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An Assessment of Environmental Clauses Development in Egyptian Building Codes from (1940-2008): Legislative Evolution and Alignment with Sustainable Development Goals

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Energy Efficiency,
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SDGs

Abstract : The Egyptian state has been working to create and update its building laws to adapt the development in construction sector and to govern and control construction process in communities in relation to the urban development in Egypt in the past hundred years in relation to the large increase in population parallel to the problems of resource depletion and global warming facing the world [1], Worldwide law makers by the end of the 20th century started to implement new codes to adapt buildings to environment in order to reach energy efficiency and occupants thermal comfort, this paper studies presence and impact of the environmental clauses in the Egyptian Building Laws from the first published Building Law no. 51 in 1940 till the Current Law no.119 in 2008 and its affect in Egyptian buildings industry and did the law makers tried to adapt the law to Sustainable development goals (SDG) in comparison to other international examples in order to achieve Sustainable built environment.

1. Introduction

Throughout history humans began to develop some rules that aim to protect the rights of individuals and to determine their duties and responsibilities towards the main group or society. Definition of law appeared as “a system of rules that are created and applied through social or governmental institutions to regulate behavior.” [2], the world established the first building law in Babylon during the reign of King Hammurabi, who ruled from 1792 to 1750 BC. It was known as the “Code of Hammurabi” and was written on one obelisk. The Code of Hammurabi included a few regulations pertaining to building and urbanization in the Babylonian state [3]. Later world governments and councils started to develop building Laws that target to governance the method of establishing a safely constructed, fire resistant and easily accessible for occupants without affecting the surrounding-built environment. In the recent 50 years, world began to face problems of energy depletion, increase in Earth’s temperature as a result of global warming and increase in carbon emissions which closely related to human thermal comfort that firstly appeared as a global concerning issue in 1982 when the World Health Organization (WHO) recognized the term "Sick

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Building Syndrome" (SBS) which is defined as s a medical condition where people in a building suffer from symptoms of illness or feel unwell for no apparent reason [4] , SBS mainly causes are poor indoor air quality due to lacking of natural ventilation ,poor maintained air conditioning systems , lack of natural lighting , dust, smoke or fumes in the air ; In addition the United Nations Member States in 2015 adopted what is called “United Nations Sustainable Development Goals (SDGs)” which are a set of 17 global goals targeting achieving a 2030 global Agenda for Sustainable Development including goal no. 11 “ Sustainable Cities and Communities” that requires sustainable urban planning in addition to preserve environmental impact of cities from energy consumption , air quality and waste management [1] .

2. Methods and tools

According to (**Fig. 1**), The research methodology is based on studying the legalization of environmental clauses in the Egyptian building laws and its development with developing the law from its first edition in 1940 till the current edition, the literature review will be based on a brief about the governance of Building in Egypt before publishing the first Law no.51 in 1940 and then the study proceeds in stating the environmental clauses in the various law updates until the current working Law , stating clauses that focus in Energy Efficiency, natural lighting , ventilation , noise prohibition and indoor environmental quality. Study analysis is based on analysis of Law updates with applicable example in each period with application of the environmental clauses and tracking its effect in studying various building cases in order to identify how it affects the built environment, the analysis results will be stated and in comparison to worldwide examples of Building laws that necessitates achieve sustainability in construction in accordance to the UN SDGs with applicable examples, the study targets to define where the Egyptian Building Law stands in terms of sustainability and what are the expected addition to achieve a sustainable building law .

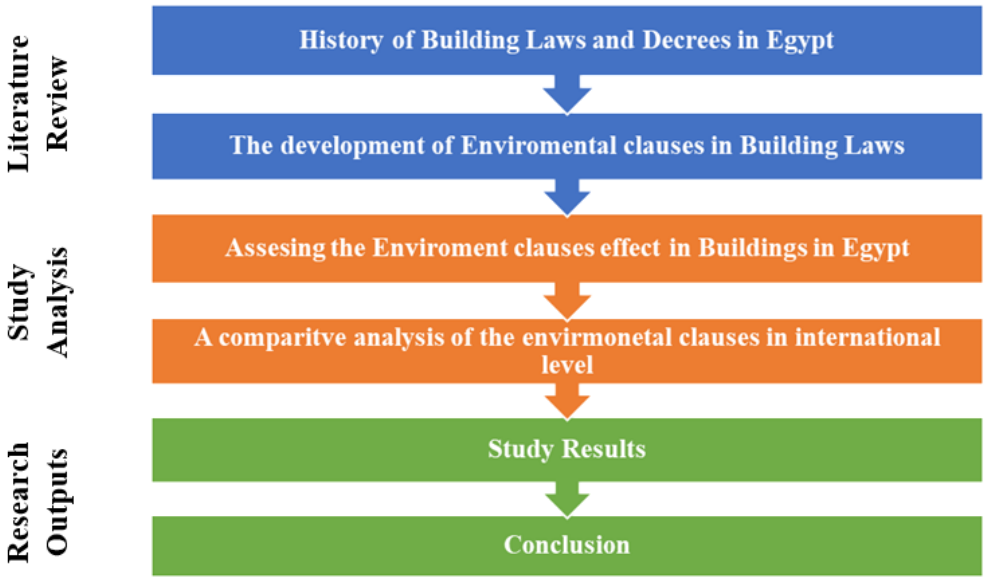

Fig. 1: Research Methodology

3. Historical Development of Building Laws in Egypt

With the development of urbanization throughout history, the Egyptian state experienced different periods, some of which the country passed by flourishing construction and urbanization, and other

periods that witnessed decline and delay, The urbanization process was historically linked with the economic growth of the state since urban development is considered an economy mirror. Ancient Egyptians adapted Laws that organize the building process in ancient Egypt but its provisions were based on penalties for violating general regulation or social relations between occupants also it didn't address technical or environmental aspects of the construction process ; With the beginning of the Islamic era, legislators and planners treated the city as a living organism that must be preserved, and this was evident in creating detailed plan of the city where the land uses are defined whether commercial , crafts or residential according to (**Fig. 2**) [5] .

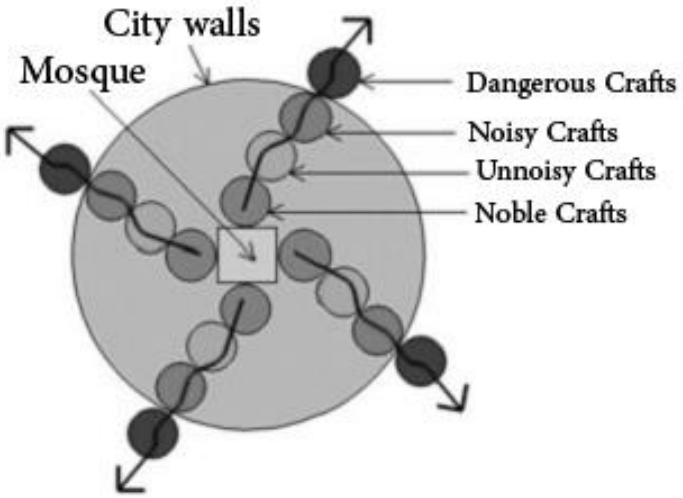

Fig. 2: Distribution of crafts in the city according to their size of harmfulness

By the end of the French campaign on Egypt in 1801 and the beginning of Mohamed Ali regime in 1805 which focused on modernizing the state , he created a governmental structure to manage the state affairs and divided it into departments (current : Ministries) managing the state's sectors and divided the state administration into governorates , Egypt regained a huge urban transformation mainly in greater Cairo area where the state focused on creating new lanes in the city , widening narrow streets , street lighting and removing solid and demolishing wastes in city suburbs by creating waste hauls out of the city and naming streets and numbering houses meanwhile the state did not issue a building law or code during this time [6]. In 1863 with the beginning of khedive Ismail era, which considered an extension to his grandfather Muhammad Ali development plan, the country witnessed a major urban boom which was clearly influenced by European urbanism. However, the country did not witness the issuance of a building law or a decree to governance the building industry in Egypt, but there was a radical development of the urbanization of Cairo and Alexandria in addition to the creation of a new urban community in the Suez Canal cities, during this period the government developed the city infrastructure including plumbing and sewage besides its attention in creating public areas, gardens and landscapes in main streets. Khedive Ismail's influence by European urbanism, especially the city of Paris, led him to think about creating a new extension to the city of Cairo which is known as the "Khedival Cairo "and was the first planned city model in Egypt where the lands were divided and sold into plots ready for construction connected to Public infrastructure like sewage, roads and utilities which dividing the land used to 30% of the roads and networks, buildings 13%, and gardens and parks 57% [7].

The first written regulation to govern the affairs of Building industry in Egypt was published in on 26th of August 1889 during Khedive Tawfik regime, law appeared at this time as a regulatory regulation regarding the provisions of the Planning Authority and published in the official

governmental Gazette, the law dealt with a set of rules aimed to improve the construction process from an organizational standpoint, without mentioning any technical or environmental affairs[9] ; the decree was a kick off for future legislation governing urbanization in Egypt, and it remained in effect until the issuance of Law No. 51,52 of 1940 which is considered the first legislation issued as an Egyptian law dealing with the organization and governance of construction work in Egypt, its clauses dealt with the technical specifications and requirements for the building itself and its relationship to urban development. It defined regulation concerning obtaining building permit, technical aspects of the building like building heights, room spacing and firefighting systems [10].

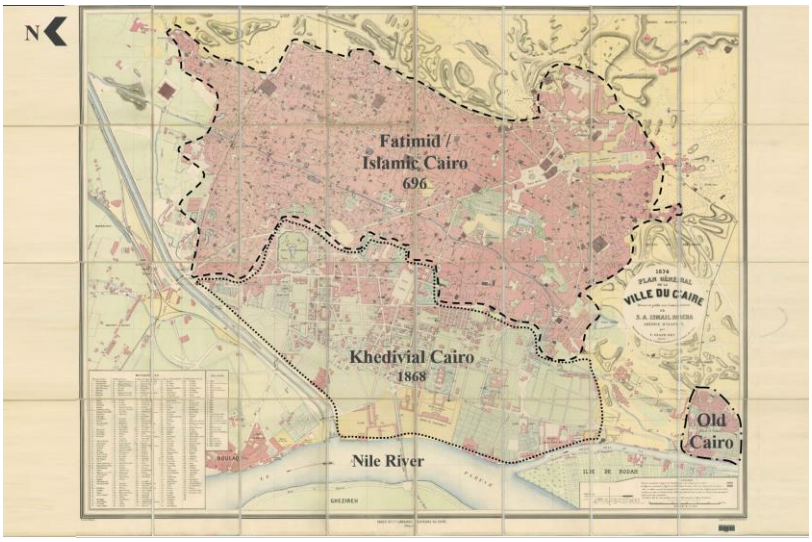

Fig. 3 : map shows the comparison between khedivial Cairo and old Cairo [8]

After 1952 revolution and declaration of the republic in 1953, the Egyptian government issued the new building law no. 656 of 1954 [11], provided that the time gap between Laws 52 of 1940 and 656 of 1954 wasn't a long period and the country did not witness any development or radical change in the economy or demographics , the law was considered a regulatory law that aims to identify the rule of state authorities, the law is therefore considered part of a package of laws aiming to transform the country's politics from monarchy to republic with the same technical specifications as per the pervious law until the issuance of the law no. 45 of 1962 which did not differ from its predecessor in technical matters or in the procedures for issuing licenses but it achieved a shift in its administrative and legal clauses which relied on decentralization of decisions, it gave the governors and the local public councils of the governorate the power and responsibility of organizational affairs in defining building zone , license requirements and publishing license which was the authority of the Minister of Municipal and Rural Affairs in the preceding law [12] , this law remained the state building law until the issuance of the law 106 of 1976 [13], which achieved a transformation in the building laws in comparison to the previous issues.

The law no. 106 of 1976 is considered more detailed version in technical, administrative and legal affairs than the previous law. The law attempted to govern construction in Egyptian cities and control the construction market which witnessed expansion in that period with the state's economic boom after the 1973 war and it's openness to private sector building and urban development projects in new cities, the law criminalized building on agricultural lands in addition to update the technical specifications of building space, lighting, ventilation, stairs…etc. to adapt with the socio-economic development of the country, six years later the law was accompanied by urban planning law no. 3 of 1982 which was the first urban planning law in Egypt [14] , through which the state decided to amend the legislation related to urban planning, the issuance of urban plans for cities and

villages through GOPP " General organization for Physical planning" and separating the building law from urban planning , through which the government proceeded in establishing a strategic plans for the city which define city region, urban extensions and master plan for each city defining building plot areas , city urban boundaries and land uses that help governorates and city councils to governance the building industry in the city without loading the infrastructure or reducing occupants needs of open spaces or green areas.

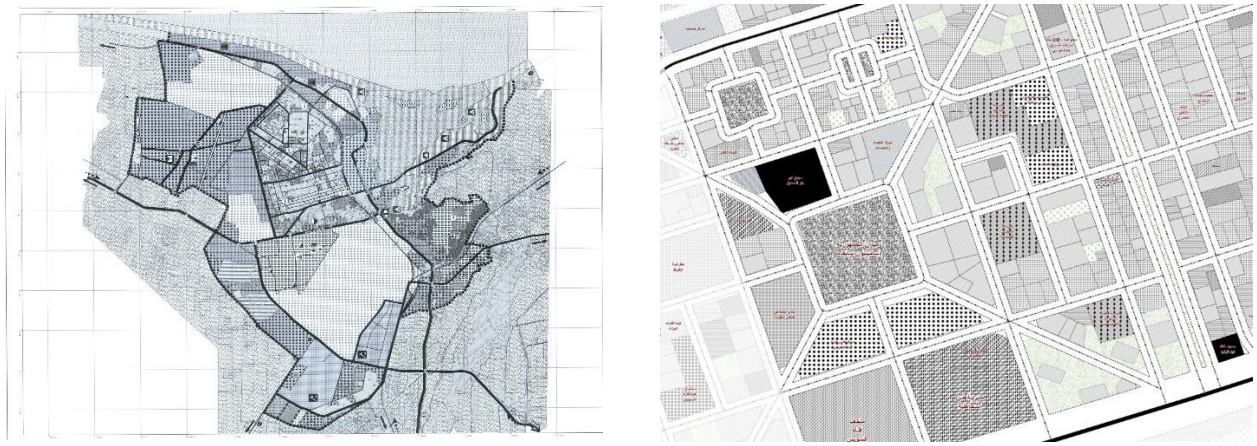

Fig. 4 :An example of strategic plan (Left) and master plan (Right) of Ismailia city (Ismailia Governorate)

The current building law no. 119 of 2008 was issued as an update to law No. 106 of 1976 and to urban planning law No. 3 of 1982 became the unified law for construction and planning in Egypt, The aim of this law was to unify the building industry in Egypt from urban planning, building and construction permits in governorates, new cities administrated New Urban Communities, regulations of National Organization for Urban Harmony and the buildings conversation committees under one umbrella. In terms of Building specifications, the law adhered to most of the technical aspects of the past Law no. 106 of 1976 and its executive regulations , but updated some requirements related to the building spaces like rooms, garages, courtyards to preserve needs of ventilation and natural lighting, besides adding some technical clauses to assure fire safety , accessibility and open spaces in the buildings ; In terms of legal clauses the law provided faster period of license issuance , required building commissioning before inhabitance and obligates establishment of owners building association to assure building maintenance after occupancy[15].

In 30th of April 2021, the Egyptian government issued a new building regulations that worked in parallel with The current building law no. 119 of 2008 and its executive register , the aim of this new regulations was "To control and govern the building process in Egyptian cities in accordance with the current laws and to regulate urban development in a legal framework and integrated digital system as part of the state's plan to digitize government transactions in order to reduce any corruption that may result from paper transactions , this regulations unified the building heights in the cities in relation to the street width , Built up area (BUA) don't exceed 70% of the plot area and the facade width should not be less than 8.5 meters in addition regulation the technical review of the building drawings required for permit issuance to the local university in each governorate as a third party to assure fair review. Due to long period of permit issuance and to complicated documents, the Egyptian government issued a repeal of the regulations and returned back to work solely in the building law no. 119 of 2008 and its executive register [16].

4. The development of the environmental clauses in the Egyptian Building Laws

With the development of the Egyptian building code through the stated versions, the state targeted governance the building industry and legalize its procedure to preserve the rights of the stakeholders' weather project owners and their relation with occupants or tenants in terms of providing a safely constructed, life safety and healthy building or with the government in terms of preservation of the built environment. Each building law from the stated laws in the previous section included different clauses that aims to execute the state vision in creating a sustainable built environment that targets governance of building sector in Egypt in a formal legal way (**Fig. 5**).

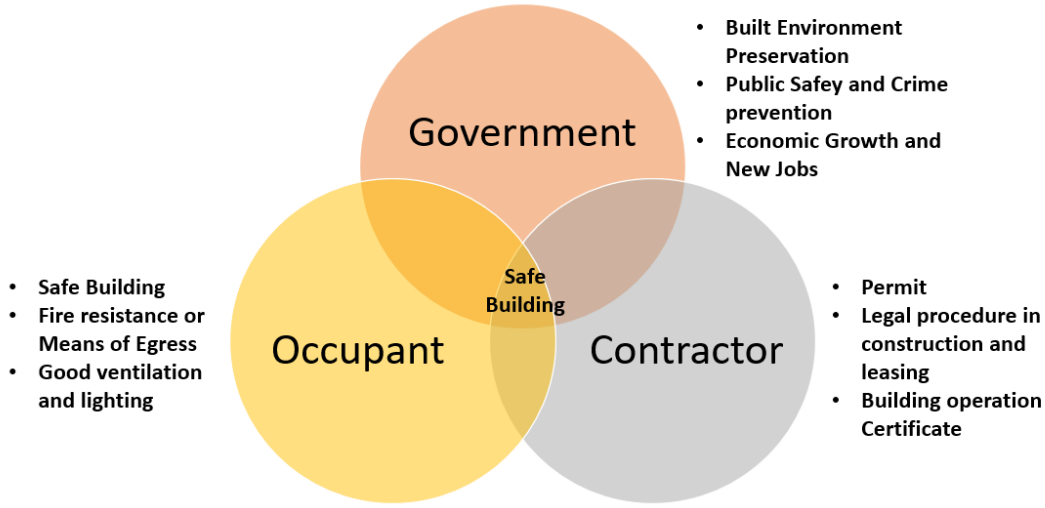

Fig. 5 : Stakeholders relation in building law

In terms of environment, the above-mentioned laws set a number environmental clauses targets creating a healthy building for occupants which preserves the occupants' rights in fresh air and natural lighting in addition to create an environmentally friendly surrounding-built environment; the updated versions of building laws mainly focused in two main concerns:

- The built environment: agricultural land protection, historic sites preservation, prohibition of building near natural preserved sites like marine areas or natural protectorates.
- Building occupants: providing the minimum requirements for the building occupants in terms of natural lighting, ventilation to achieve required thermal comfort and avert of sick building.

With reference to the total legislations issued, updated versions of the Egyptian building law took into account the inclusion of a number of clauses concerned with environment, starting from Law No. 51 of 1940 until Law No. 119 of 2008, by tracking this inclusion and its updates it mainly happened in order to treat a specific social or environmental problem that occurred in the past law, meanwhile each law included a number of clauses described as follows:

a) **Law No. 51 of 1940:** the law imposed and specified special requirements for the presence of courtyards, which weren't mentioned in any preceding legal, with the aim of obligating property owners to use natural lighting and ventilation inside residential units in the time Egyptian cities started an obvious urban development, mentioned below the environmental clauses [11] as per follows:

1) Clause no. 6: the law obligated that Built up area (BUA) set at 60% of the land area prepared for construction, which applies to date in the current law to maintain ventilation and lighting of all facades of the building and create response areas that can be exploited as green space in the property.

2) Clause no. 8: the law defined the area of internal courts to be 10 m^2 and the least side length to be 2.5 m for bathrooms, toilets and kitchens.
3) Clause no. 9: Obligate attached buildings to create joint courts with similar dimensions as per clause 8.

Analyzing the environmental clauses application in buildings during the time of the law, an example like "Ahmed Abdelkhalek Apartment building" in garden city area established in 1948 and designed by Architect sherif Noaman, the building applied the area required for internal courts in addition of applying the idea of joint court while provided the required ventilation to all building space as per (**Fig. 6**).

Fig. 6 : Ahmed Abdelkhalek Apartment building by sherif Noaman [17]

Another example studied was the "Immeuble de Emile Zidan" located in champlion Street, Downtown Cairo designed by Albert Zananiri in 1947; which applied the same specifications of the law as per pervious example (

Fig. 7 : Immeuble de Emile Zidan by Albert Zananiri [18]

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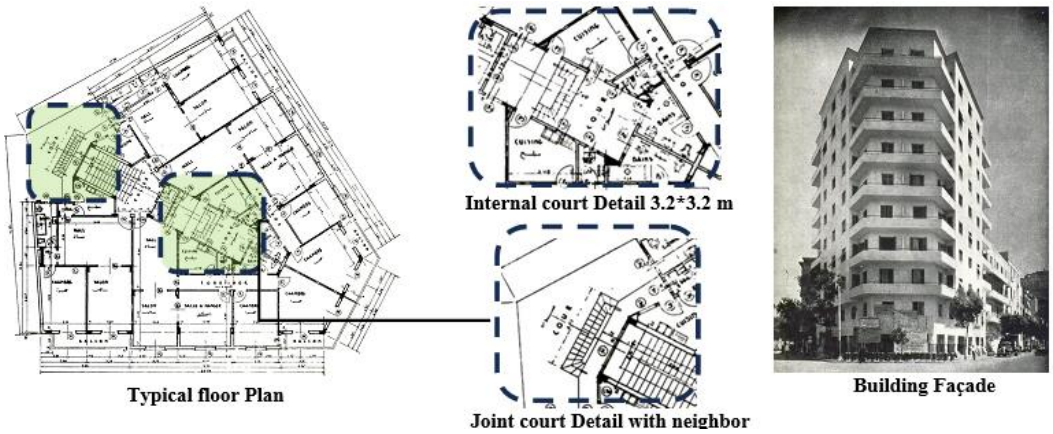

Fig. 7 : Immeuble de Emile Zidan by Albert Zananiri [18]

b) **<u>Law No. 656 of 1954:</u>** The law maintained the same Built-up area (BUA) and Courts specifications as per previous law in addition to adding some developments providing more privileges for occupants in terms of lighting and ventilation to all spaces as per follows:

1) Clause no. 22: the law introduced setbacks in buildings in order to provide natural ventilation to space that aren't exposed to façades or courts and set dimension width to be not less than ½ the setback length [12].
2) Clause no. 27: introduced the addition of garbage collection methods inside the property for properties with more than 20 residential units.

One of the main examples of during this period is "Zamalek tower " designed by Sayed Karim in 1956, the building applied law clauses besides it is considered an example of post 1952 revolution modernism that was a significant movement in this time, in terms of advanced environmental features the building introduced the fixed shadings as part of the southern façade to reduce solar heat gain as a part of preserving thermal comfort for occupants in south facades as per (**Fig. 8**).

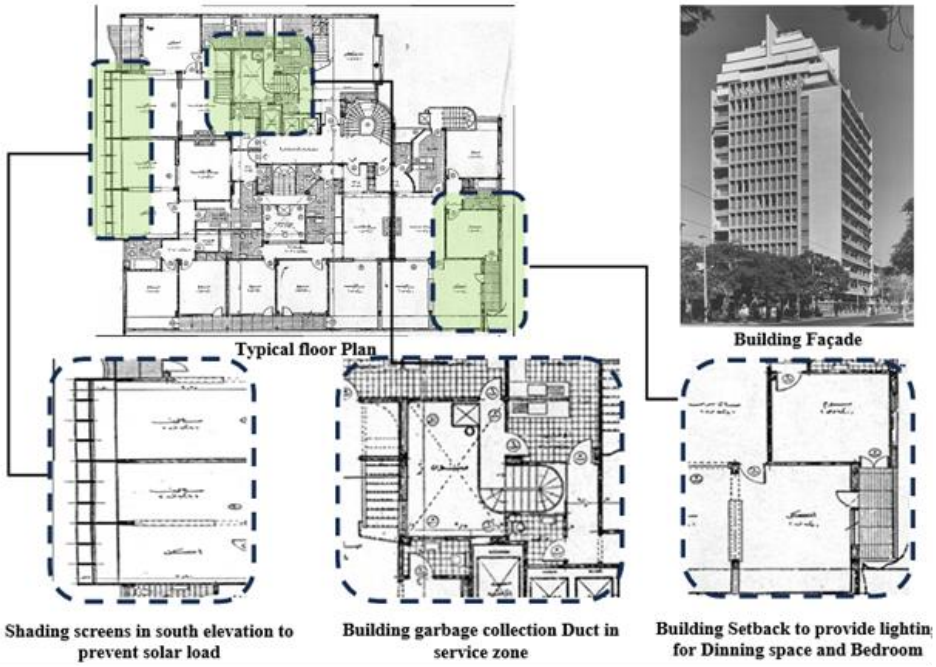

Fig. 8: Zamalek tower by Sayed Karim [19]

Another example is "Mohamed Sherif Noaman Apartment building" in Dokki, Giza designed by sherif Noaman in 1954; which applied the same environmental specifications of the law as per pervious example (***Fig. 9***).

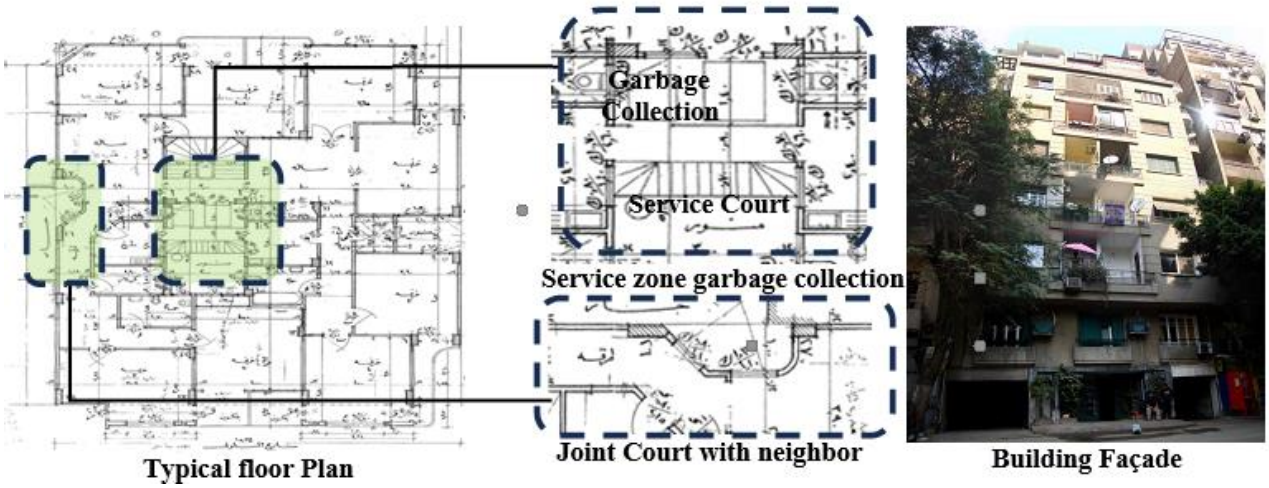

Fig. 9 : Laila Murad Apartment building by Sherif Noaman [17]

c) **<u>Law no. 45 of 1962:</u>** The law maintained the same environmental clauses as per the last law.

d) **<u>Law no.106 of 1976:</u>** the law updated the environmental clauses of the previous law and added other environmental clauses to the law as follows:

1) Clause no. 8: all buildings should provide waste bins fits with all dwellings.
2) Clause no.12: the law defined the windows opening size according to space dimensions which is equals to 8% of the space for rooms and offices and 10 % for bathrooms and kitchens.
3) Clause no. 13: maintained the court dimensions as per the previous law but added some updates for court space to be 12.5m2 in buildings higher than 20 m and less than 30 m and to increase by 2.5 m2 for every 10 m rise in building height [13].

An Example is the economic housing prototype designed by Tawfik Abdel Gawad in 1978, the building applied the required clauses mentioned above in addition to adding horizontal shading screens for southern façade windows for balconies in order to preserve thermal comfort and reduce solar load (***Fig. 10***).

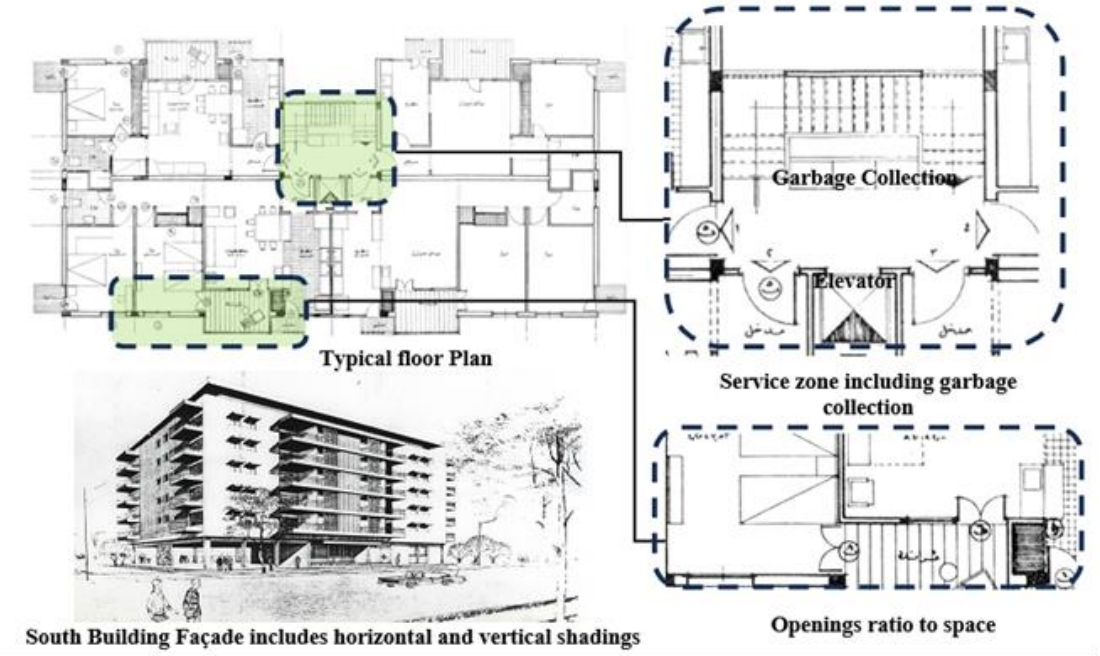

Fig. 10: Economic housing prototype by Tawfik Abdel Gawad [20]

e) **Law of Urban design no.3 of 1982:** the law targeted preserve environmental aspects by preventing building on agricultural lands and near irrigation infrastructure, besides committing building to the estate's specific city regions and urban extension zones in order to preserve agricultural lands and protected lands as per stated clauses:

1) Clause no. 2: building is prohibited in agriculture lands or any lands that lies out of the city urban borders besides no building license should be issued to plots that lies near irrigation infrastructure includes canals, lakes or open water.
2) Clause no. 13: for any new residential projects it is required to issue a master plan including ready building plots after the approval of the governorate and after revising the Built-up area (BUA) in relation to open spaces, allowed building heights and infrastructure conditions.
3) Clause 32: Building of industrial activities or manufacturing should be built industrial zones out of the urban area and prohibited inside cities [14].

The Egyptian state approach of integrating private sector in housing industries started in the 1980s in order to fulfill high housing demand in Egypt which expanded real estate developer's role from single residential buildings to establishment of cities and communities, one of the famous examples is Rehab city in new Cairo which was established in 1997 as one of the first gated communities in Egypt, the city was planned as a garden city with 60% as green areas surround all residential buildings [21] targeting improving quality of life and providing open public spaces for residence in addition to achieve thermal comfort , the city design maintained the law environmental clauses in terms of prohibiting industrial activities , preserving building heights to street width and infrastructure as per (**Fig. 11**) .

Fig. 11 : Al Rehab neighborhood pattern and design [21]

f) **<u>Unified Building no.119 of 2008:</u>** The law sets additional requirements for preserving the environment and exploiting natural resources that includes cultivation and provision of public gardens and parks in strategic plans, in addition prohibiting noise in public areas, prohibiting creating garbage dumps in building areas and establishing retaining walls or piles in places where beaches are eroded in coastal cities according to the law executive regulations [15] as follows:

1) Clause 2: updated the previous law and added that building in agricultural land can be exclusively permitted for activities related to agriculture or animal farming and should be authorized by the ministry of agriculture.
2) Clause 96: preserved the same opening for spaces as per previous law, but added that dimensions required for sky lighting which is similar to wall openings.
3) Clauses 108: the law obligated creation of parking spaces under the building or creation of required parking space above ground according to building type as per the Egyptian code for parking space. [15]

Parallel to the law issuance, Governmental and private sectors approached investments in housing sector whether in low, middle or high-income classes , it approaches decreasing the needs in affordable homes, one of the prominent examples of housing projects is Janna housing projects which was executed by the ministry of Housing and urban communities, the projects constructed in satellite cities in terms of the state approach in expansion out of the dense urban cities , the apartment building applied the required clauses mentioned above from forbidding building in agricultural lands ,Lighting and ventilations openings requirements , Built up area (BUA) in addition to parking spaces without any environmental add-ons that targets green solutions (**Fig. 12**).

Fig. 12: Jannah new Cairo project [22]

Another example of housing projects that were constructed in Egypt after the issuance of the Current Law is "Madinaty city" in new Cairo, which is considered as a finest example of full cooperation of private sector in planning constructing and operation of a city scale, with an area approximately equals to 8000 Feddans and includes 120k housing units [23] , the city 1st phase of the residential zones was constructed in 2010 including apartment buildings and villas , the apartment building applied the required clauses mentioned in the law , with respect to provide additional features in the project that provide environmental features including green areas and parks all over the community increasing air quality and reduce heat island effects in addition to adding some features including grey water treatments for irrigation of landscape areas besides providing a solid waste management system including underground big trash bins and a small entry trash bins placed at entrances and categorized as organics, plastics, and metals according to color.

Fig. 13 : Madinaty apartment buildings prototype with an example of garbage collection method [23]

5. Analysis of environmental clauses effect in the buildings in Egypt

By analyzing the environmentally related clauses addressed in the above-mentioned building laws since the beginning of legalizing the building industry in Egypt, the law updates passed by environmental changes such as setting specified spaces for openings and courtyards aiming to introduce lighting and natural ventilation to the residents of the property or prohibiting building in the Agricultural areas to preserve the Eco-system, all of these amendments and additions to the law aimed at solving a problem that is appeared due to socio-economic changes within the period of the law or to preserve occupants quality of life versus the increase of population within the dense cities as mentioned in **Table 1**.

Table 1: Technical Comparison between clauses update by each law

<table>
<tr><th rowspan="2">Law No.</th><th rowspan="2">Year</th><th colspan="6">Law Clauses</th></tr>
<tr><th>Site Selection</th><th>Built up area (BUA)</th><th>Openings</th><th>Courts and setbacks</th><th>Garbage Collection</th><th>Parking Area</th></tr>
<tr><td>51</td><td>1940</td><td>-</td><td rowspan="4">Built up area (BUA) set at 60%</td><td>-</td><td>Internal courts = 10 m2 and the least side length = 2.5 m</td><td>-</td><td>-</td></tr>
<tr><td>656</td><td>1954</td><td>-</td><td>-</td><td rowspan="5">Obligate attached buildings to create joint courts with similar dimensions Introduced setbacks in buildings in order to provide natural ventilation</td><td rowspan="5">addition of garbage collection methods inside the property</td><td>-</td></tr>
<tr><td>45</td><td>1962</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>106</td><td>1976</td><td rowspan="3">Prohibited building in agriculture lands and areas near irrigation infrastructure</td><td rowspan="3">Windows size dimensions = 8% of rooms and offices space dimensions and = 10 % for bathrooms and kitchens</td><td>-</td></tr>
<tr><td>3</td><td>1982</td><td>-</td></tr>
<tr><td>119</td><td>2008</td><td>According to City strategic and master plan uses</td><td>The law obligated creation of parking spaces as per the Egyptian code for parking space</td></tr>
</table>

According ***Table 1*** , Egyptian building laws have progressively evolved to address environmental concerns that target basic needs. The Law no. 51 of 1940 law set foundational limits on built-up areas and internal court sizes to regulate natural lighting and ventilation. While law no. 656 of 1954, regulations introduced mandatory joint courts, building setbacks for ventilation and lighting only besides adding on-site garbage collection system due to increase in waste disposals. Later, the law no. 106 of 1976 law marked a significant shift by prohibiting construction on agricultural land and near water bodies as a concern of preserving agricultural lands, while also standardizing window sizes to ensure adequate natural lighting and ventilation which is considered the base of environmental clauses in the law; The law no. 3 of 1982 and unified building law 119 of 2008 aligned construction with urban master plans and introduced mandatory parking requirements based on building type, reflecting a growing emphasis on reduce the automotives carbon foot print. Previous studies analyzed the environmental impacts of building Egyptian building law, a study [24] focused in the unified building law applications in residential buildings part of the law that don't account for prevailing climatic conditions and fail to differentiate between hot-arid and hot-humid climates which results an urban fabric that is incompatible with the surrounding environmental context, other study [25] concluded that there has been a growing and urgent need to redefine the concepts of energy consumption and conservation, particularly in the residential

building sector which needs to merge green building codes concept in the building law as a part of creating sustainable built environment.

6. A study of environmental clauses in International Building laws

a) The United States: International Building Code (IBC):

A comprehensive set of regulations developed by the International Code Council (ICC) considered as the main building Law in the United States, the environmental section is based on Chapter 13 targeting achieving Zero Energy building by ensuring that buildings are designed and constructed to promote efficient energy utilization clauses listed in the IECC (International Energy Conservation Code) which act as the executive environmental regulation of the law [11].The Section clauses targets achieving the triple bottom lines of sustainability by creating energy efficient – environmental friendly buildings , the clauses applications are set in setting a minimum specific attributes for Building Envelope, Mechanical Ventilation Systems , Lighting Systems,. Service Water Heating that each building should meet in order to reach the required target of energy performance, most of the U.S. states regions adopt the IBC with adding states amendments that are based on state characteristics and culture meanwhile compliance with the IBC becomes mandatory for issuing a building permit and receiving a certificate of occupancy making achieving the Code clauses in terms of energy efficiency is considered obligatory [26].

An example of the code application is “The Link Evanston: Mid-Rise Residential Building” in Chicago, IL which meets IBC requirements in terms in energy conservation, consisting of 6 floors with Built up area (BUA) 26,000 m^2 designed with a ground floor retail and 242 residential apartments; the building achieved the required environmental clauses of the IBC 2021 in terms of Energy Efficiency that complies with IECC 2021 (referenced by IBC Chapter 13) [25] as follows:

1) Building envelope: Windows are double-glazed with low-E coated film in addition to thermally insulated metal panels as per (***Fig. 14***) that reduce thermal heat transfer.

Fig. 14 : The Link Evanston residential building envelope [27]

2) Mechanical Ventilation Systems: based on state of Illinois adaptation of IECC 2021 model R405 that obligates building energy modeling before permit submittal to calculate building energy, HVAC efficiency reaches 45 % compared to similar building consumption meanwhile programmable thermostats installed to facilitate residents to manage energy use effectively and Demand-controlled ventilation (DCV) to reduce un necessary spaces energy leakage.
3) Lighting Systems: Daylight-responsive lighting controls are installed to preserve artificial lighting consumption.

4) Energy Management: Building energy tracking by Smart submeters in which every unit where residents could monitor consumption meanwhile main building automation systems (BAS) applied Monitoring energy performance, finally the obligation of ENERGY STAR appliances in units as certified low energy appliance.

b) Germany: Baugesetzbuch (BauGB) – Federal Building Code:

The main building law of the Federal Republic of Germany and legal framework of construction in Germany, developed by Federal Ministry for Transport, Construction and Housing , the law includes two Divisions : Bauordnung (BO) which includes the executive regulations of each state in terms of construction safety, means of egress…etc. and GEG (Gebäudeenergiegesetz) – Building Energy Act 2020 which regulates sustainability and energy efficiency in buildings ; the law and its subsidies fulfillment is required to obtain building permit and certificate of occupancy [28].

GEG is includes a number of clauses that target achieving sustainable building in Germany in terms of energy efficiency, heating, cooling, use of renewable energy use in new and existing buildings, this clauses set minimum standards that each building should achieve and measured via building energy model where the building achieve the Energy Performance Certificates (Energieausweis) which defines the percentage of energy efficiency ranging from A+ to H the building achieved and it is required for any future actions in the building like selling , leasing or future renovation and all perspective buildings in Germany should obtain Energieausweis.

“PlusEnergy Quarter P18” in Stuttgart-Bad Cannstatt an example of a housing project that complies with GEG, constructed in 2023 as a complex of six mid-rise residential buildings with Built up area (BUA) 24,478 m^2 and total of 330 residential units; the building achieved ranking of KfW Efficiency House 40+ standard reducing primary energy demand 60% lower than the reference building defined by the GEG [29] as follows:

1) Building envelope: the solid façade envelope is built of Prefabricated timber modules including underneath layer of rockwool thermal insulation that provides thermal load reduction meanwhile the windows glass specifications is a Triple-glazed windows with low U-value enhancing thermal efficiency (***Fig. 15***).
2) Mechanical Ventilation Systems: based on heat recovery system that ensures optimal indoor air quality in addition to heat water systems that is integrated with automated heat pumps and powered by renewable energy sources to reduce demand on energy.
3) Lighting Systems: lighting system preserve 60% of energy consumption compared to Similar GEG base cases, daylight harvesting sensors that adjust artificial light levels in units with smart home systems that track lighting energy use and provide feedback to residents.
4) Renewable energy: the building installed Photovoltaic-Thermal (PVT) Collectors used for electricity and hot water heating besides the reuse of heat pump systems exhaust air as a source of thermal energy used in building heating.

Fig. 15 : PlusEnergy Quarter P18 [29]

7. Analysis of environmental clauses in terms of UN SDGs

The UN Sustainable Development Goals (SDGs) are a set of 17 global goals adopted by all UN Member States in 2015 as part of the 2030 Agenda for Sustainable Development , The UN "SDG goal no. 11: Sustainable Cities and Communities" is the goal focusing Sustainable built environment and approaches "Make Cities and human settlements inclusive, safe, resilient and sustainable" which addresses the challenges of urbanization aiming to ensure that cities offer opportunities for all while improving sustainability and quality of life, the goal is divided into 10 targets according to (**Fig. 16**) [30]:

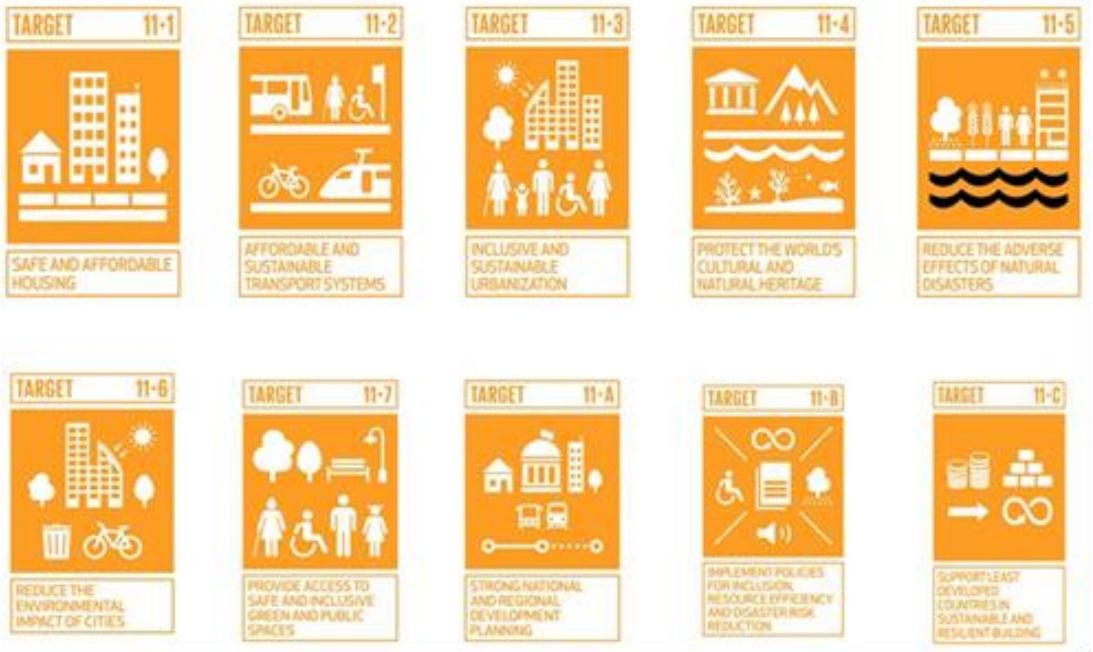

Fig. 16 : Key targets for SDG 11 [28]

As mentioned above, SDG goal no. 11 includes six targets that focus on green buildings as follows:

- Target 11.1: Assure Safe, affordable housing and Ensure access for all adequate basic services.
- Target 11.3: Enhance inclusive and sustainable urbanization including net zero energy buildings and urban infrastructure
- Target 11.6: Reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
- Target 11.7: Access to green public spaces
- Target 11.b: Implementing integrated policies and plans towards inclusion, resilience, and resource efficiency.
- Target 11.c: Support least developed countries in building sustainable and resilient buildings using local materials.

The stated SDGs is considered a mandatory target for world nations that works under the umbrella of the United Nations 2030 agenda, since Egypt has demonstrated a strong commitment to work parallel to the agenda by planning a national Vision for 2030 that integrates the SDGs into its framework and ensures that national development plans are working in harmony with global objectives including the building and construction sector which require to evaluate if its national Building law cope with the SDGs targets mentioned above, the process of sustaining the building sector requires to review if the Building law clauses and its updates are coping with the agenda , as per (**Table 2**).

Table 2: Environmental Clauses in Egyptian laws achievement of SDG 11 targets

	SDG goals	Law No. 51 of 1940	Law No. 656 of 1954	Law no.106 of 1976	Law of Urban design no.3 of 1982	Unified building Law 2008
1	Target 11.1	Clause 6		Clause 12,18	Clause 2	Clause 2
2	Target 11.3					
3	Target 11.6	Clause 8,9	Clause 22,27	Clause 8	Clause 32	Clauses 96, 108
4	Target 11.7				Clause 13	
5	Target 11. b					
6	Target 11.c					

According to **Table 2** , The environmental clauses in the Egyptian building laws didn't fully cope with the SDG goals no. 11 targets except with Target 11.1 and 11.6 which focused on Assure Safe, affordable housing adequate basic services like electricity and fresh water and reduce the adverse per capita environmental impact by encouraging better air quality and waste management in building meanwhile other targets 4 targets weren't planned to be included in the Law , meanwhile by comparing the latest edition of the law "Egyptian Unified building Law 2008" to the international examples mentioned above with similar targets as per (**Table 3**).

According to **Table 3**, which compares the Egyptian Unified building Law 2008 (Current building law) to the United States IBC and its subsidy ICCC and Germany Baugesetzbuch (BauGB) – Federal Building Code , the table reviews that the Egyptian law in comparison to international building regulations have various degrees of alignment with the Sustainable Development Goal 11 targets meanwhile the German code offer the most comprehensive integration of sustainability principles, including energy efficiency, renewable energy, environmental protection, and public space planning. The U.S. IBC demonstrate strong enforcement of achieving zero energy performance. In contrast, Egypt's Unified Building Law (2008) shows limited alignment with SDG 11 targets, in addition to emphasizing in the mentioned 3 environmental clauses in the law nearly show no technical specific targets to be achieved or specified numerical rates in comparison to the two other laws.

Table 3: Egyptian unified building law and international examples achievement of SDG 11 targets

<table>
<tr><th colspan="2" rowspan="2"></th><th rowspan="2">Egypt Unified building Law 2008</th><th colspan="2">United States
IBC and ICCC</th><th colspan="2">Germany
Baugesetzbuch (BauGB) – Federal Building Code</th></tr>
<tr><th>Residential Section (R-1)</th><th>Commercial Section (C-1)</th><th>Residential Section</th><th>Non -Residential Section</th></tr>
<tr><td>1</td><td>Target 11.1</td><td>Clause 2</td><td colspan="2">1) 1206 Sound Transmission
2) 1208.4 Efficiency dwelling units
3) R404 (Service Water Heating) | 3) C404 (Service Water Heating)</td><td colspan="2">1) Section §62: Water Heaters Without Heat Exchangers
2) Section §66: Humidity Control</td></tr>
<tr><td>2</td><td>Target 11.3</td><td></td><td>1) R402 (Building Envelope Specs.)
2) R403 (Building Mechanical systems)</td><td>1) C402 (Building Envelope Specs.)
2) C403 (Building Mechanical systems)</td><td>1) Section §10 - §16: Principle and Nearly Zero-Energy Buildings
2) Section §20: Calculation of Annual Primary Energy Demand</td><td>1) Section §21: Calculation of Annual Primary Energy Demand
2) Section §23: Renewable Energy generation
3) Section §28: Credit for Mechanical Ventilation Systems</td></tr>
<tr><td></td><td></td><td></td><td colspan="2"></td><td colspan="2">4) Section §65: Limiting electrical Power</td></tr>
</table>

3	Target 11.6	Clauses 96, 108	1) 506-4 (Open space access) 2) 506-6 & 1205 Open Yards & Courts 3) 510.3 to 510.8 Parking Areas 4) 1204.2 Natural lighting in buildings 5) R303	5) C303	1) Section 1a: Consideration for Environmental Concerns 2) Section 32: Use Restrictions on Spaces for Future Community Use, for Transport, Infrastructure and Green Spaces.
4	Target 11.7				1) Section 32: Use Restrictions on Spaces for Future Community Use, for Transport, Infrastructure and Green Spaces.
5	Target 11. b		1) R405 (Electrical Power and Lighting Systems) 2) R406 (Energy Rating Index Compliance Alternative)	1) C405 (Electrical Power and Lighting Systems)	1) Section §89 Funding Programs 2) §71a Building Automation
6	Target 11.c				

8. Conclusions

This study highlights the progressive evolution of environmental clauses in Egyptian building laws from 1940 to the present Unified Building Law No. 119 of 2008 , while each Law update introduced incremental improvement—particularly in ventilation, lighting, waste management, and preservation of land use it did not consider the critical dimensions of sustainability like energy consumption , water use or Renewable energy integration , meanwhile all law updates were largely a response and lacked a comprehensive strategy for sustainable development which occurred as a contemporary solution for a rising social, environmental or economic problem the society or to fix an earlier version problem . Comparative analysis with international Legalizations, such as the U.S. IBC and Germany's BauGB, revealed significant gaps in Egypt's current legal framework, especially in terms of achieving a sustainable or green building environment that copes with the country sustainable development vision that is committed to the UN Sustainable Development Goals especially (SDG 11). Research findings suggest that current law fall short in fully addressing SDG 11- six targets, particularly those related to resilient infrastructure, inclusive urban planning, access to green public spaces, implementing integrated policies and plans towards inclusion, resilience, and resource efficiency. Future amendments to Egyptian building law should incorporate explicit environmental performance indicators, enforce mandatory sustainability assessments, and establish incentive-based mechanisms to foster innovation, energy efficiency, and healthy building environments in alignment with Egypt's commitment to the UN Sustainable Development Goals.

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