High-Rise Towers and Their Relation to Context-Sensitive Design Elements in Architectural Education

İbrahim Saleh, Amr Abdelfattah
German University in Cairo Department of Architecture and Urban Design
arch.ibrahimsamy@gmail.com, amr.abdelfattah@guc.edu.eg
https://orcid.org/0000-0003-3204-9784
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Abstract: *This paper studies modern towers' architecture from a pedagogical point of view focusing on elements of towers' impact on its surrounding context and its impact on architecture students' understanding of high-rise building typology. The paper examines towers' impact on the surrounding context if it is far greater than the contextual parameters that affect their architecture itself, regardless of the tower's spatial program and functions. The research followed an analytical methodology to break down students' projects within different locations in Egypt from the 6th semester design course in the Architecture and Urban Design program, German University in Cairo. The locations are characterized by being a new urban community development by the government. These new communities have business districts with a vision of high-rise structures plugged in them. The selected projects were done over a duration of 6 years (2013-2019). A series of comparative analysis were achieved by proposing a matrix that highlights the interrelations between the different types of towers and the contextual sensitive design parameters. The paper categorizes the projects according to their locations within new cities in Egypt, and these locations are New Cairo, New Capital and New Alamein City. All collected data and analysis are compiled through the proposed matrix of contextual sensitive design parameters based on three factors: architecture approach, street and Infrastructure, and public realm.*

Keywords: *High-rise, context-sensitive design parameters, architectural education, new cities*

Yüksek Katlı Yapılar ve Bu Yapıların Mimarlık Eğitiminde Bağlama Duyarlı Tasarım Ögeleriyle İlişkisi

Öz: *Bu makale, yüksek katlı modern yapı mimarisinin çevresindeki bağlam üzerine etkisini ve mimarlık öğrencilerinin yüksek katlı bina tipolojisi anlayışını pedagojik bir bakış açısıyla incelemektedir. Makale yüksek katlı binanın mekânsal programı ve işlevlerinden bağımsız olarak, mimarisinde rol oynayan yapı çevresindeki bağlam üzerine etkisini ve bağlamsal parametrelerini incelemektedir. Araştırmada, Kahire Alman Üniversitesi Mimarlık ve Kentsel Tasarım Programı 6. dönem tasarım dersi öğrenci projelerini Mısır'ın farklı bölgelerinde ayrıntılandırırken analitik metodoloji yöntemi izlenilmiştir. Seçilen konumların tamamı, devlet yönetimi tarafından yeni kamusal oluşum olarak nitelendirilmektedir. Bahsi gecen kamusal oluşumların ticari bölgeleri yüksek katlı yapılar ile tahayyül edilmektedir. Seçilen projeler 6 yıllık bir süre boyunca (2013-2019) yapılmıştır. Süreçte, farklı kule türleri ve bağlama duyarlı tasarım parametreleri arasındaki karşılıklı ilişkileri vurgulayan bir matris önerilerek bir dizi karşılaştırmalı analiz gerçekleştirilmiştir. Makalede projeler yeni inşa edilen şehirlerdeki konumlarına göre sınıflandırılmıştır. Bu şehirler, Yeni Kahire (New Cairo), Yeni Başkent (New Capital) ve Yeni Al Alamein Şehri (New Al Alamein City)'dir. Elde edilen veriler ve analizlerin tümü önerilen, üç faktöre dayalı bağlama duyarlı tasarım matris parametreleri olarak derlenmiştir. Bu faktörler; mimari yaklaşım, sokak ve altyapı ve kamusal alandır.*

Anahtar Kelimeler: *Yüksek katlı yapı, Bağlama duyarlı tasarım parametreleri, Mimari eğitim, Yeni şehirler*

1. INTRODUCTION

Metropolitan vertical expansion became a main urban and architectural theme of many MENA cities as a vision for futuristic development and globalization. There are 387 high-rise structures in different contextual parameters that led to the debate of towers context-sensitive design approaches in the architectural professional and educational community especially in the MENA region in the past few years. High-rise towers have turned into significant architectural typology since the industrial revolution and the wide use of steel frame construction in the late 18th century, which resulted in urban vertical expansion until today, with a competition among most architects in constructing the most noteworthy vertical structures have existed since this industrial revolution [1, 2].

Conceptual ideas for Mega City Pyramid by Shimizu Corporation that done in 2004 as a vision for 2030 in Tokyo-Japan. It is a conceptual proposal for the construction of a massive pyramid to house 1 million people, and there are many other proposals that aimed at creating the feasibility for occupants to live from support to shrine without a need to go outside beyond what many would consider possible as other optimistic musings. Notwithstanding the way that reminiscent of Le Corbusier's planning and architectural visions for the Contemporary City [3], Mega City ideas of the 20th century, the Pyramid and Sky metropolitan regions illustrated some possible metropolitan living environments. They combine trails and examinations of inventive structural segments, building/construction technical approaches, and advancement techniques that cause all of them to show up the proof and possibility to realize these ideas and proposals.

There were 119 accomplished high-rise structures of 150 meters or more prominent height as the Council of Tall Buildings and Urban Habitat stated in 2008, and there were 387 high-rise building structures by 2018, within an average of twenty-seven towers every year for these ten years somewhere in the range of 2008 and 2018.

The development pace of these high-rise structures depends on some aspects as administrative arrangements, futuristic visions, population growth and density. As populace development functions a crucial part in high-rise blended use lodging projects existences in mega urban areas over the MENA region. The elements and the purposes behind high-rise development in the region are as assorted as the cities that include it.

The focus of this paper will be analysis of architecture students in German University in Cairo over 6 years in 6th semester - design studio towers. The studio focused only on high-rise mixed-use towers typology from an urban, architectural, environmental, and structural point of view. The selected site are all in business districts in new urban communities proposed by the Egyptian government as part of the governmental urban development goals and visions for 2030 and 2050. The presence of high-rise towers typology in these districts is also part of the government’s visions and the design studio tried to tackle different approaches to test the design and impact of these mega structures in these new communities.

2. RESEARCH HYPOTHESIS

The paper endeavors to discuss if modern towers’ architecture from the comprehension of architectural student is supple to the incorporating context impact. In addition, it battles that modern towers’ effect on the encompassing context is undeniably more distinct than the pertinent parameters that affect their design itself, paying little heed to the tower’s principle functions and spatial program.

As indicated by the literature reviews, the three primary types of sustainability are the social, environmental and economic. Accordingly, the significant standards will take into consideration these viewpoints in the

analytical part that uses the proposed matrix to expand and enhance the potential function of residential urban spaces.

3. RESEARCH AIMS AND OBJECTIVES

This research intends to recognize the relation between the modernistic towers and their encompassing context. Furthermore, the research pursues to build up a matrix conducted from the diverse designed towers in various locations and the contextual sensitive design parameters. The proposed matrix examines the towers' impact on the encompassing context and how far can influence it.

In this manner, the research outlines its objectives through:

- Identifying the contextual sensitive design components.
- Assigning the correlations between the contextual sensitive parameters and the towers over the proposed matrix.
- Confirming the presence of the referenced correlations within the Egyptian academic comprehension.

4. RESEARCH METHODOLOGY

The research seeks after an analytical methodology that separates thirty student tower projects amongst three different site locations from the sixth semester design course in the Architecture and Urban Design program, German University in Cairo. The students' sample of projects were done during four years between 2015 and 2019. The proposed developed matrix achieved a concatenation of comparative investigations that determines the correlations between the different kinds of towers and the relevant contextual sensitive design components.

This research arranges the chosen towers by their distinctive locations within different cities in Egypt, and these locations are New Cairo City as metropolitan expansion context in 2015, New Capital City as new contextual city alongside Cairo in 2016 and 2018, while New Alamein City as modern metropolitan seafront extension setting in 2019.

The projects of students' towers expanded an extent of various models from the four unique site locations, and every pattern shapes of sixteen endeavors circulated correspondingly as demonstrated by the students' GPA. The proposed matrix of contextual sensitive design components requests and filters all assembled information and analysis dependent on three fundamental considerations, and they are components of public realm, street and Infrastructure components, and architectural components [4].

5. LOCATIONS AND STUDIO STRUCTURE OF SELECTED CASE STUDY IN GUC TOWERS DESIGN STUDIO

5.1. Studio Introduction

5.1.1. Selected locations

Characteristics of selected sites:

1. In new urban community

a. 2015: in New Cairo City – a new community planned in 2000 on an area of 300 square kilometers and it has been under construction since then with the aim to have a residential and business community outside the crowded center of the capital Cairo (Figure 1).

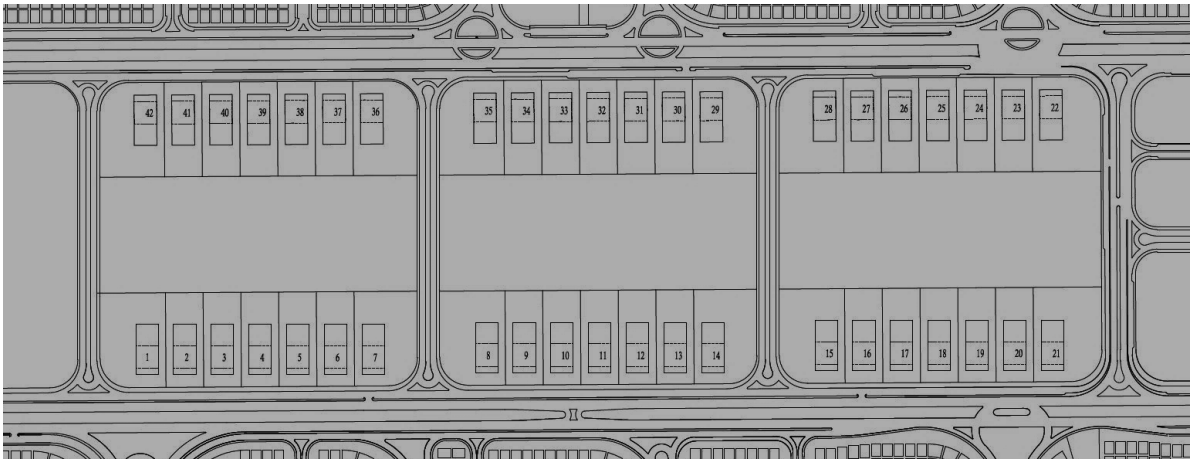

Figure 1. New Cairo proposed sites in design studio towers 2015. Authors, 2021.

b. 2016 and 2018: in New Administrative Capital - a new community planned in 2015 on an area of 700 square kilometers. It has been under construction since then with the aim to have all governmental administrative headquarters outside the crowded center of the capital Cairo along with business, residential and recreational zones as one of Egypt's biggest currently ongoing national projects.

c. The new capital will have high-rise business district with the tallest tower in Africa already under construction and the selected site for the design studio this year was in the same district (Figures 2, 3).

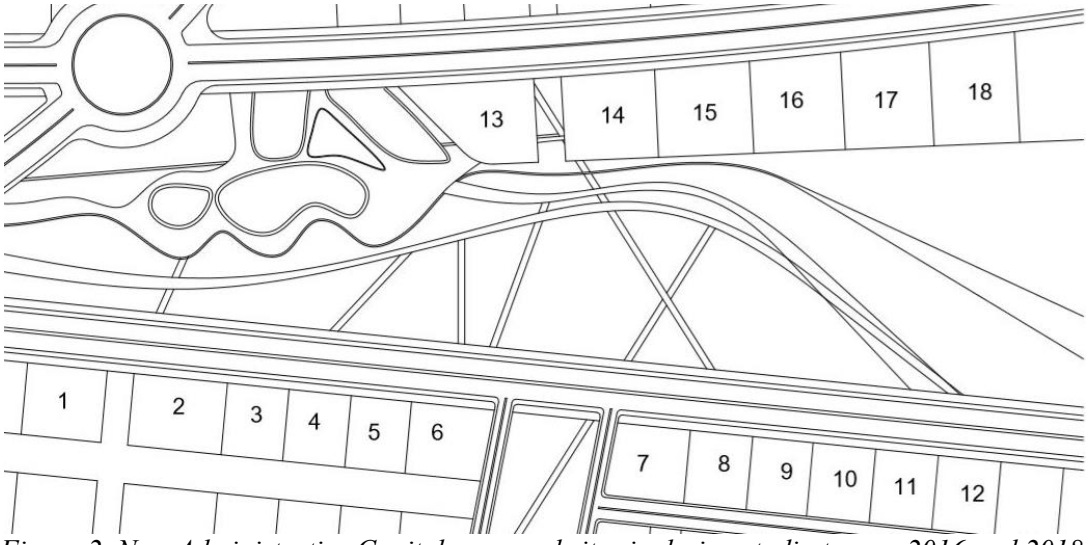

Figure 2. New Administrative Capital proposed sites in design studio towers 2016 and 2018. Authors, 2021

Figure 3. New Administrative Capital in Egypt proposed visions by the government [5]

d. 2019: in New Alamein City - a new costal city by the Mediterranean Sea planned in 2018 on an area of 210 square kilometers and it has been under construction since then with the aim to have a new recreational and residential hub next to the historic city of Alexandria by the Mediterranean.
All the water front development in this city will be high-rise structures and this is the location for the design studio towers in this year (Figures 4, 5).

Figure 4. New Alamein City proposed sites in design studio towers 2019. Authors, 2021

Figure 5. New Alamein City waterfront under construction towers [6]

The following Figure6 highlight the different selected sites for the design studios on the strategic vision map done for the government in 2018 with the red circles highlighting important existing cities as part of the development vision to link new and existing cities.

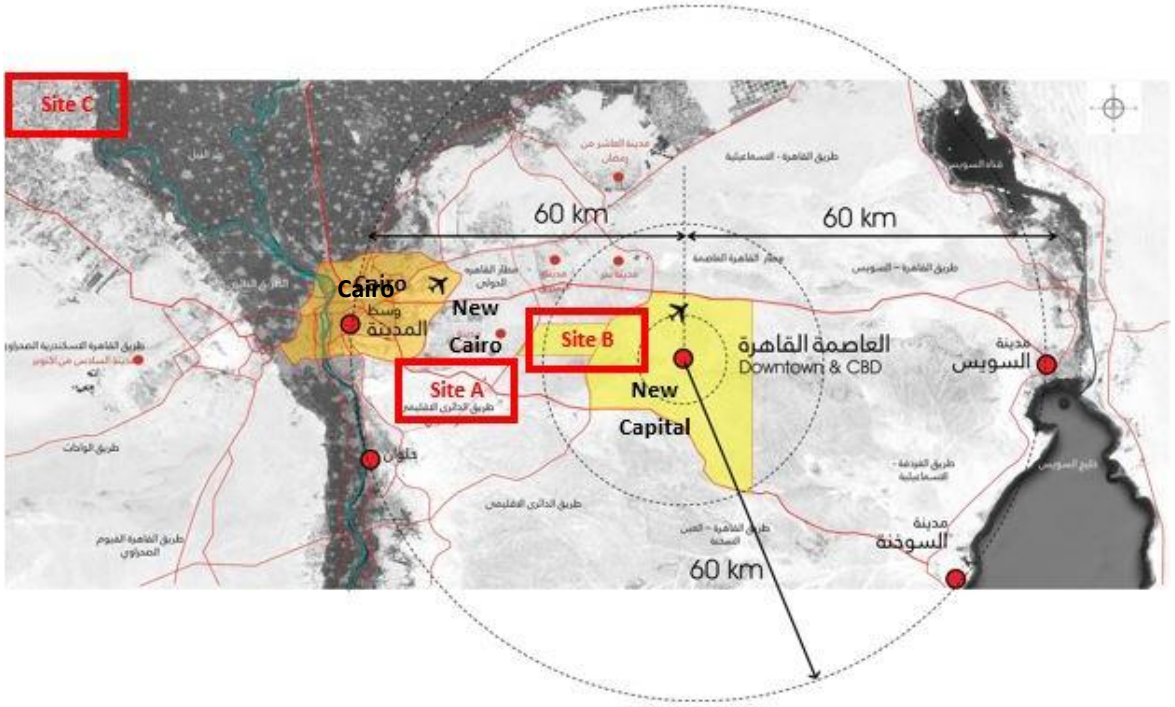

Figure 6. Different selected sites for the design studios on the strategic vision map done for the government in 2018 [5]

5.1.2. Studio Structure

The studio –over the selected years- have some common requirements from students to achieve the final project as listed in Table1. The structure was based on developing their knowledge of high-rise towers and their impact gradually over the semester's 13 weeks. The first 2-3 weeks started with site understanding, context analysis, site visit and first urban approach ideas.

Weeks 4-6 normally focused on transforming the student's urban approaches into keywords and design ideas for the tower mass and form itself. The remaining part of the semester focused on structural solutions and façade engineering of the developed ideas.

The students worked with model making techniques on different scales:

- Macro scale – Urban scale. Normally from scale 1:5000 to 1:10000,
- Medium scale – tower mass in neighboring context scale. Normally scale 1:1000
- Micro scale – tower engineering (structure and façade) scale. Normally scale 1:400 to 1:20 details.

Also the students in parallel to this model making approach worked on providing 2D drawings and 3D software models + working on developing ideas via parametric tools and environmental simulation tools such as Rhino, Grasshopper, and Ladybug tools.

Table 1. Summary of Students Tasks over the semester in selected case studies in GUC. Authors, 2020

WEEK	PHASE	STUDIO/TUTORIAL
01	Introduction	Site Visit
		Context Analysis
02	Mass and Form	Intro to Studio work (Models, Sketches, and Ideas)
	Urban Analysis	1st Urban Approach Ideas and Site Analysis
03	Tower Building Examples + Core design	Towers Research + inspirations/concepts/ models/sketches Tower in Context Impacta
04	Tower Examples + Hotel Design Standards	Review students projects + Studio work (Models, Plans, and sections)
05	Review students projects + Studio work (Models, Core Design, Plans, and sections)	
06	High rise buildings Structure	Review students projects + Studio work (Models, Layout, Core Design, Structure, Plans, Facades, and sections)
07	MIDTERM SUBMISSION	
08		Review students projects + Studio work (Models, Core Design, Structure, Plans, Facades, and sections)
09	Façade Engineering / Wall Sections	Review students projects + Studio work (Models, Core Design, Structure, Plans, Facades, and sections)
10	Review students projects + Studio work (Models, Layout, Core Design, Structure, Plans, Facades, and sections)	
11	Review students projects + Studio work (Models, Layout, Core Design, Structure, Plans, Facades, and sections)	
12	Review students projects + Studio work (Models, Layout, Core Design, Structure, Plans, Facades, and sections)	
13	Final Drawing Submission	
14 & 15	MODELS WORKSHOP	
	MODELS WORKSHOP	
	FINAL Submission Model	
	FINAL PRESENTATION	

The given space program was normally a mixed-use high-rise tower of 40 floors with footprint of around 1500 square meters. The towers included office spaces, commercial and recreational areas, residential hotel units, galleries, restaurants, and the students were given the freedom to modify and tailor the space program to match their urban and conceptual design approach.

Other semesters the proposed space program was slightly changed to housing projects or special typology such as community service centers to match the selected site needs with always having some mixed use spaces integrated in the tower.

5.2. Example Space Program

5.2.1. Example 01_Luxury Hotel + International Office Firm (proposed in 2015, 2016, 2018, and 2019 design studio cycles)

Entrance Hall
Information desk/ Security/ Waiting areas 200m2
Conference hall 300m2
Exhibition space 200m2
Core area 150m2
Commercial Zone
Shops (clothes/ furniture/ books/ tourist agents/ banks) 1000m2
Coffee shop and restaurant 300m2
Services 500m2
Outdoor Area
A well-landscaped area, including main entrance, side entrance, underground parking and service entrance and an entertainment area
7 & 5 stars Hotel Tower
Hotel Rooms space per floor approximately 1000m2
Core and service area approximately 200m2
Panoramic Restaurant
Exclusive restaurant with a special theme on the top floor with its services- 400m2
Vertical Circulation Core(s) include:
Elevators
Main staircase and fire escape stairs
WCs
HVAC
Electrical room
Low current and network room
BMS (Building Management System)
Storage and services

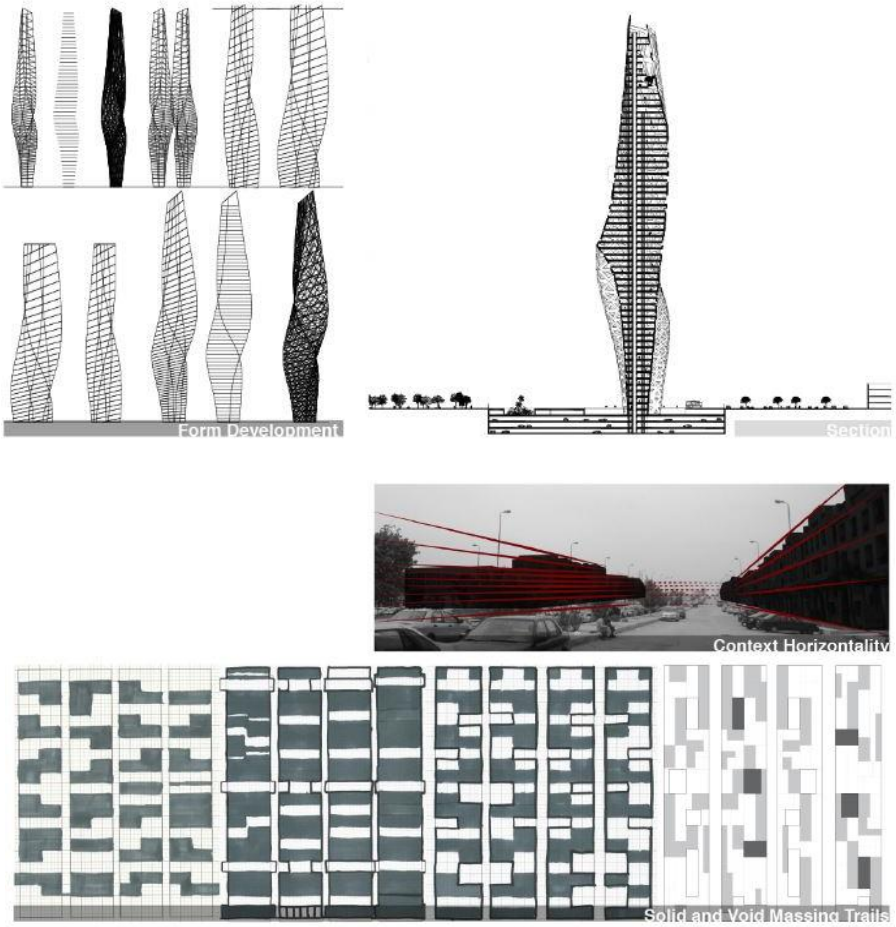

Figure 7, 8. Example of studio towers 2015 in New Cairo with the student using parametric grasshopper tool for form generation and structure solutions by student Karim El Kurdi. Authors, 2020

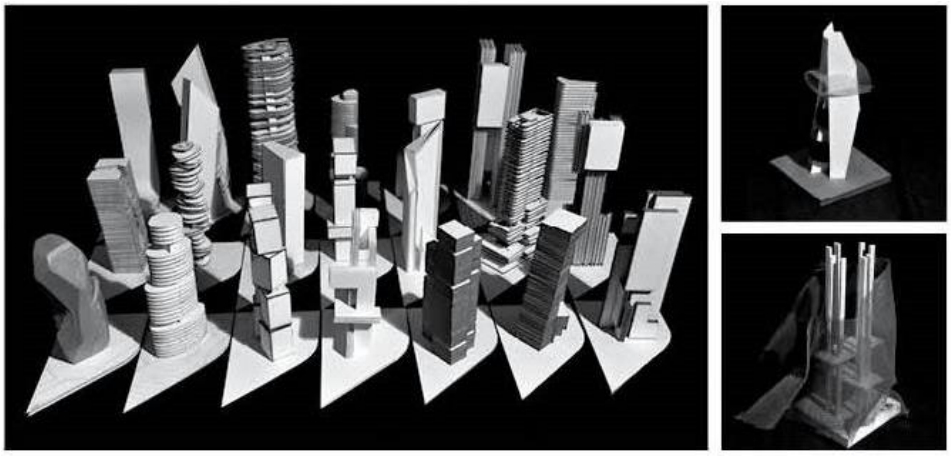

Figure 9. Example of studio towers 2019 in New Alamein City with the student using physical models scale 1:1000 for form generation alternatives. Authors, 2020

The comparison in this research also investigates the results of the students' work in different locations as mentioned before and with reference to similar and slightly modified space programs and if these locations change and these space programs affected the context sensitive tower design elements presence and impact or not.

6. CONTEXTUAL SENSITIVE DESIGN ELEMENTS

Each project has an alternate setting while the project's comprehension context plays a crucial role in the accomplishment of every design project especially in its final architectural design result. Furthermore, the surrounding context can be tended as compel as well as design opportunity. The diverse case studies of international contextual sensitive guidelines taking into consideration the relevance of the design components to the tower architectural design project, which results from a pedagogical perspective, created and improved a set of conducted components. These elements were been sorted into three fundamental divisions:

- Contextual Sensitive Streets and Infrastructure Elements.
- Contextual Sensitive Architectural Elements.
- Contextual Sensitive Public Realm Elements.

Every division comprises a list of subdivisions that include a scope of contextual components as figured in Table 2.

Table 2. Contextual sensitive design components. Authors, 2020

	Contextual Sensitive Streets and Infrastructure Elements
01	Present urban characteristics.
02	Consider the connection between open spaces, streets and buildings.
03	Supply remarkable situations.
04	Promote and bolster corridors' view.
05	Make a characterized and dynamic street wall.
06	Adjust various utilizations for sustainable environment.
07	Comply with naturalistic aspects.
08	Integrate infrastructure network (streets, bridges, sidewalks, transportation systems …).
	Contextual Sensitive Architectural Elements
09	Integrate clear architectural ideas toward the context.
10	Incorporate encompassing materials with building designs.
11	Consider the project's design from different viewpoints.
12	Supply dynamic building fronts.
13	Utilize sustainable approaches.
14	Integrate building techniques and materiality with the domestic context.
15	Consolidate landscape elements with public open spaces.
	Contextual Sensitive Public Realm Elements
16	Integrate site topography.
17	Connect public open spaces with the streetscape.
18	Supply public spaces to enhance the physical comfort, diverse social activities and visual accessibility
19	Highlight the local characteristics.
20	Provide bicycling and public transportation.
21	Promote pedestrian pathways.
22	Consolidate social, environmental & cultural features.
23	Boost economic sustainability (land uses, business and other activities …etc.).
24	Esteem naturalistic features (as connection to water or a view, open space, mountain…).
25	Consider the ecological features (climate, energy, water…).

7. APPLYING THE PROPOSED MATRIX

GUC students of Towers design studio were asked to fill-in a survey based on Table1 to rate the relevance of their design results to each criteria with 0 representing no relevance and 5 representing maximum relevance. A total of 80 out of 140 total tower students (average of 26 students per each tower design studio answered the survey). Figure 02 represents samples of students design results. The survey results' summary for each of the design locations is represented in Table3. The students were asked to choose between range of 0-5 (0 representing the non-existence of the criteria and 5 representing strongly agree with the implementation of this criteria in the design studio).

Table 3. Average scores of each criteria based on results of students' survey. Authors, 2020

Tower Studio	Present urban characteristics	Consider the connection between open spaces, streets and buildings.	Supply remarkable situations.	Promote and bolster corridors' view.	Make a characterized and dynamic street wall.	Adjust various utilizations for sustainable environment.	Comply with naturalistic aspects.	Integrate infrastructure network (streets, bridges, sidewalks, transportation systems …).	Integrate clear architectural ideas toward the context.	Incorporate encompassing materials with building designs.	Consider the project's design from different viewpoints.	Supply dynamic building fronts.	Employ sustainable features	Integrate building techniques and materiality with the domestic context.	Consolidate landscape elements with public open spaces.	Integrate site topography.	Connect public open spaces with the streetscape.	Supply public spaces to enhance the physical comfort, diverse social activities and visu	Highlight the local characteristics.	Provide bicycling and public transportation.	Promote pedestrian pathways.	Consolidate social, environmental & cultural features.	Integrate social environment & cultural characteristics	Boost economic sustainability (land uses, business and other activities …etc.).	Esteem naturalistic features (as connection to water or a view, open space, mountain…)	Consider the ecological features (climate, energy, water…).
New Alamein Tower 2019	3.66	3.63	4.17	4.19	3.05	3.67	3.97	3.82	4.34	3.32	4.11	3.81	3.01	2.57	4.08	3.25	3.77	4.11	3.22	2.97	4.01	4.26	3.56	4.10	4.51	3.14
New Cairo Tower 2015	3.34	3.56	3.70	3.86	2.98	3.48	3.08	3.10	3.92	2.89	3.47	3.36	2.74	2.40	3.84	2.25	3.59	3.76	3.01	2.60	3.10	3.73	3.15	4.04	3.48	2.54
New Capital Tower 2016	3.04	3.20	3.46	3.78	3.11	3.37	2.84	2.99	4.05	2.75	3.51	3.53	2.61	2.31	3.91	2.27	3.67	3.69	2.89	2.38	2.90	3.65	3.09	3.79	3.17	2.22
New Capital Tower 2018	2.72	3.07	3.26	3.72	3.27	3.45	2.74	3.06	4.04	2.93	3.79	3.56	2.59	2.43	3.93	2.09	3.57	3.69	3.01	2.32	2.87	3.58	3.17	3.81	3.16	2.33

The summary for New Cairo tower in 6th semester - 2015 showed weakness in the following criteria elements: Integrate building techniques and materiality with the domestic context and Integrate site topography. It showed strength in the following criteria elements: Boost economic sustainability (land uses, business and other activities …etc.).

The survey results' summary for New Capital tower in 6th semester - 2018 and 2016 showed weakness in the following elements: Provide bicycling and public transportation, Consider the ecological features (climate, energy, water…), and Integrate site topography. It showed strength in the following criteria elements: Promote and bolster corridors' view, Integrate clear architectural ideas toward the context and Consolidate landscape elements with public open spaces.

The survey results' summary for New Alamein tower in 6th semester - 2019 showed weakness in the following elements: Integrate building techniques and materiality with the domestic context and Provide bicycling and public transportation. It showed strength in the following criteria elements: Esteem naturalistic features (as connection to water or a view, open space, mountain…) and Supply remarkable situations.

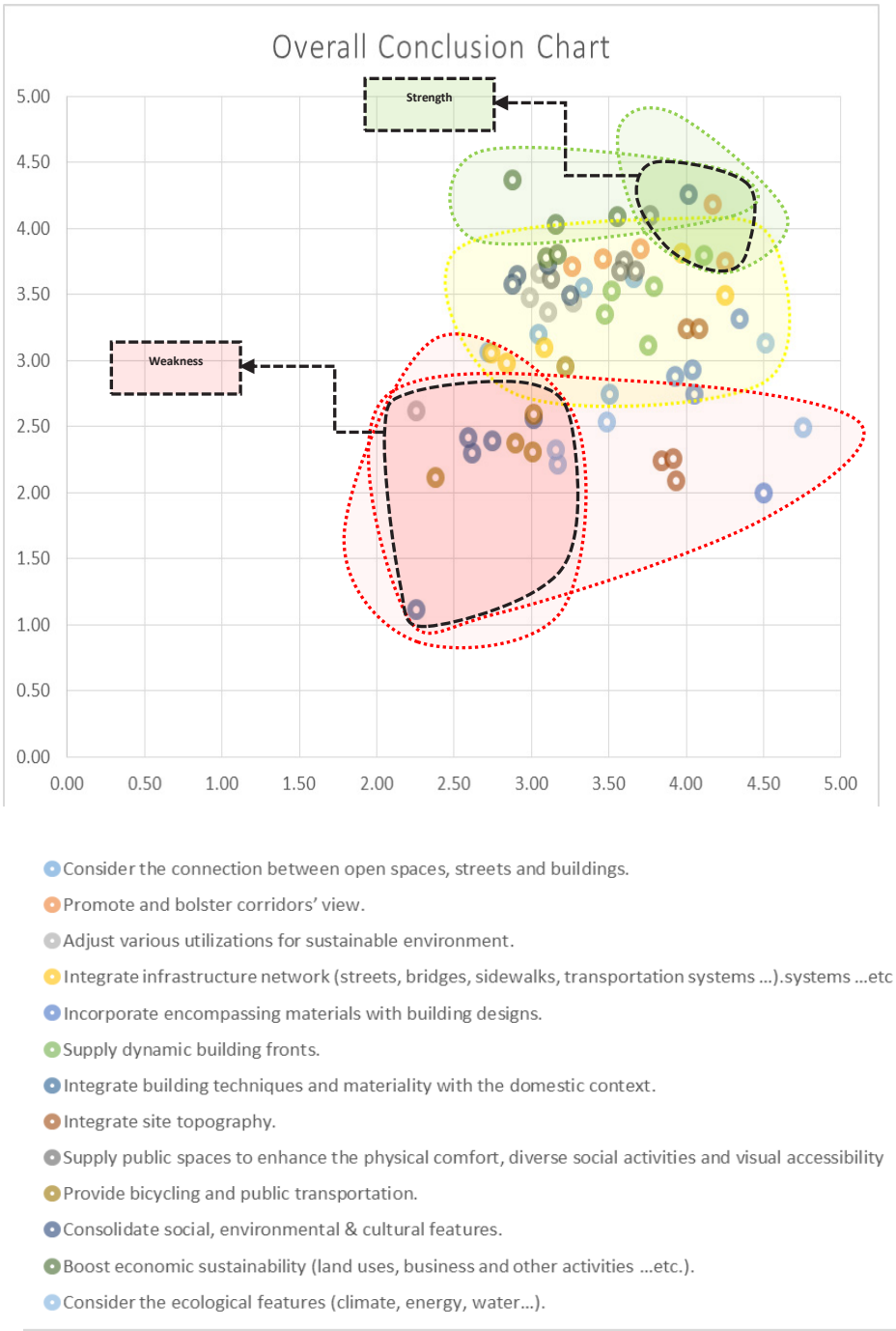

Figure 10. Overall strength and weakness categories based on survey results. Authors, 2020

Figure 11 represents a summary of overall strength and weakness categories based on survey results.

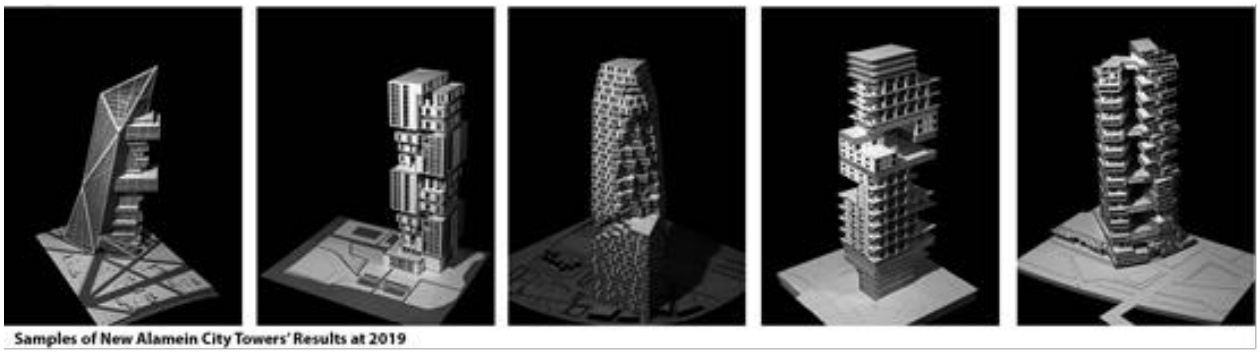

Figure 11. Example of the results in design studio towers. Authors, 2020

8. CONCLUSION

The analysis and results in Table4 and Figure12 represent mainly a set of missing context sensitive elements according to each of the four case studies. The GUC 6th semester tower design projects and survey results proved the students' projects to be responsive to context in some criteria elements but the architectural tower design project itself is dominant in comparison to the context sensitive factors.

Table 4. Context sensitive elements high (in green color) and low (in red color) average scores. Authors, 2020

Tower Studio	Present urban characteristics	Consider the connection between open spaces, streets and buildings.	Supply remarkable situations.	Promote and bolster corridors' view.	Make a characterized and dynamic street wall.	Adjust various utilizations for sustainable environment.	Comply with naturalistic aspects.	Integrate infrastructure network (streets, bridges, sidewalks, transportation systems ...).	Integrate clear architectural ideas toward the context.	Incorporate encompassing materials with building designs.	Consider the project's design from different viewpoints.	Supply dynamic building fronts.	Employ sustainable features	Integrate building techniques and materiality with the domestic context.	Consolidate landscape elements with public open spaces.	Integrate site topography.	Connect public open spaces with the streetscape.	Supply public spaces to enhance the physical comfort, diverse social activities and visu	Highlight the local characteristics.	Provide bicycling and public transportation.	Promote pedestrian pathways.	Consolidate social, environmental & cultural features.	Integrate social environment & cultural characteristics	Boost economic sustainability (land uses, business and other activities ...etc.).	Esteem naturalistic features (as connection to water or a view, open space, mountain...)	Consider the ecological features (climate, energy, water...).
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New Cairo Tower 2015	3.34	3.56	3.70	3.86	2.98	3.48	3.08	3.10	3.92	2.89	3.47	3.36	2.74	2.40	3.84	2.25	3.59	3.76	3.01	2.60	3.10	3.73	3.15	4.04	3.48	2.54
New Capital Tower 2016	3.04	3.20	3.46	3.78	3.11	3.37	2.84	2.99	4.05	2.75	3.51	3.53	2.61	2.31	3.91	2.27	3.67	3.69	2.89	2.38	2.90	3.65	3.09	3.79	3.17	2.22
New Capital Tower 2018	2.72	3.07	3.26	3.72	3.27	3.45	2.74	3.06	4.04	2.93	3.79	3.56	2.59	2.43	3.93	2.09	3.57	3.69	3.01	2.32	2.87	3.58	3.17	3.81	3.16	2.33
AVG.	3.25	3.24	3.77	3.86	2.93	3.32	3.37	3.29	4.17	2.78	3.73	3.48	2.64	2.16	3.95	2.62	3.54	3.77	2.90	2.48	3.23	3.75	3.17	4.02	3.81	2.55

The common weakness in context sensitive criteria were selected based on scores less than 3.00 from the survey results table and they are as follows:

- Incorporate encompassing materials with building designs.
- Make a characterized and dynamic street wall.
- Integrate building techniques and materiality with the domestic context.
- Integrate site topography.
- Highlight the local characteristics.
- Provide bicycling and public transportation.
- Consider the ecological features (climate, energy, water…).

The common strength elements in context sensitive criteria were selected based on scores more than 4.00 from the survey results table and they are as follows:

- Provide remarkable situations.
- Integrate clear architectural ideas.
- Integrate landscape elements with public open spaces.
- Supply public spaces to enhance the physical comfort, diverse social activities and visual accessibility.
- Boost economic sustainability (land uses, business and other activities …etc.).

This research paper concludes that there is no regular pattern for the students' reaction to the contextual sensitive design elements when designing high-rise towers. These reactions are subjective to each student's design approach and finally the research concludes some common weaknesses and strengths, which are conducted from the survey's findings as shown in Figure 12 and Table 4.

In order to develop the design models of the high-rise students in relation to the context-sensitive design the architecture students are encouraged to follow the guidelines in Table2 to be part of their holistic design approach and proposals.

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IBRAHIM SALEH, M.Sc.
He is currently working as an Instructor in the Architecture and Urban Design Program at The German University in Cairo, Egypt. He obtained his B.Sc. in Architecture from Cairo University, Egypt in 2010, and obtained his Master of Sciences in Architectural Engineering & Environmental Design from Cairo University, Egypt in 2015. He is currently a PhD candidate in Architecture Department at Ain Shams University. His research interests includes participatory architecture, community-based design, and educational buildings architectural upgrade approaches.

AMR ABDELFATTAH, M.Sc.
He is currently working as Assistant Lecturer in Architecture and Urban Design Program at The German University in Cairo. He obtained his B.Sc. in Architecture from Helwan University, Egypt in 2007, and his Master of Sciences in Architectural Engineering & Environmental Design from the Arab Academy for Science and Technology in Egypt in 2015. Now he is a PhD candidate in Architecture at Ain Shams University. His research interests include urban spaces and design in general and more social-behavior issues in urban design.