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Form-based code as a tool for organising the 6th of October City's townscape

A. B. Khalil^{1*}  and A. M. Ouf^{2,3}

*Correspondence:

ashrafammar29@yahoo.com
¹ Department of Architecture,
Faculty of Engineering, Sohag
University, Sohag, Egypt
Full list of author information
is available at the end of the
article

Abstract

This research uses a form-based code (FBC) to affect the townscape through its procedures and components. Impacts of the FBC's features on the townscape are classified into three categories the effect on urban spaces, buildings, and landscape architecture. This research explores the components of the categories and makes reference to those components within the 6th of October City, Egypt, from 2020 to 2021. Urban spaces are included, regulating plan, and public realm standards were investigated in the central axis and the inner streets. Buildings were also explored; block and lot and building type standards have been inspected at Al-Hossary Square and the 7th District, while survey field observations investigated the frontage type and architectural standards. In addition, landscape architecture components of the FBC were explored through fieldwork observed throughout the city. This research employs an inductive approach of the literature base, a comparative analytical approach to compare the unified building law (UBL) with the FBC components, and a documentary survey method for fieldwork. The results extracted a proposed townscape code and some modifications of the building law (modifying some existing articles and adding new ones) to make FBC applicable in the surveyed city.

Keywords: FBCs, Townscape, Urban regulations, Urban quality, 6th of October City

Introduction

Urban legislation philosophy and approaches shifted several times throughout history from focusing on property rights to city morphology (Hammurabi legislation) [1, 2]. At Roman times, urban legislation focused on setting parameters for construction and building forms; so, Vitruvius formulated the laws of amending the geometrical structure to keep urban coherence which was revived during the European renaissance [3, 4]. In Muslim City buildings, urban legislation focused on safeguarding the community, maintaining facilities from the outside, guaranteeing building crafts' quality, and controlling pollution and harmful uses in residential areas [5]. Post-World War II's post-modern movements rejected the separation of land uses resulting in "performance zoning" and "incentive-based zoning" to emphasise the need for flexibility in land uses and give the developers some advantages [6]. Some urban challenges resulting from focusing on performance and incentive-based zoning were the lack of visual coherence and poor

townscape coordination, making it necessary to resegment harmonious townscape and its components [7, 8].

In the 1980s, some focus was on creating standards for transportation systems (standard widths of street pavements, and the separation between the pedestrian sidewalk and movement of the car) and frontage and building types to enhance townscape [6]. The concept of the FBC was then adopted as an alternative to “Use-Based Codes” (UBC) in 2001 [6]. Some successful application models have adopted FBCs; such as Seaside City in Florida in 1981, redevelopment of the Hulme of Manchester city in the 1990s, Miami code, Florida in 2007, Santa Ana and Benicia, California project in 2008, and Urban Code for Wadi Hanifa of Riyadh city in 2021 [9, 10]. Those models have proven the influence of FBCs on townscape components through their impacts on urban spaces, buildings, and the landscape [11].

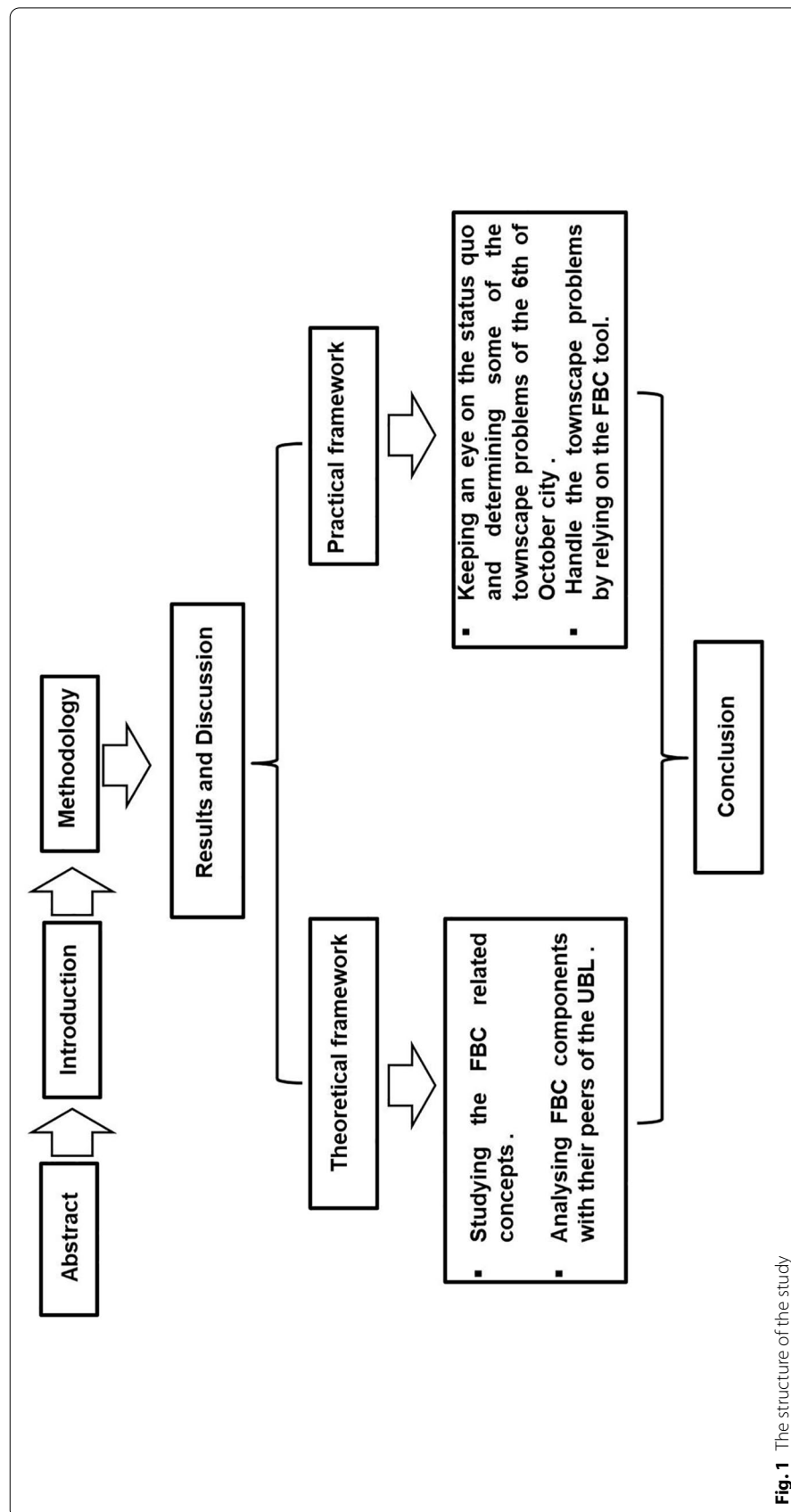
Despite the continuous development of building laws and legislations in Egypt, the resulting townscape still suffered from visual pollution and the distortions of the architectural and urban character for many reasons. Improvements of local regulations were mostly negligent to comparable international regulations [12, 13], unable to integrate both structural and architectural typologies and their relationships to UBC [14, 15].

This study aims to cover part of this knowledge gap by comparing elements of the Egyptian townscape (as represented in the 6th of October City) to the international standards set for components of FBCs. The concluded remarks of this study propose visions and recommendations for applying selected international standards of some FBC components on the Egyptian townscape. This research aims to clarify form-based code components, check their relevance to existing urban legislations, evaluate their coherence to international standards, and then propose improvements to the existing building and land use codes to foster a better urban environment.

Methodology

To achieve the aims of this study, the researcher adopted an inductive approach to literature review of the topic and its related issues. The literature review covered the history of urban legislation (in general) and Egyptian urban legislation (in particular). Then, a comparative analytical approach was adopted to compare the UBC with FBC components to find out its weaknesses. This analytical approach put forward several suggestions for its development, and the documentary survey method of the case study to collect townscape components to investigate the current situation of its townscape [9, 16]. The research structure is divided into theoretical and practical components (Fig. 1).

The 6th of October City was selected as a case study because of its familiarity to the researcher, its representation of all the new generations of Egyptian cities that started in the 1980s, and because of the presence of all the townscape elements of interest to this research. In addition, the 6th of October City is easy to get to through two entrances: the first is at the 25-km sign on Cairo/Alexandria Desert Road and the second is at the 19-km sign of Cairo/Fayoum Desert Road. It is located within the Greater Cairo Region, about 17 km away from the pyramids and 38 km away from the middle of the Egyptian capital. Its location is characterised by plain topography that overlooks the tourist area of the pyramids. The city's total area is 400 km², and its coordination is 29° 57' 9.5544" N, 30° 55' 18.9084" E [17, 18].



Data was collected in several 6th of October City locations (central city axis, internal streets, Al-Hossary Square, and the 7th district) to cover most townscape components (urban spaces, buildings, and landscape) through structured observations. The researchers visited the city several times during the year 2021 to document the observations through photos of buildings, roads, pedestrian paths, landscape elements, and the different types of activities in the city's public realm. The visual survey was conducted to document the city's urban elements that create its character (such as roads, sidewalks, building facades, building types) and to monitor the elements related to human activities (public spaces, ground floor uses, etc.). Data was collected using some images taken with a Nikon COOLPIX L330. These images are edited by using Adobe Photoshop CS5 and Autodesk AutoCAD 2021. The satellite images were based on georeferencing material examined and plotted by Google Earth.

Results and discussion

FBC and unified building law (UBL) No. 119 concept

FBCs are based on a set of rules and principles that can be applied to figure out and shape the urban environment. Based on its conditions, those rules always take the format of obligatory laws controlling the process of urban development [9]. Such urban control laws get their powers from advocating good quality and better physical form of urban structure as a public good. The Form-Based Codes Institute (FBCI) was established to further the development and advocacy of the form-based code as:

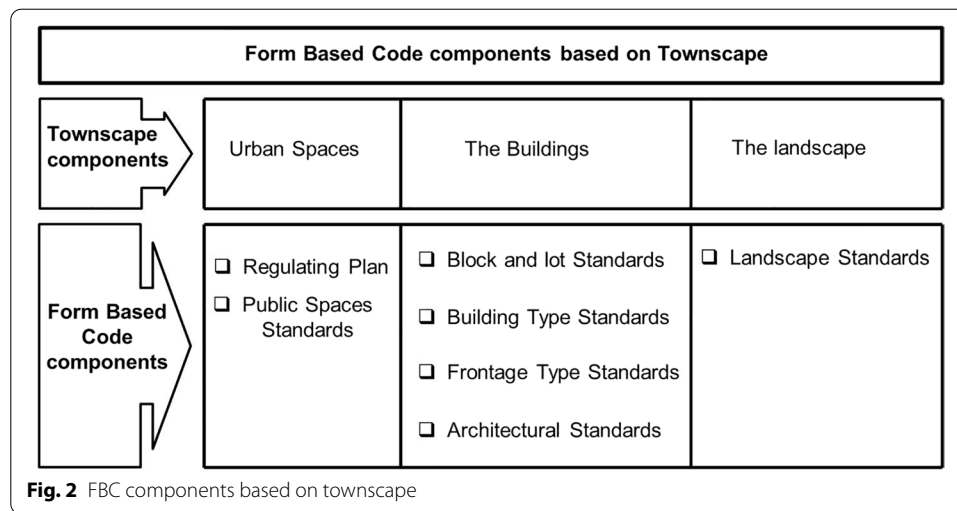
a technique for organising urban development and achieving a hoped-for townscape according to a specific character by creating predicted public domain through controlling physical facilities, with less focus on land uses, through the city regulations and law [19].

On the other hand, UBL No. 119 is the unified law currently enforced in Egypt to control construction works, urban planning, and the preservation of real estate heritage. It was published in the Official Gazette - No. 19 bis (a) on May 11, 2008, and Ministerial Resolution No. 144 of 2009 were issued [20].

FBC components

Adopting the preceding definition employed by FBCI, there is no uniform template for FBCs' components that can be applied to all regions, but the FBCI has developed three main categories of components as shown below: urban spaces category (the regulating plan, public spaces standards), the buildings category (block and lot standards, building type standard, frontage type standards, architectural standards), and landscape category (landscape standards) (Fig. 2) [19].

The following are some explanations of the FBC components with some hints for implementation for each component, as will be explained to ensure a desirable townscape and establish a comparison to UBL. In addition, the following research components present some aspects of the current townscape in the 6th of October City as a case study and ways it could change if the FBC is applied.



Regulating plan

The regulating plan needs to be a detailed three-dimensional plan by which urban regulation zones and development requirements will be set. This plan recognises the obligatory building line to ensure the shapes of the outcome and the expected dramatic scenes [6, 9]. The regulating plan using UBC led to some weakness points [20]: the first point is the lack of an article preparation three-dimensional detailed plan obligatory for any proposed urban project when they submit their documents to apply for a planning or building permit. Second, the provision of a two-dimensional detailed plan (Article No. (20) of the executive regulations of Law No. 119) is required to explain the distribution of uses, the minimum area of the lot, building setbacks, and the width of streets. Consequently, no description of the character (urban or architecture) is necessary for issuing planning or a building permit. To prove the inadequacy of the two-dimensional plan required by the UBC, the researcher studied the different cross-sections with along the 6th of October City central axis. Simple comparisons of cross-sections, Fig. 3 shows what is planned by the two-dimensional plan requirement, the apparent discrepancy in the positioning of the building lines led to discontinuity in the townscape and a difference in the cross-section view of the central axis because of the different widths of the service road and different allocations for the parking areas.

Applying some FBC controls to the permitting process would overcome any inequality in the building line's positioning and the visual line's discontinuity in the central axis. This central axis is applied to the height of buildings by using the palm trees due to their suitable size with the buildings and by changing the finishing materials for the car parking (e.g., interlock tiles) (Fig. 4).

Public space standards

In addition to achieving sustainability for the urban environment, public spaces have an essential role in the quality of life due to their influential role in designing the shapes of the places and providing a district health system for the public [21]. Public spaces are concerned with urban spaces, roads, streets, and parking lot standards [6,

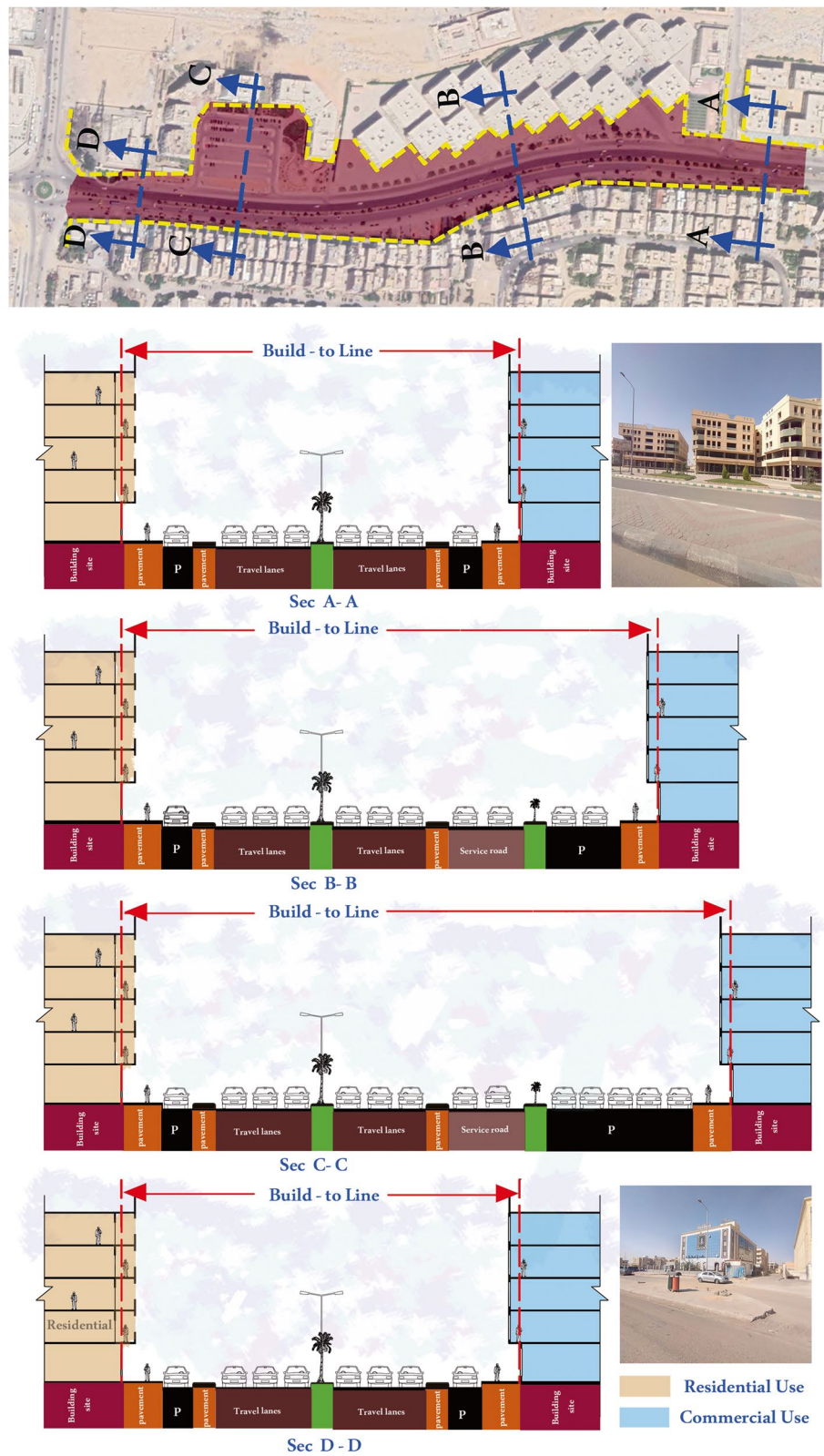


Fig. 3 Illustrated sections of the current disparity of building line in the central axis in the 6th of October City of car parking



Fig. 4 The current situation of the central axis before and after applying the FBC tool

9]. Urban space standards are concerned with organising the external profile of the city and determining its specific criteria: allowable transect zones, acreage, size, walls, landscape, activity type, and the scope of service to its components: park, green, square, plaza, and playground regions [6, 9].

Roads and streets constitute the central point of healthy residential neighbourhoods, not only for their role as carriers for the movement of machinery but also for pedestrian traffic [6, 9]. Its components include defining the cross-section components based on their function and identifying: right-of-way, movement type, design speed, traffic lanes, the width of pedestrian sidewalks, pedestrian crossing time, side service lanes, parking lanes, bicycle lanes, medians, curb radius, curb face to curb face width, the distance between intersections, landscape architecture types distribution, and techniques to control the car speed within residential neighbourhoods [6, 9].

Parking lots are known for their 'noxious use'. They cause unattractive voids and gaps in the urban fabric to be undesirable for pedestrians, so they must be away from the townscape. Different finishing materials should distinguish their floors, and their buildings and arrangements should be in accordance with traffic rules [6, 9]. Public Realm Standards (cross-section of the street network) throughout the UBL leads to a lack of links between these requirements and their functions. These standards are limited to linking the minimum width of roads and their location to the urban block. According to Article No. (26) of the implementing regulations to law No. (119), the limits are 8 m to roads within the urban block and 10 m to urban extension.

Figure 5 shows the cross-section view of most of the internal streets in residential neighbourhoods in the 6th of October City. The priority is given to movement and perpendicular parking of cars which prevent the sufficient sidewalk for pedestrians. According to the UBL, the minimum width allowed within the urban block is 8 m. As mentioned in the previous example, there is not enough space to increase the width of the sidewalk because the street is divided into three lanes, namely two lanes



Fig. 5 The cross-section view of most of the internal streets in residential neighbourhoods in the 6th of October City

for perpendicular parking and one in the middle for car movement. According to the FBC tool, the street should be humanised by resorting to techniques to reduce the speed of the car by using one of the following techniques: (1) changes in pavement material, (2) pavement narrowing, (3) shifts in pavement, (4) traffic diverters/barriers, (5) pinch point in pavement, and (6) speed humps [8].

Figure 6 shows the status quo of most of the internal streets in the residential neighbourhoods before and after using the FBC tool. Changes in pavement material (to be interlock tiles instead of asphalt) are used to enhance the pedestrian path to reduce vehicular speed and coordinate the landscaping works on the street.

Block and lot standards

A block is a group of adjacent buildings in a particular order that let each lot form its own space, and they are divided into single blocks and double blocks. The single block should be linked to the highways and provide a service lane or put a buffer zone of trees to give a view of the townscape of the street. In case of changing the use, the changes should be conducted to the entire block according to rules in agreement with the development partners and getting to know what the transition between mixed use and residential use looks like. The block standards components



Fig. 6 The status quo of most of the internal streets in the residential neighbourhoods before and after using the FBC tool

should include defining the maximum block length and perimeter and finding two types of building disposition (according to the surrounding area of the building) at least for each block. Lot development regulations are used to integrate buildings on the corner lots by linking the depth of the lot to its width, determining the maximum width of the lot for the land, and not allowing the change of use of the lot within a residential block to a nonresidential one [6, 9, 22].

Block and lot standards throughout the UBL led to some weakness points: according to Article No. (53) of the implementing regulations to law 119, the maximum block length should not exceed 250 m, and the width of the blocks should be proportionate with the use, in contrast, without mentioning a maximum block perimeter, and without linking the buildings on the corner lots to each other, especially those overlooking public squares [20].

Block and Lot Standards have been applied on the Al-Hossary Square in the 6th of October City, where it was noticed that there is visual inconsistency due to some deterioration of the surrounding buildings and their elevations, in addition to the lack of architectural feature homogeneity, which resulted in a poor spatial containment. Figure 7 shows the current situation of the square before and after applying the FBC tool. The physical definition of the square by its overlooking buildings and consequently the positioning of the future buildings (respecting a modified building line) should be redetermined for their visual importance.

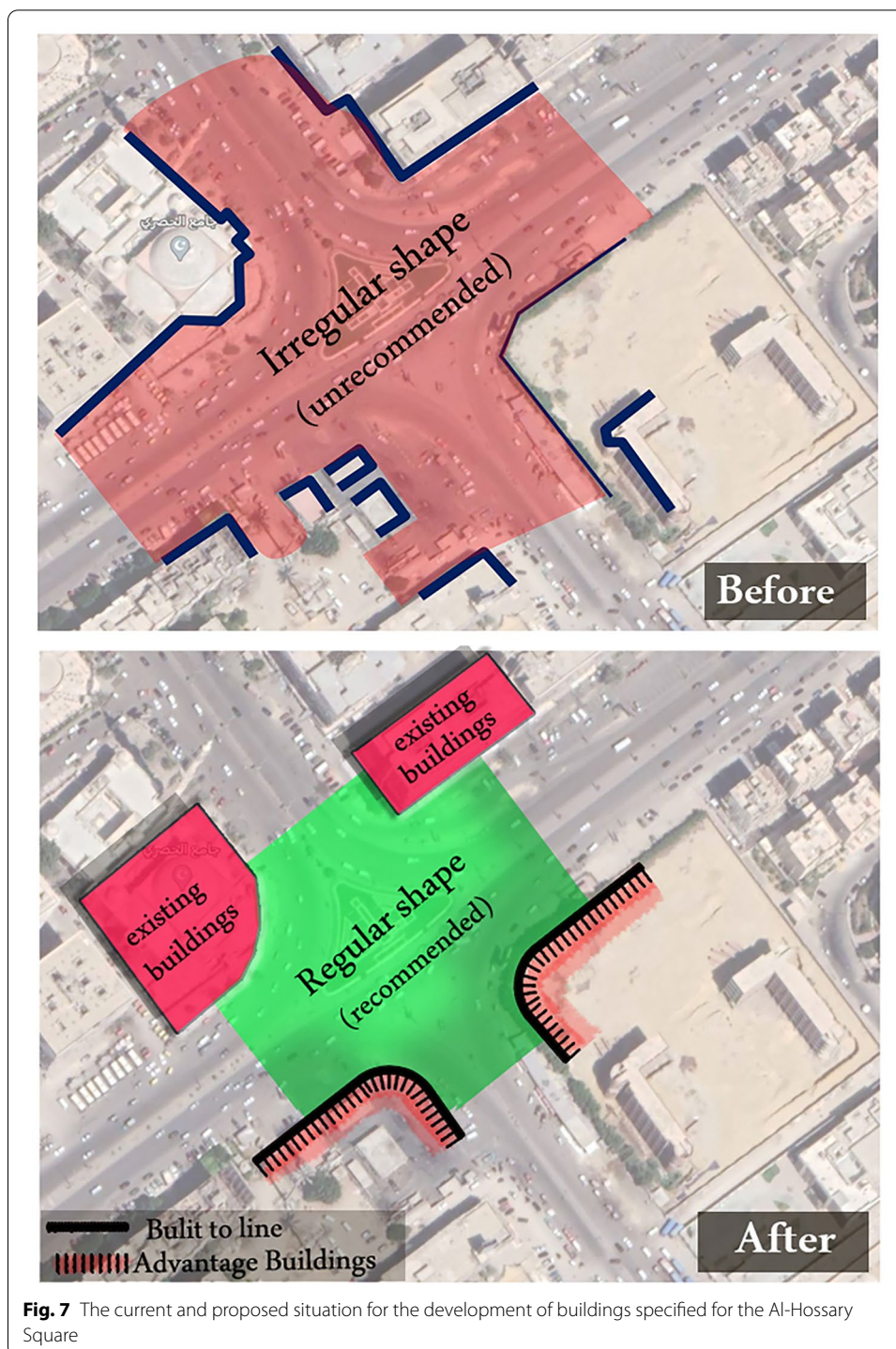


Fig. 7 The current and proposed situation for the development of buildings specified for the Al-Hossary Square

Building type standards

The diversity of building disposition (at least two types) of the block is one of the most critical components of FBC to provide a distinctive urban fabric. Building Type Standards are the specific standards designed to determine the building type according to its use (Villa, Apartment, Duplex, Commercial building) or according to the resulting space

of the setback system (e.g., front space, backspace, middle space, and border space) [6]. Building Type Standards throughout the UBL in Article No. (28) determine the building disposition according to their position on many lands and choose the building types according to their function. On the other hand, the setback system is limited to determining the types of buildings without setbacks meant to achieve the building ratio factor while focusing only on the length and depth of the facade of the lot. This led to the poor urban formation and unpleasant aesthetic values, according to Article No. (29) of the executive regulations of Law No. 119. The physical repetition and the gaps of the urban environment are some of the most critical weakness points of the current situation of the setback system (Fig. 8).

According to the FBC tool, two setback systems suggest achieving a lively visual formation at the residential block level. First is the diversity of the building position on the ground floor level; the building position of apartments for the ground floor has three proposed options: (1) over the entire area with front setback (Fig. 9, Lot. Nos. 1 and 4), (2) only frontal and back setbacks (Fig. 9, Lot. Nos. 2 and 5); (3) frontal and lateral setbacks (Fig. 9, Lot. Nos. 3 and 6). The upper floor is always in the centre. For villas and duplexes, the ground floor can utilise two setbacks laterally and posteriorly as a maximum for the villas, while only one setback is used for the duplexes [23]. Second is the Building Priority Law (BPL); BPL aims to accelerate construction and obtain a more beautiful urban environment by conforming to the law's privileges from the full exploitation of the land area [24]. Figure 10 shows the proposed residential block scenario consisting of 10 lots. In case lots, numbers 1, 2, and 3 have the right to build the entire area, whereas lot number 4 has the right to utilise the lateral setbacks. In addition, lots number 5 and 6 have the right to use only the posterior setback. Finally, lot numbers 7, 8, 9, and 10 have the right to utilise one setback, but it should be far away from the neighbours. This approach encouraged an infinite number of different scenarios for the location of buildings and the surrounding squares within the lots of lands, which results in the diversity of the urban fabric.

Frontage type standards

The primary purpose of setting regulations and standards for organising facades are to achieve an appropriate detailed treatment of the building's interaction with the public space in addition to ensuring a smooth transition between them. The facade patterns

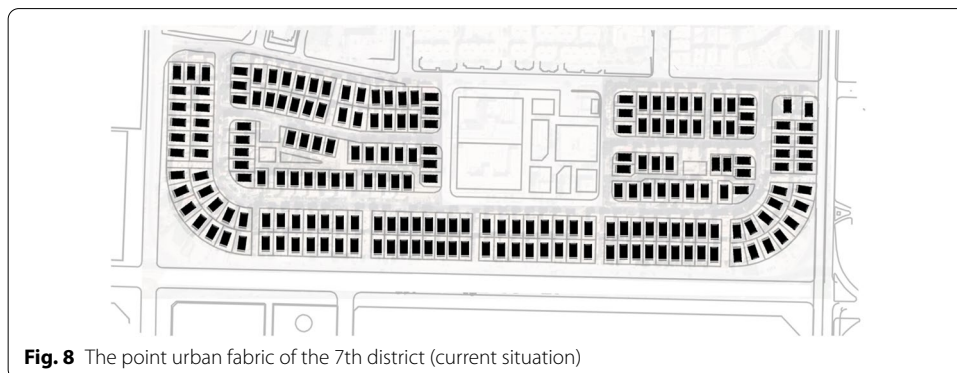
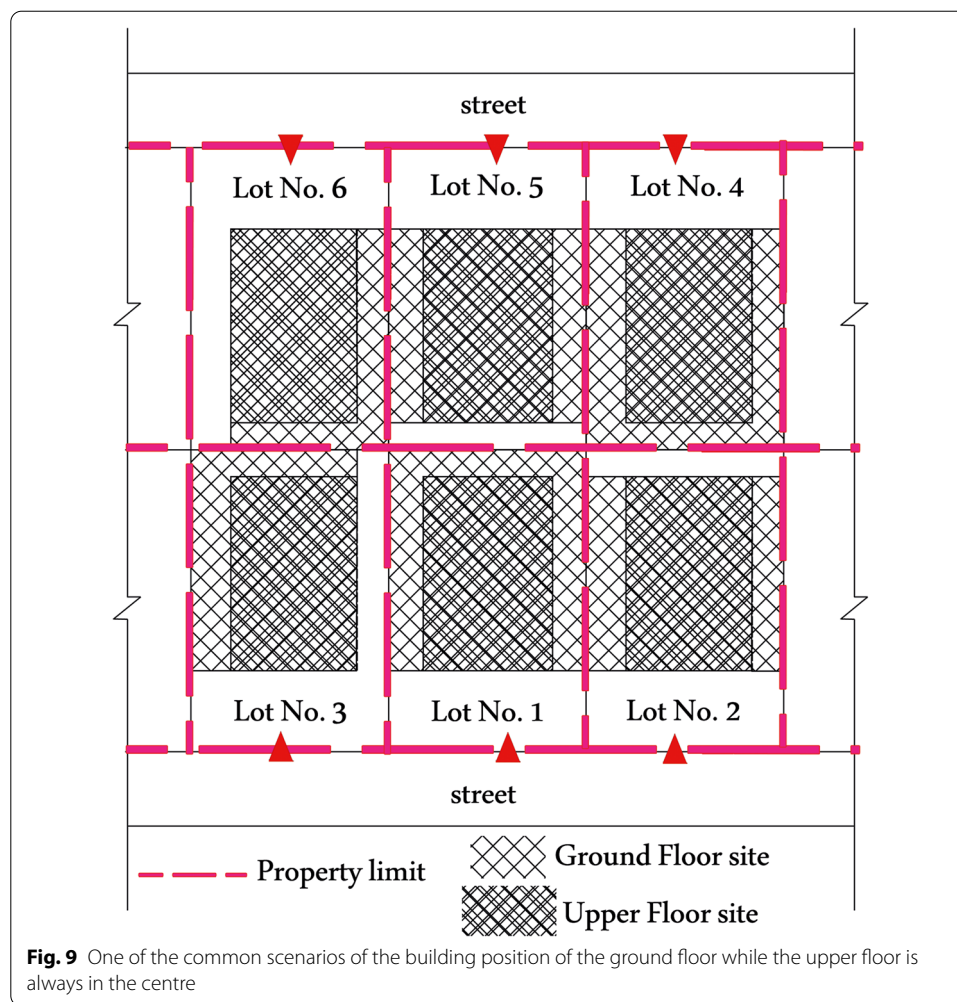


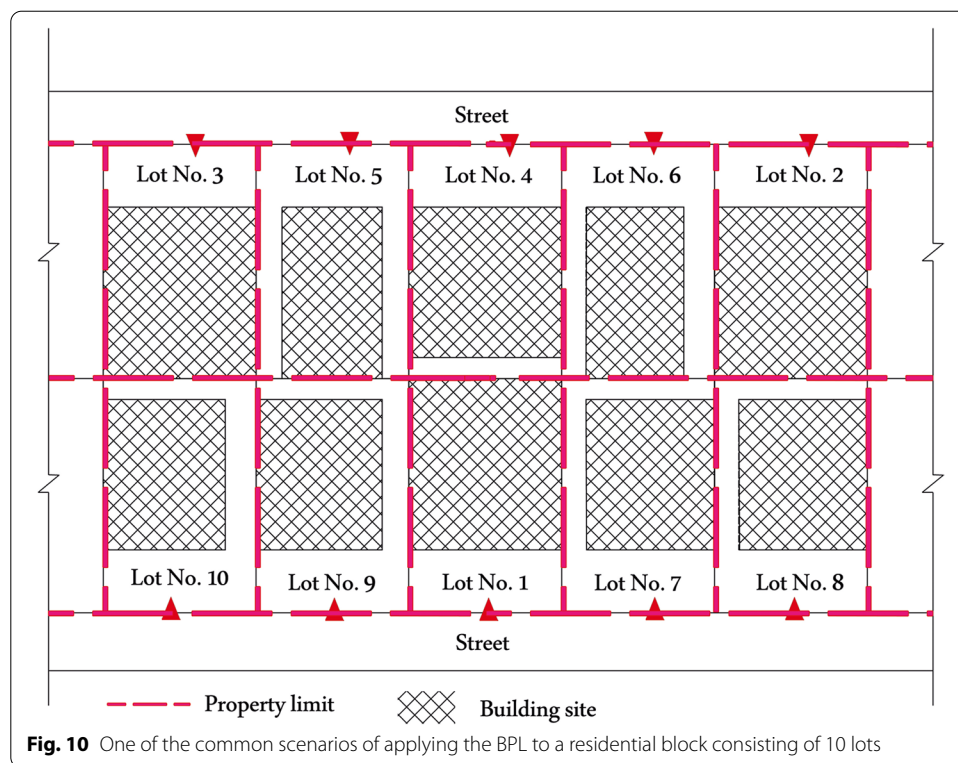
Fig. 8 The point urban fabric of the 7th district (current situation)



and their relationship to the public street are classified into (1) forecourt frontage, which includes front yard frontage standards, dooryard frontage standards, and walled yard frontage standards and (2) building frontage, which provides for gallery frontage standards, shopfront frontage standards, parking court frontage standards, porch frontage standards, and stoop frontage standards [25].

The FBC noted that the designs of facade models should vary according to specific regulations for each building type and land use for the entire city. This is conducted to diversify the links between public spaces and private ones according to an advanced study conducted to provide the diversity of the townscape of the entire city.

Frontage type standards throughout the UBL lack an article to define the permissible facade types and method of transition between public and private spaces. By implementing the field survey to the 6th of October City, it has been shown, despite many types of frontages around the city, that it was interwoven with each other at the single street level. Front yard frontages, as an example, have different treatments by owners, such as using a private garden while surrounding it with a wall of trees or using it to beautify the entrances to the buildings. The research surveys resulted in the absence of coherence and consistency between the entrances of adjacent structures (Fig. 11).



Architectural standards

Architectural standards control the shape of the building and define its architectural details. The shape of the building includes the determination of the height of the building as a whole; the level of the ground floor from the level of the external sidewalk, the ground floor, the upper floors, the upper annexe, the upper parapets of the building, the upper parapets of the upper annexe, and the formation of the roofs [10]. The components of the architectural detail standards include windows, doors, garage openings, awnings, canopies, balconies, columns, piers, arches, intercolumniation, arcades, loggias, roofs, architectural elements, shopfronts, signage, porches, stoops, garden fences, cornices, colours, and the finishing materials [26].

Architectural Standards throughout the UBL led to some weakness points [20]: the law is restricted to determine the internal height of one floor in general (2.70 m) in accordance with Article No. (93). It determines the minimum height of the handrails of balconies (0.90 m) and their maximum protrusion in accordance with Article No. (103). This law also determines the minimum height of the window seals and the minimum width of the doors in accordance with Article No. (96, 97). In order to ensure the height of service facilities on the roof, this does not fall within either the height of the building or according to what is required by the technical requirements for elevators in accordance with Article No. (104) of the executive regulations of Law No. 119.

Article No. (15) of Law No. (119) regarding the determination of the heights of buildings has linked the heights of buildings to the width of the street (1.5:1), or it should go according to the detailed plan. In contrast, the International Code Council [27], the American Building Code [28], and the Saudi Building Code [29] have different standards



Fig. 11 **A** and **B** Different aspects. **A** Front yard frontage as a private garden or using it to beautify the entrances to the buildings. **B** Different types of frontages on the same street

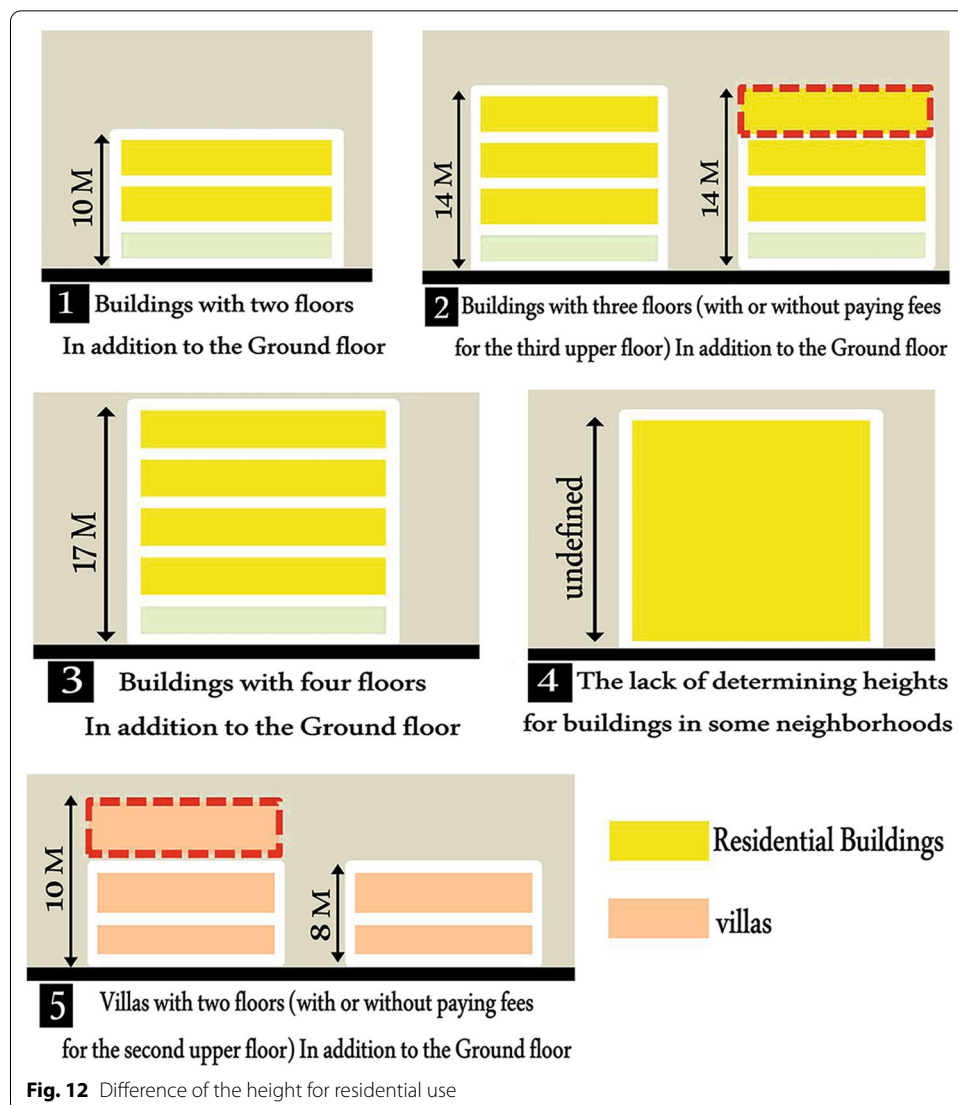
(types of construction, occupancy classifications, and automatic sprinkler systems). Upon reviewing the strategic plan of the 6th of October City [17] (as a case study) for Architectural Standards Components, it was revealed that there are buildings with a height of two floors and other buildings with three floors (with or without paying fees for the third upper floor). It has been disclosed that there is a lack of determining the heights for buildings in some neighbourhoods, such as the 6th Neighbourhood and the 12th Neighbourhood that will be implemented by the city organisation or the developers. This means that a fixed mechanism for regulating the heights in the city is not precise (Fig. 12). The stability of the setback system (front, back, and side) on all residential neighbourhoods in the city led to the existence of a point fabric for all neighbourhoods of the city (Fig. 8).

As for the level of the architectural facades, it is clear that the architectural styles make them different (Fig. 13). The difference in the level of the adjacent buildings from the sidewalk level resulted in a difference in the level of the roof of the ground floor and the rest of the floors (Fig. 14).

The FBC tool urged the necessity of specifying all architectural standards and details, and this should be accompanied by the building permit while following the style of illustrations in clarifying all the necessary requirements [6].

Landscape standards

Landscape Standards mean the organisation and placement of complementary elements (such as rubbish bins, trees, palms (allowed), billboards, light poles, seating areas, etc.) to achieve a coherent visual character [6]. According to the UBL, there is no obligatory article to separate the pedestrian paths and car lanes, especially within



residential neighbourhoods. There is also a lack of preparing car parks and paying attention to their impact on the townscape. According to Article No. (108) of Law No. (119) of the executive regulations, there are no specifying parking locations inside or outside the residential lots. On the other hand, there was no article concerned with how to place the elements of the street furnishings on the pedestrian sidewalk and their relationship to the car lanes. This was evident through the current survey where the areas of the sidewalk furnishings overlapped with the pedestrian path (Fig. 15).

Finally, the FBC's components were compared to the articles of UBL to show their impact on the current situation of the 6th of October City. A reconnaissance visual observation was utilised to decide on the several places that were chosen within the 6th of October City to inspect the main components of the FBC tool:

- The central axis and Al-Hossary Square were selected as examples of streets and squares that suffer from the lack of clarity in its urban form and shape as a result



Fig. 13 A mix of different architectural styles

of the lack of confirmation of the specific buildings for it, and this was addressed by a proposal to use palm trees in the central axis in line with the heights of the surrounding buildings and defining the organisation line for future constructions in Al-Hossary Square.

- Internal streets in the 6th of October City were selected as a representation of streets that suffer car movement dominance and the marginalisation of pedestrian traffic. It was treated by enhancing pedestrian movement by changing the paving medium to interlock instead of asphalt, in addition to redistributing and coordinating the trees on the street.
- The 7th district was selected as an example of the city's neighbourhoods that suffer from visual boredom of its urban fabric because of its independent buildings' fabric because of the setback system that is currently enforced. This issue was addressed by introducing two setback systems that would diversify the development of future urban fabric.



Fig. 14 The difference in the level of the floor and ceiling of the ground floor in adjacent buildings

- The types of existing facades and their relationship to streets' building lines were monitored, and there were different building facade types on the level of the street. This issue was addressed by recommending an article to the building control law for coordinating the types of facades at the street level.
- Architectural details were monitored in city buildings, and it turned out that they suffer from visual distortion and lack of coherence. The study recommended adding an article about the interdependence of architectural details at the street level and buildings' clusters and not only on one building level.
- The distribution of cityscape elements was observed on the neighbourhood level throughout the city. It became clear that cityscape elements were not coordinated and distributed randomly; so sometimes, they overlapped with pedestrian movement and sometimes conflicted with car movements. The study recommended the need for good monitoring by a competent authority of the type and location of cityscape elements.

Now, it is clear from the results of this study that the current situation of the townscape elements of the 6th of October City needs to be addressed, and that the application of a well-coordinated FBC tool would be beneficial. The current study addressed the gap between the local UBL [12, 13] and international regulations (FBC) that could improve townscape elements' weakness on a city level.



However, this study did not cover all the sub-elements of the FBC tool, nor did it hide all the elements of the city's townscape. Therefore, further research is necessary to inspect and discuss other criteria of the FBC tool to the entire city and its urban components to generalise the research results on townscape elements to all Egyptian cities.

The results of this study could encourage the concerned authorities (The National Organisation of Urban Harmony and the 6th of October City Development Authority) to undertake the following actions:

1. Setting an Egyptian urban code according to the FBC tool that is compatible with each metropolitan region offers appropriate community participation mechanisms, local townscape components and distinctive climatic factors for the purpose of environmental sustainability.
2. Updating the building code for each region every 5 years to be responsive to the rapidly changing urban morphology using FBC.
3. Determining the heights of the buildings according to the types of construction, occupancy classifications, and automatic sprinkler system.

Conclusions

Through clarifying the impact of FBC on the townscape of the 6th of October City, it becomes clear that the FBC tool should have the ability to improve and control the urban townscape of similar Egyptian cities. The main components of FBC were compared with the articles of UBL No. 119, which are mainly concerned with specifying the minimum and maximum physical dimension limits of the features, regardless of the details that affected the cityscape elements and structures as a whole. Through the research's analysis of the 6th of October City, it was discovered that the townscape suffers from the lack of coherence and harmony of its buildings, public spaces, and landscape. Assessment of the current situation would require the articles of the UBL No. 119 of 2008 to be updated and developed to counter the observed urban and architectural problems.

Abbreviations

FBCs: Form-based codes; UBL: Unified building law; UBC: Use-based codes; FBCI: Form-Based Codes Institute; BPL: Building Priority Law.

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Authors' contributions

Both authors participated in conceptualising the study. AB reviewed literature, survey and photography, data analysis, writing original draft, reviewing, and editing, while AO revised data and initial draft. It has to be said that both authors read and approved the final manuscript.

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Consent for publication

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Competing interests

The authors declare that they have no competing interests.

Author details

¹Department of Architecture, Faculty of Engineering, Sohag University, Sohag, Egypt. ²Department of Community & Regional Planning, Alabama A&M University, Huntsville, AL 35810, USA. ³Department of Architecture, Faculty of Engineering, Cairo University, Giza, Egypt.

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