sustainable development for building competitive cities. In India, the concept of GI is at an early stage and research and evidence relating to GI planning is limited to a small number of studies which focus on evaluating changes in the proportion of green space, urban trees, conservation of urban forests and storm water management issues (Gupta, Sharma, Krishnamurthy, and Kolapkar, 2011; I. Mell, 2014; Panchal, 2017; Rao and Puntambekar, 2014; Savitha, 2014; Singh *et al*., 2010). As a consequence, the concept of GI in India has been limited to open space redevelopment and planning of isolated pockets of UGSs.

What is missing is a holistic approach, which encompasses the benefits of GI through planning of multi-functional GI. Current approaches to policy formation address place-based economic development. In recent years, the Government of India Smart Cities mission, AMRUT cities mission and HRIDAY mission are some of the policy mechanisms which aim at creating a balance between economic growth and urban sustainable development to build competitive cities (C. Mell, 2015; Policy, 2015). In particular, The Smart Cities Mission policy strategies which include investing in pan-city and area-based retrofitting, redevelopment and green-field development to promote competiveness, well-being and efficient use of resources. Linkages between urban green infrastructure and well-being and urban green infrastructure and efficient use of resources are well researched. But, literature which draws direct linkages between GI and competitiveness is scarce. This paper explores the linkages between multi-functionality of urban green infrastructure and urban competitiveness in India cities by reviewing literature relating to aspects of GI can be found in literature on sustainability and competitiveness, physical infrastructure competitiveness, social competitiveness and ecological environment competeveness.

MATERIALS AND METHODS

The paper is structured into 3 main sections. The first section reviews literature and case studies relating to concepts and practices of urban green infrastructure multi-functionality at a global level. Though meta-analysis of urban green infrastructure multi-functionality case studies, ten cases studies relating to urban green infrastructure multi-functionality have been identified. The following steps were followed for the meta-analysis:

- An extensive internet-based search of published literature and grey literature was carried out using keywords – green infrastructure, urban green infrastructure, urban green spaces and green-blue network.
- Ninety-five papers were reviewed out of which seventy three papers which addressed urban green infrastructure in their research were selected; These included twenty seven published papers on global cities, fifteen published papers on Indian cities, twenty eight unpublished literature on global cities such and five unpublished literature on Indian cities.
- As a next step we identified papers which use the term multi-functional or multi-functionality in the title or as a key word. A total of twenty-seven papers (eighteen published and nine unpublished) were shortlisted.
- Out of these ten papers addressed multi-functionality through case studies. 5) We analyse the selected ten case study based papers on multi-functionality to understand their approach to multi-functionality and aspects of multi-functionality that they address (refer table 1). The second section of the paper is a review of literature on urban competitiveness which addresses aspects of green infrastructure. Literature which directly draws linkages between GI and competitiveness is scarce. However, strands of literature relating to aspects of GI have been identified from literature on sustainability and competitiveness, physical infrastructure competitiveness, social competitiveness and ecological environment competeveness. The third section explores linkages between competeveness and urban green infrastructure based on our analysis in section one and two. A conceptual framework is proposed which links multi-functional green infrastructure strategies to urban competitiveness at the area-based level.

Multi-functionality of Urban green infrastructure: Methods and approaches

Green areas perform important environmental functions, such as biodiversity conservation and provide social benefits such as improving health and well-being. Multi-functionality refers to the ability of land to provide several benefits by combining different performance functions and thus using limited space more effectively (Ahern, 2007; Madureira and Andresen, 2014; Youngquist, 2009). In general it is assumed that the total sum of multi-functional urban green infrastructure functions and benefits should exceed the sum of mono-functional grey or green infrastructure (De Groot, 2006; Mastrangelo *et al*., 2014; Willemen, 2010). Nevertheless, it is also important to recognize that while addressing multi-functionality, GI functions may come into conflict with each other making it important to explore the potential synergies, conflicts and trade-offs among different functions, benefits and values (Commission, 2012; Demuzere *et al*., 2014; Grant, 2010; Madureira, Andresen, and Monteiro, 2011; Tzoulas *et al*., 2007).

Literature on multi-functionality is predominantly studied through the lens of landscape management and ecosystem services or based on a particular sector, for example, multi-functionality of agricultural areas (Mastrangelo *et al*., 2014; Shi, 2008; Willemen, 2010). Depending on the need of the city, GI planning strategies varies. For example, the city of Stuttgart, in Germany, focuses creating green structure corridors to improve the air flow function and quality for the city. The city of Malmo makes use of decentralized storm-water techniques, such as, bio-swales to reduce the problem of flooding and in the process benefits from increased green space in the city (Basiago, 1999; Kazmierczak and Carter, 2010). Most case studies on urban green infrastructure focus on one major problem that the city might be grappling with and in the process enjoy the associated benefits and case studies which address multi-functionality of GI in urban areas seldom address the conflicts arising between different GI functions. For example, Madureira *et al*. (2011) prioritize functions of temperature regulation and proximity to green space for the city of Porto; for the city of Delhi, Khurana (2014) proposes a model to optimized environmental functions for large green areas; for the city of Detroit, Meerow and Newell, (2017), propose a green infrastructure spatial planning model to maximize ecosystem services taking into account stakeholders perspective and identify future trade-off for site/project level sites. For urban areas, the general approach towards assessing multi-functionality is to spatially analyse land-cover maps. Land-use and land-cover maps are used to inform GI spatial policy and design, while spatial models can be used to evaluate the effect of applied green infrastructure strategies. However, there seems to be lacking a universally accepted method for spatial assessments to quantify the functions and benefits provided by multi-functional GI based on different green infrastructure strategies (Selman, 2009; Willemen, 2010). Mastrangelo *et al*. (2014) examine literature on landscape multi-functionality and ecosystem services to propose a framework for assessing landscape multi-functionality.

They classify multi-functionality into 3 types based on the method of assessment: a) pattern-based multi- functionality which is based on the spatial configuration b) process-based multi-functionality which is based on the interaction of ecological processes c) socially-relevant, pattern based or process- based multi-functionality. As a first step towards identifying methods used for assessing and enhancing urban green infrastructure multi-functionality and identifying functions and benefits which literature on green infrastructure multi-functionality addresses, we analyse urban green infrastructure multi-functionality based on the classification method proposed by Mastrangelo *et al*. (2014) (table 1). Though a meta-analysis of urban green infrastructure multi-functionality case studies, we identified ten cases studies relating to urban green infrastructure multi-functionality, according to the method outlined in the methodology section. The cases are analysed based on: scale of assessment, method and approach of evaluating multi-functionality and number and type of benefits considered.

Scale of assessment: Seven out of the ten case studies address multi-functionality at the local/neighbourhood or site level. Three studies are at the city level out of which Bhopal case study looks at multi-functional greens at multiple geographic scales.

Methods for evaluating multi-functionality: Most of the case studies follow a spatial based or socio-spatial based method for evaluating multi-functionality. The city of Porto in Portugal and Detroit in USA follow methods which attempt to quantify and prioritize multi-functionality by identifying hot-spots in the city. For Porto, Madureira *et al*. (2014), assesses multi-functionality based on land-cover analysis and identifying hotspots to prioritize two indicators- proximity to green spaces as a social function and temperature regulation as an environmental function. For Detroit, Meerow and Newell (2017), use a holistic and integrated approach to analyse multi-functionality. They propose a Green infrastructure spatial planning model to prioritizing socio-spatial multi-functionality based on spatial analysis and stakeholder opinions.

Approaches to multi-functionality The approach to multi-functionality is through the perspective of: 1) urban green space management at the neighbourhood level (Bangalore, Delhi and Bhopal) 2) urban green space conservation at the city level (Jaipur, Bhopal) 3) Urban green space adaptation and re-development at the local/site level (London, Germany) 4) green infrastructure policy (Ahmedabad, Porto) and 5) Landscape connectivity through small greens (Romania, Detroit). For India based case studies, approaches to multi-functional green space planning and development is through the perspective of urban green space management at the local level and urban green space conservation at the city level, such as, urban forest conservation efforts in Jaipur. Some green infrastructure related planning policy initiatives are found at the local level in India, such as, the Delhi biodiversity parks policy by Delhi Development Authority. However, these are piecemeal efforts which need a more planned and systematic approach supported by evidence and policy. Case studies which follow the adaption and redevelopment of vacant land and green spaces approach to address multi-functionality are less documented for India cities. Under the Smart cities India Mission 100 cities have been identified for area based development.

The proposed strategies include retrofitting, redevelopment and green-field development projects. However, the emphasis of these projects is on designing for multiple use spaces and less on multi-functionality of functions, increasing landscape connectivity and addressing issues of green space fragmentation.

Functions, benefits and values: In global case studies the emphasis of multi-functionality is more on ecological and environmental functions and social benefits of proximity to green space. For cities in India, biodiversity conservation, accessibility to green space, facilities provision, visual appeal and provision for multiple uses are the main aspects of multi-functionality. The functions, benefits and value additions from the meta-analysis have been depicted in figure 1.Further on in the paper linkages have been drawn between the identified functions, benefits and values and literature on competitiveness. In the next section, literature on competitiveness has been reviewed to identify aspects green infrastructure.

Urban competitiveness and Urban Green infrastructure

The quality and quantity of urban green space tends to be included as one of the important aspects of urban competitiveness with regard to quality of life. Urban green infrastructure have important place-making potential through regeneration projects and the cultural association that people feel towards certain locations (Andersson *et al*., 2015; Ecotec, 2008). Nevertheless, urban greens are weakly addressed in the discussions on urban competitiveness and are covered under the broad factor of environmental quality (Hu, 2015). The literature on competitiveness has evolved through different viewpoints. These included, explaining competiveness based on Export base theory, Schumpeter's famous process of creative destruction, Porter's diamond model and Porter's Cluster theory.

According to Krugman competitiveness is an attribute of companies not of cities, regions, countries or continents. However, the use of the term urban competitiveness with spatial connotations suggests that cities compete in more complex ways to balance urban sustainable development goals. Begg (1999) brings together these diverse approaches to provide a framework for considering the various influences on urban economic performance. According to Begg (1999) land is one of the major urban assets which acts as a 'driver' for competitiveness. Physical development and transformation of land through urban regeneration strategies, infrastructure development, improved environmental quality has the potential to attract people and capital to urban areas. In this respect, urban competitiveness maybe defined an economy's ability to optimize its local resources and use to its advantage urban assets present within its geographic boundary, to attract people and capital. The range of potential factors which enhance competitiveness is very wide and much of the literature on competitiveness does not directly address the role and input of green infrastructure. However, some linkages between green infrastructure and competitiveness can be found in research addressing sustainability and urban competitiveness, infrastructure competitiveness, social competiveness and ecological environmental competitiveness. Table 2 lists some of the aspects of green infrastructure indirectly addressed in literature on competiveness.

Table 1. Methods of assessing urban green infrastructure multi-functionality

S. No.	Case Study City	Scale	Method For Evaluating Multi-Functionality	Functions, Benefits and Values Considered	References
1	Porto, Portugal	City	Spatial- Prioritizing functions identifying hotspots, land-cover analysis	1. Proximity to public greens 2. Local Temperature regulation	(Madureira *et al*., 2011)
2	Bucharest, Romania	Small Green Areas	Socio-spatial- Questionnaire based survey of green in school areas, statistical analysis	1. Accessibility 2. Educational value 3. Landscape connectivity	(Iojă, Grădinaru, Onose, Vânău, and Tudor, 2014)
3	Stuttgart, Germany	Site specific-Ludwigsburg-green living room project	Spatial-Urban climate context zone action plan, vulnerability analysis, green living wall	1. Attractiveness of open spaces 2. Urban heat island mitigation 3. Biodiversity 4. High amenity value 5. Noise reduction	(Connop *et al*., 2015)
4	Detroit, USA	Site specific	Socio-spatial-Prioritizing functions based on Green infrastructure spatial planning model/ GIS based. Stakeholders meeting, spatial matrices	1. storm-water management 2. accessibility 3. air quality 4. landscape connectivity	(Meerow and Newell, 2017)
5	London, UK	Barking riverside-Neighborhood level-Brownfield site	Socio-spatial-Urban regeneration, Bio-mimicry based design, stakeholders collaboration, educating residents about biodiversity	1. storm-water storage 2. biodiversity 3. green space access	(Connop *et al*., 2015)
6	Jaipur	City	Spatial-policy lessons for conservation of urban forests, developing multi-functional biodiversity parks	1. biodiversity conservation 2. Financing innovation for resource management	(Singh *et al*., 2010)
7	Delhi	Neighborhood level	Spatial-Planning for multiple-uses of neighborhood parks and tot lots based on network analysis and buffer analysis	3. Green space facilities 4. Green space accessibility	(Gupta *et al*., 2011)
8	Bangalore	Neighborhood parks	Socio-spatial- Socio-ecological systems of small green spaces and neighborhood parks, green space management	1. Biodiversity 2. Aesthetics 3. Recreation	(Savitha, 2014)
9	Bhopal	Multiple scales	Socio-spatial-qualitative and quantitative aspects of Urban Green Spaces, multiple benefits at different scales	1. Accessibility 2. Attractive 3. health and wellbeing 4. maintenance and management 5. Biodiversity	(Rao and Puntambekar, 2014)
10	Ahmedabad	town plans of six Neighborhood/ municipal areas	Socio-spatial-Qualitative and quantitative aspects of Urban Greens, stakeholder views, allocation of green infrastructure.	Policy recommendations to mainstream GI at the neighbourhood level	(Panchal, 2017)

Table 2. Identifying aspects of Green infrastructure in city competitiveness literature

S. No.	Literature	References to Green Infrastructure	References
1	Sustainability and urban competitiveness	• Environmental protection • Environmental performance • Locational factors • Urban landscape	(Hu, 2015; Rogerson, 1999; Shen, Ochoa, Shah, and Zhang, 2011; Shimomura Tetsuya and Matsumoto Tadashi, 2010; Singhal, Mcgreal, and Berry, 2013; Wojtarowicz, 2013)
2	Social competitiveness	• Social cohesion • Level of urban development • Social performance or Liveability • Public infrastructure	(Beauvais and Jenson, 2002; Knowledge-building, 2009; Mihaela, 2015; Rogerson, 1999; Savitha, 2014)
3	Infrastructure competiveness	• Local infrastructure development • Decentralized infrastructure services • Physical development of transportation corridors	(Hodson and Marvin, 2009; Jianping *et al*., 2014; Peterson and Muzzini, n.d.)
4	Ecological and environmental competitiveness	• Environmental protection • environmental quality • environmental governance	(Hu, 2015; Jianping *et al*., 2014; Singhal, Berry, and Mcgreal, 2009; World Economic Forum, 2014)

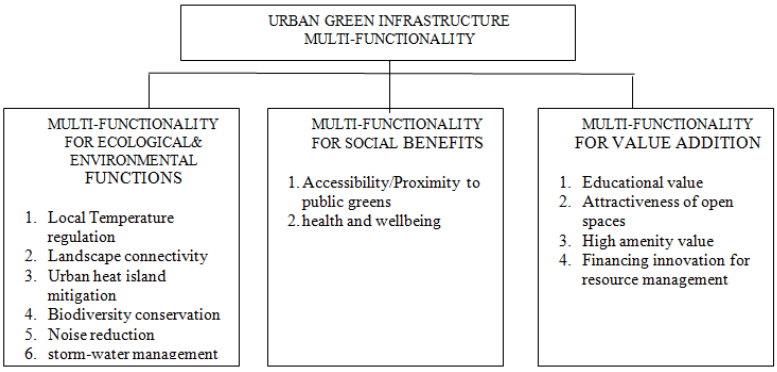

Figure 1. Functions, benefits and value addition of Multi-Functionality

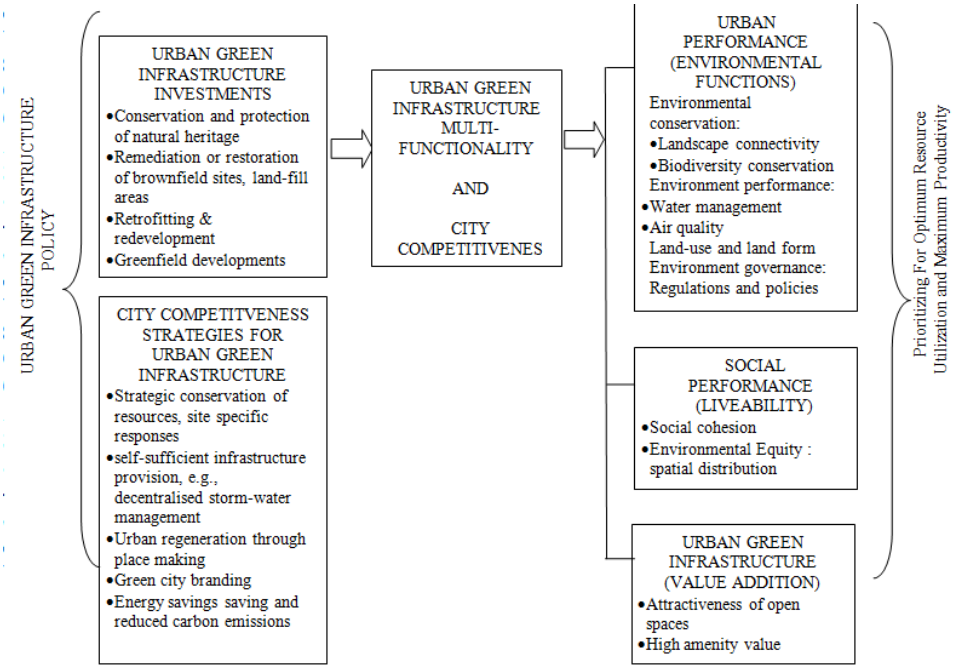

Figure 2. Conceptual framework for area based green infrastructure investment and planning strategies for urban competiveness

SNO		Sustainability and urban competitiveness	Social competitiveness	Infrastructure competiveness	Ecological and environmental competitiveness
Urban green Infrastructure Ecological functions					
1.1	Local Temperature regulation	Environmental performance	-	-	-
1.2	Landscape connectivity	Environmental protection	-	-	Environmental protection
1.3	Urban heat island mitigation	Environmental performance	-	-	-
1.4	Biodiversity conservation	Environmental protection	-	-	Environmental protection
1.5	Noise reduction	Environmental performance	-	-	
1.6	storm-water management	Environmental performance	-	-	Environmental governance
1.7	air quality	Environmental performance	-	-	Environmental governance
Urban green Infrastructure Social benefits					
2.1	Proximity to public greens		Social cohesion	-	-
2.2	health and wellbeing		Livability	-	-
Urban Green infrastructure value addition					
3.1	Educational value	-	Education	-	-
3.2	Attractiveness of open spaces	Urban landscape	Livability	-	-
3.3	High amenity value	Urban landscape	Livability	-	-
3.4	Financing innovation for resource management	-	-	-	Environmental governance

Green infrastructure, Sustainability and urban competitiveness: Majority of the Studies linking sustainability and competitiveness focus majorly on environmental sustainability. Environmental performance and environmental protection and the main factors addressed in these studies. The main indicators for environmental performance include ecological footprint optimization, environmentally responsible property development (Singhal *et al*., 2009), air quality, water quality and management, waste treatment and green space. Shen and Yang (2014), include urban landscape as a factor of environmental competitiveness. The indicators for urban landscapes include- green coverage rate in built up areas and national garden award. The per capital green space availability and percentage of urban green space in the city are included as important indicators of environmental performance. However, indicators which measure the quality of green spaces and the environmental and social performance of urban green spaces and network are rarely included in studies on competitiveness. Based on the principles of connectivity and multi-functionality the potential of green spaces and networks in the cities have the potential to enhance the environmental performance of cities and contribute towards sustainable competitiveness. Examples of urban green infrastructure multi-functionality have been discussed in Table 1.

Among green infrastructure strategies for sustainable development and competitiveness- green urban regeneration and green city branding have been explored in various studies. Singhal *et al*. (2009) provide a framework of urban competitiveness and urban regeneration strategies. They identify linkages between competitiveness and urban regeneration through three factors: Physical environment, Social capital and Finance. Examples of green urban regeneration strategy to improve the physical environment can be found in many cities around the world, example, Barking Riverside neighbourhood brownfield development in London is an example of urban regeneration through multifunctional green infrastructure planning.

Green infrastructure and social competitiveness: Social competitiveness in cities can attract the knowledge class to the city based on the socio-cultural advantage and level of development in the city. Literature on urban competitiveness which addresses social competitiveness includes factors of social cohesion (social inclusion and accessibility), quality of life, public infrastructure (including green spaces) and level of physical development in the city (Du *et al*., 2014; Hu, 2015). Green infrastructure in the form of parks and recreational areas form an important part of public infrastructure which contributes to the quality of place and quality of life in a city (Ecotec, 2008; I. C. Mell, 2010). Accessibility to green areas is one of the most important aspects of green space planning in developing countries such as India (Authority, 2007; Gupta *et al*., 2011; Panchal, 2017; Rao and Puntambekar, 2014).

Green infrastructure and physical infrastructure competitiveness: Most research on physical infrastructure and competitiveness links transportation systems and utility corridors to infrastructure competitiveness. Physical development, including green space development, around transit oriented areas has potential for place-making (Hickman and Banister, 2003). Such areas allow for innovation which maybe through green infrastructure planning (Ahern, 2007). According to Hodson and Marvin (2009), decentralized infrastructure development decouples cities from national and regional infrastructure to create autonomous self-sufficient areas. Such strategies are creating a new form of competitiveness where cities position themselves to control the supply and consumption of resources to, for example, achieve water neutrality or carbon neutrality. Green infrastructure based strategies such as sustainable urban drainage systems help create decentralized infrastructure system (Ahern, 2007; Meerow and Newell, 2017; Pickett *et al*., 2004) and reduce dependence on grey infrastructure.

Green infrastructure and ecological and environmental competitiveness: Literature on Ecological and environmental competitiveness has some amount of overlap with the literature on sustainability and competitiveness. Ecological environmental competitiveness focus more on the regional and national level of competitiveness and addresses aspects of Ecological governance, ecological resource conservation and ecological security (Hodson and Marvin, 2009; Jianping *et al*., 2014). Competitiveness in respect to ecological security looks at innovation in infrastructure development to promote resource security within the city and among cities (Hickman and Banister, 2003). The next section draws linkages between multi-functionality and urban competitiveness.

Linkages between multi-functionality of Urban Green

Infrastructure and urban competiveness

In this section we draw linkages between urban green infrastructure multi-functionality and urban competiveness based on the analysis in section 2 and 3. The functions, benefits and value additions of multi-functional urban green infrastructure, as identified from the meta-analysis, in figure 1 and aspects of urban green infrastructure identified from literature on urban competitiveness in table 2 are shown to be linked in as per Table 3. Reference to urban green infrastructure ecological functions is found both in literature on sustainability and competitiveness and ecological environmental competitiveness. Landscape connectivity, biodiversity conservation, storm-water management and air quality are environmental functions common to sustainability and ecological environmental competitiveness literature which enhance the urban performance of cities. References to urban green infrastructure social benefits measured as proximity/accessibility to green space and health and well-being are found in literature on social competitiveness where they are important indicators which support social cohesion and liveability to enhance the social performance of cities. References to urban green infrastructure value adding functions include educational value, attractiveness of open spaces, high amenity value and innovation for resource management are found in literature on sustainability, social competiveness and ecological environmental competiveness. Literature on physical infrastructure competiveness does not reference to green space indicators but suggests strategies which are applicable to urban green infrastructure planning. Figure 2 summarizes the findings of this review. Figure 2 suggests that urban green infrastructure policies for investing in green infrastructure and green infrastructure planning strategies can enhance the urban and social performance of cities by creating multi-functional green infrastructure. Next section discusses the proposed linkages in the context of cities in India.

Discussion and way forward for cities in India

Urban green infrastructure investments in India: Green infrastructure is perceived as offering lower economic returns compared to other forms of built infrastructure, such as housing and transportation. This may be attributed to the lack of awareness about environmental resources and more pressing infrastructure needs (C. Mell, 2015; Singh *et al*., 2010). The recently introduced policy mechanisms, such as, the smart cities mission and the AMRUT mission promote place-based economic development that seeks to attract investments by promotion of Public-Private-Partnerships. Some examples of urban green infrastructure investment in India include the Swach Ganga Abhiyan and the Sabarmati river front development. The method and approach towards the planning and implementation of these projects has been questioned by practitioners and scholars. A multi-functionality-based approach to prioritize functions, benefits and value addition may balance the economic needs with sustainable development in such cases. Examples of State-led local policy initiatives for investing in green and blue spaces include establishing biodiversity parks in Delhi. However, these may be viewed as piecemeal initiatives which need to be streamlined into mainstream policy for greening cities.

Urban green infrastructure strategies for India cities: Drawing from literature in physical infrastructure competitiveness and urban regeneration for competitiveness the paper identifies- strategic conservation of resources, self-sufficient infrastructure provision, urban regeneration through place making and green city branding as the main strategies for planning and implementation of green infrastructure. With the exception of green city branding, which is a city level strategy for promoting green infrastructure, the remaining are area-based strategies for green infrastructure development. Strategic conservation of resources references to conservation and protection of natural resource sites such as urban forests and bio-reserves in the city. For example, Conservation of Sundar Nursery as part of the larger initiative of urban renewal of Nizam-ud-din area in Delhi, funded by the Aga Khan foundation. Self-sufficient infrastructure provision refers to planning for de-centralized systems for solving urban problems such as storm-water management and waste water treatment. Such initiatives in India exist at the local or the community level. Constructed wetlands for wastewater treatment would be an example of one such strategy. Area based decentralized or nature-based strategies have well documented case studies from UK and USA where bio-swales and green roof typologies are used for management storm water run-off and rain water respectively.

Green infrastructure investments and green infrastructure strategies which support competitiveness can enhance the urban and social performance and competiveness of cities by creating multi-functional green infrastructure which supports multiple environmental functions, provides for social benefits and incorporates value added functions. However, it is important to prioritize these functions and benefits for optimum resource utilization and maximizing productivity of green spaces. This paper proposes a conceptual framework which links multi-functional green infrastructure strategies to urban competitiveness at the area-based level. A meta-analysis of multi-functional urban green infrastructure case studies shows that there is potential for cities in India to enhance the multi-functionality of green and blue spaces by improving the landscape connectivity and addressing green space fragmentation. Based on the premise that multi-functionality enhances competitiveness by addressing multiple functions and benefits that green spaces can provide, we identify - strategic conservation of resources, self-sufficient infrastructure provision, urban regeneration through place making and green city branding as urban green infrastructure planning strategies which support urban competitiveness. These strategies also align with the current policies in India which focus on place-based economic development. Developing optimal policy structure which balances the need for urban green infrastructure planning and the economic development of cities is required for comprehensive value creation for cities in India.

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