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Application of BIM/GIS-based Integrated Models on the Historic Urban Districts of Rosetta City, Egypt

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ABSTRACT

Integrated applications of BIM and GIS technologies have recently become essential in the smart city concept and urban development phases. They offer a digital representation for both architectural and urban scale to produce efficient governance model and sustain the quality of life and urban dynamics in cities. The vitality of historic urban districts has a great influence on sustainable urban development and urban regeneration approaches in cities. Egypt is rich with historic locations of which many are under threat from poor urban management and inadequate identity preservation especially in the Delta Region. The research aims to apply GIS digital tools and BIM models to the urban heritage context in Egypt to produce 3D integrated model for documentation, visualization and data analysis of the historic district in Rosetta City. The methodology process includes field survey, digital mapping and BIM models integration in GIS platforms using City Engine software. The process is discussed in terms of the accuracy of BIM-GIS data especially in Egypt, technical issues related to integration process and related urban policies in historic districts that could be supported by generated models. Digital maps are published using Google Maps and City Engine Web Scene online platforms.

INTRODUCTION

The redevelopment of historic urban districts is essential to enrich and sustain urban, social, and economic aspects. Several cities from around the world have decided to develop renewal plans for their historic districts and centers to sustain their urban patterns, architectural and urban character, and economic and social values especially for European cities after WWII (Boodaghi, et al., 2022). In Egypt, many historic cities especially in Delta region are neglected facing lack of care of the historic built environments, pollution, fast urbanization and urban sprawl (Ragheb, et al., 2022). Economic development, social justice, culture, environment, and urban development are some of the ten pillars of the sustainable development strategy (SDS) of Egypt Vision 2030 whose indicators are integrated with the development of historic sites in Egypt. The sustainable development of historic cities supports the strategic objectives of these pillars such as protecting and maintaining cultural heritage, raising internal and external awareness, improving the tourism potential, and enhancing social inclusion for better standards of living for all citizens (SDS, 2020). It is hypothesized that Egypt Vision 2030 can be achieved more efficiently using smart and digital applications through monitoring and analysis of the key performance indicators for each pillar and supporting decision making.

As cities get smarter, they are becoming more livable, responsive, and resilient. The ideas of e-information, e-government, e-participation, and e-collaboration are developed and integrated with urban planning processes (Palacin, et al., 2021) (Akmentina, 2022). In the contemporary planning process, city developments are produced in digital methods and forms e.g., geographic information systems (GIS) data and CAD models. One of the main problems is the availability of data and level of Details and Accuracy regarding GIS database related to Egyptian cities. The collection of data on existing buildings or a certain urban area is quite challenging due to the lack of connections between databases of different Governmental institutions as they create their own data for specific purposes independently.

The collection and structuring of data using GIS platforms and smart technologies is very essential to support efficient governance model and to sustain the quality of life and urban dynamics in cities. The modelling of urban information from single models of buildings to city wide, is the core of many smart city application (Pasquinelli et al., 2016). Different terms and expressions can be found in related literature to this type of 3D urban models such as urban informational model, digital city, intelligent city, city information model, 3d GIS city model, smart 3D city, procedural city modeling, etc. (Stavric et al., 2012). The term City information modelling (CIM) or urban information modelling became widely used starting in the mid-2000s, inspired by Building Information Modeling and its benefits and potential for the construction industry. CIM is described as a cross-disciplinary, comprehensive approach to the creation and

visualization of integrated spatial data models with semantic data and elements which are used to manage and mediate the demand for land, property, and environmental resources (Thompson, et al., 2016).
The research aims to use 3D integrated GIS-BIM models in urban heritage context in Egypt, determine the ability to visualize a realistic description for documentation, monitoring, analysis and evaluation and assist the urban heritage management through 2 main research questions: (1) how to develop 3D GIS urban models, a BIM/GIS integration application to assess and create a comprehensive description and analysis for current urban data of historic cities in Egypt, and its feasibility to support decision-making for sustainable development and urban management. (2) What are the obstacles and limitations of the application process in the Egyptian historic urban context?
The research defines computational-based urban approaches and tools which support the research methodology, case study analysis and 3d GIS modeling process. Rosetta city, one of the most important historic cities in Egypt, is selected as a case study for its unique urban and architectural features. The final results of the study are discussed to achieve the following objectives:

1. Developing and updating required GIS Data for 3D visualization for the historic district and data analysis
2. Digital Documentation of heritage buildings and creating a 3D GIS virtual model for the whole historic district of Rosetta city
3. Integrating BIM model for a selected historic building within GIS platform.
4. Investigating the potential of applying CIM methodology on the urban development process of the historic urban districts.

COMPUTATIONAL-BASED URBAN TOOLS

It is necessary to understand urban systems to achieve sustainable development goals for cities. Accurate 3D urban models become obviously an important tool that supports the urban knowledge of urban systems and processes to ensure and evaluate its performance towards sustainable urban development. Urban knowledge refers to information that is specific to urban areas. It deals with the formalization of information about physical and non-physical urban objects, their properties, and the relationships between them. Knowledge about the urban environment supports the content and the aim of GIS urban models. These models help us to estimate and analyze quantities to understand urban systems and their processes. Urban model is a representation of a city or area in the real world. Each element in the model represents a specific feature of the city or area, and the model as a whole represents a part of the world where cities and areas are located (Billen, et al, 2014). It offers a flexible interactive system for providing the best visual interpretation, planning and decision-making process. The built model becomes one of the most efficient technologies for spatial data management and analysis. Integration of GIS spatial data with local authorities helps to improve quality, productivity and asset management. BIM (Building Information Modelling), GIS (Geographic Information System), and CIM (City Information Modelling) can partly support urban development process and sustain urban heritage.

Building Information Modeling (BIM)

Building Information Modeling (BIM) is a multidisciplinary technology integrating 3D visual model of a building, its components and systems within its site, and geographical information data through a range of computer software. It controls the management of project different phases from the main concept to its implementation, maintenance, and future development. It also offers detailed construction and coordination plans and documentation, construction sequences, cost estimation and building assessment such as energy consumption (Alashi, & Koramaz, 2019). BIM applications are originally developed for sharing and management of information throughout the lifecycle of a building process. Nowadays urban management requires the integration and collaboration of building elements and datasets containing geometric and semantic information on building components and structure (Galego, 2014).

Many research approaches test the ability of involving a 3D BIM model for a Historic building into a 3D GIS environment for further management and analysis. The concept of Historic Building Information Modelling (HBIM) is introduced as a process to model historic structure through mapping using laser scanning or photogrammetric survey data with the support of CAD programs such as Civil 3D, SketchUp, Autodesk Revit, Navisworks (Stefano, et al., 2019) (Carvajal-Ramírez, et al., 2019) (Bruno, et al., 2018) (Dore, & Murphy, 2012) (Di Stephen, et al., 2011). The study uses all available plans, facades and sections documented for a historic building with on -site survey and detailed measurement to create CAD model using Revit software as another process for modelling.

Geographic Information Systems (GIS)

Geographic information systems (GIS) is a technology designed to capture, store, analyze and map all types of data in relation with its location. It helps to check and solve problems through providing several ways to examine and making decisions among alternative solutions. It becomes more automated, social and more dynamic and interactive by integrating with worldwide web. It allows more easily to analyze different patterns and relationships. It integrates all needed information that helps to understand and discover solutions to problems. This information database related to real-world features is dynamically linked to an on-screen map that shows different output graphic options include cartographic-quality maps as well as reports, lists, and graphs for a certain area. The map is updated to reflect changes made to the GIS database. GIS has various applications in the urban planning process at different scales and planning stages such as objective determination, resource inventory, situation analysis, modelling and projection, development of planning options, selection of planning options, plan implementation, and evaluation, monitoring, and feedback (Ross, 2011).

3D GIS is an essential way of handling the spatial data in urban planning. Three-dimensional modeling is a realistic simulation of reality visualizing a realistic description for current urban context, improving urban development scenarios, evaluating urban environment and could support public participation. These models help researchers and practitioners to investigate important issues while constantly testing the simulated environment in response to its problems. They offer dynamic modeling and interchangeable feedback to evaluate how a particular scenario works in response to different parameters or updated zoning regulations (Janjira, Mishima, & Srinurak, 2022).

BIM-GIS Integrated models

The data from both GIS environment and BIM model can be integrated to help manage planning information in a coordinated way. This leads to develop the concepts of GIS and BIM into City Information Modelling (CIM) which is characterized by a multidisciplinary union of all the spatial data of the model (Grimaldi, et al., 2022). Generally Current researches on integrated application of BIM and GIS is classified into two types which are: (1) concentrating on application in certain fields for certain phases and (2) proposing a comprehensive management model for the whole lifecycle (Ma & Ren, 2017). The study goes with the first type as it focusses on the digital documentation of historic buildings and application of BIM-GIS integration for a selected Egyptian historic urban district to visualize its current urban context.

There are three modes for BIM-GIS integration as shown in Table 1. The study depends on mode 2 which is GIS leads and BIM supports. In this mode the methodology focuses on GIS-information-based methods and GIS mapping aims to study the effect of construction projects on the surrounding areas and detect the influence areas of construction projects (Wanga, et al., 2019).

Table 1- Modes of BIM-GIS integration.

Modes	Advantages	Disadvantages
Mode 1: BIM leads and GIS supports	Building project and its internal information are mainly expressed	Difficulty of integrating information from other buildings or the surrounding environment.
Mode 2: GIS leads and BIM supports	Excellent spatial data processing capabilities	low detailed attribute information of building features
Mode 3: BIM and GIS equally involved	Good information processing capabilities for both the building and the surrounding urban context	Excess data increases computer processing loads

Source: Wanga, et al. (2019).

Table 2 shows the difference between the concept of level of development in BIM and level of details in GIS. Level of Development in BIM is proposed by the American Institute of Architects (AIA) to standardize the accuracy of BIM models at each stage of a building's life cycle (Wanga H. et al., 2019). While level of Details in GIS defines the analysis and visualization of objects with different degrees of resolution according to different application requirements (Biljecki, 2017).

Table 2- Difference between the concept of LoD in BIM and GIS.

LoD in BIM; Level of Development		LoD in GIS; Level of Details	
LoD100	Conceptual design, Symbolic information of the entire building such as building height, area, and volume.	LoD0	Regional and landscape applications; Digital Elevation Model (DEM) + Digital Orthophoto Map (DOM).
LoD200	Preliminary design, Approximate information of generic systems, objects, or assemblies.	LoD1	City and region coverage applications; representation of blocks model comprising prismatic buildings with flat roof structures.
LoD300	Detailed design, Detailed information of specific systems, objects, or assemblies.	LoD2	City districts and projects applications; defining roof structures and thematically differentiated boundary surfaces.
LoD400	Construction design, Detailed information of specific systems, objects, or assemblies with complete fabrication, assembly and installation information.	LoD3	Landmarks and Historic applications; Architectural models with detailed wall and roof structures potentially including doors and windows.
LoD500	As-built design, A field verified representation with information of constructed assemblies.	LoD4	Building interior representation scale applications; adding interior structures for buildings. buildings may be composed of rooms, interior doors, stairs, and furniture.

Source: Wanga, et al. (2019) and Biljecki (2017)

It becomes very difficult and challenging when higher LoD is needed in both of BIM and GIS integrated models. LoD in the integration of BIM and GIS may differ according to the purpose of the project.

City Information Modelling (CIM)

City Information Modelling (CIM) is generated as a result of BIM and GIS integration (Roumyeh, et al., 2022). It is considered as a BIM analogy on the urban scale and 3D expansion for GIS tools (Stojanovski, 2013). It concerns with digital urban information integrating different levels of urban networks such as urban forms, infrastructure, mobility, urban governance, and human activity which assist in planning and the analysis of a city. It has opened the possibility of linking layers of data to three dimensional models and creating excellent visualization of data. It supports urban design and planning as it could describe, visualize, analyze, and monitor the current urban environment and development scenarios applied to it (Mundula, et al, 2019). CIM assists decision makers and planners in management and decision making processes and enhances community participation by making the different urban environment layers and data more analyzed, transparent, and effective. CIM can integrate and link information and different data sets provided by BIM. It became very essential to integrate CIM and GIS platforms which represents the spatial characteristics and layers of data related to urban scale with BIM technology which represents the amount of building information which affected by physical, environmental, social, and economic aspects of the surrounding urban context.

METHODOLOGY

The research depends on mixed methods to achieve the objectives. The methodology uses descriptive and analytical approached to monitor the current situation of the historic district and the documentation of historic buildings through data analysis, study visits, interviews, and surveys. Different digital tools and programs are used such as google my maps, google earth, and GIS platforms such as ArcMap, Arc Scene and Esri City Engine as 3D city platform to support digital documentation and transforming 2D spatial into 3D GIS model. The methodology could be summarized through the following steps:

1. Preparing base maps and survey groups.
2. Heritage buildings and sites documentation using digital tools.
3. Upgrading and improve exist GIS Data for the historic district of Rosetta City, attribute tables and building features for current situation using ArcGIS.

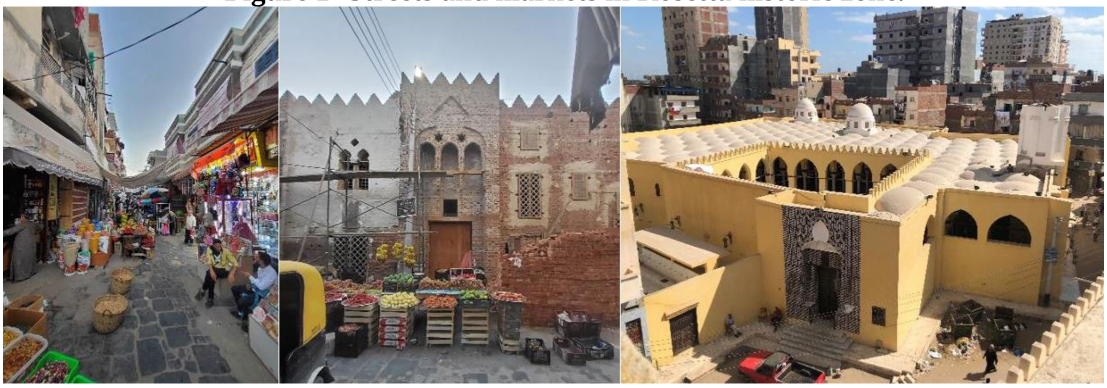
4. 3D GIS modeling using Arc Scene to compare current situation with governmental data (LoD01) and to analyze the effect of the built environment on the heritage site.
5. Developing 3d GIS model for the historic region using CGA rules in City Engine.
6. Building a BIM model using Autodesk Revit for a selected historic building using available documented drawings and on-site measurements.
7. Importing BIM model into City Engine environment.
8. Defining visualization options and 3D GIS digital documentation for urban heritage

Esri City Engine is an application created by ETH Zürich mainly used for transforming 2D geospatial data into smart 3D city models. It depends on the use of procedural modelling rules to generate 3D environments. The procedural modelling core is driven by Computer-generated Architecture (CGA) rules to automatically generate detailed 3D buildings, texture, and street geometries. 3D models and design alternatives can be processed in City Engine and loaded back into ArcGIS for further analysis or exported to simulation engines and Web-based platforms. BIM models could be integrated with City Engine workflow. The capabilities of the City Engine include the procedural construction of street networks, importing street networks, scripting of 3D buildings, parametric modelling of 3D buildings and 3D streets, map-controlled city modelling and batch export of 3D models (Stavric, et al., 2012).

CASE STUDY

Rosetta is the second city after Cairo in terms of the quantity of its Islamic houses dating back to the Ottoman era during the 18th and 19th centuries. The number of heritage buildings has decreased from 52 in 1963 to 37 at present (UNESCO, 2003) (UN-HABITAT, 2006) due to the impact of the city's proximity to the Mediterranean sea and Nile river, natural conditions such as heavy rains in winter, and the effect of ground water on buildings' foundation and the delay of maintenance and restoration work. The city's most famous piece of heritage is the "Rosetta stone" which led to understanding of hieroglyphs. The fortress of Qaitbay on the west bank of the Nile River, north of Rosetta, the place is directly connected to the Rosetta stone, which was discovered in this location during the French expedition in 1799. Many details about Rosetta's earliest history are uncertain due to a lack of reliable sources. Remains of ancient settlements have been found all over the region and on Tall Abu Mandur. The city has numerous informal peddlers and markets in the streets which lead to traffic jams and the accumulation of garbage as shown in Fig. 1 and 2. The historic area is provided with all basic urban services except a sanitation network. The lack of sanitation has led to an increase of the groundwater level, which directly affects historic buildings. It suffers from pollution caused by heavy vehicles; the vibrations also affect the structure of the historic buildings in the city.

Figure 1- Streets and markets in Rosetta historic zone.



Source: Authors.

Figure 2- Rosetta historic zone.

Source: Authors.

The city (municipality and local government) does not have any authority over centers operating under the supervision of ministries and central institutions. There is a conflict among the three authorities responsible for the city and its historic area. First, Beheira Governorate is responsible for issuing licenses for the erection of new buildings, or the alteration or clearance of existing ones, either inside or outside the historic areas. In addition, it solves problems related to housing, public buildings, and providing basic urban services. Second is the Ministry of Endowments, which is responsible for providing services and covering regular expenses of the historic mosques and renting out spaces in a number of historic buildings. Third is the Supreme Council for Antiquities, which is responsible for providing maintenance and restoration for historic buildings that are listed on the national registrar. The conflict among the authorities and their lack of coordination have partially led to the decline of many historic areas. In addition, the weak public awareness about cultural heritage resources and their significance has led to low budget priorities and illegal acts of vandalism. There is limited evidence of effective participatory mechanism for the development of these historic areas.

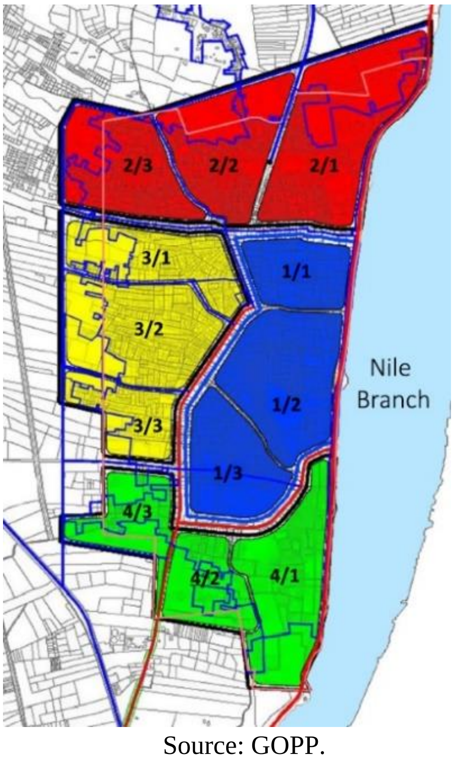
The Egyptian Classification of Urban Development Areas guide identifies development areas in cities and classifies them according to a set of criteria and indicators that have been extracted from studies, analysis, and applications on Egyptian cities. The guide aims to present the detailed applied methodology for defining and classifying the areas of urban development and the policies for dealing with them in the existing cities. The urban development areas are categorized into four classifications which are Special valued Areas, deteriorating areas, unexploited areas, and new urban extensions (UDF, 2022).

The identification and classification of development areas in cities depends on the application of a list of criteria and indicators on maps using the GIS platforms. The guide develops a process which should include the preparing of GIS base maps as shown in Fig. 3 using modern satellite images showing the urban context of the city, including basic urban data included the strategic plans and any available data (considering the data history, area coverage, accuracy. etc.) (UDF, 2022). According to General Organization for Physical Planning in Egypt (GOPP), Rosetta city is classified into 4 zones. Each zone has its urban regulations and building legislation. The 1st planning area is located at the east of Rosetta City, which represents the historic part of it as shown in Fig. 4. Its area is about 218 acres representing 24.3 % of the total area of Rosetta size as planned in 2027.

Figure 3- GIS base map for Rosetta City.

Source: GOPP.

Figure 4- Rosetta historic district in blue color.



Source: GOPP.

Despite the city's historic value, there are many high-rise buildings within the historic district which affects the city urban and visual character, as well as the infrastructure and safety of historic buildings as shown in Fig. 5. This was done due to the weak supervision and control from the concerned authorities on construction, the lack of application of laws and administrative corruption.

Figure 5- High buildings within the historic area of Rosetta city.

Source: Authors.

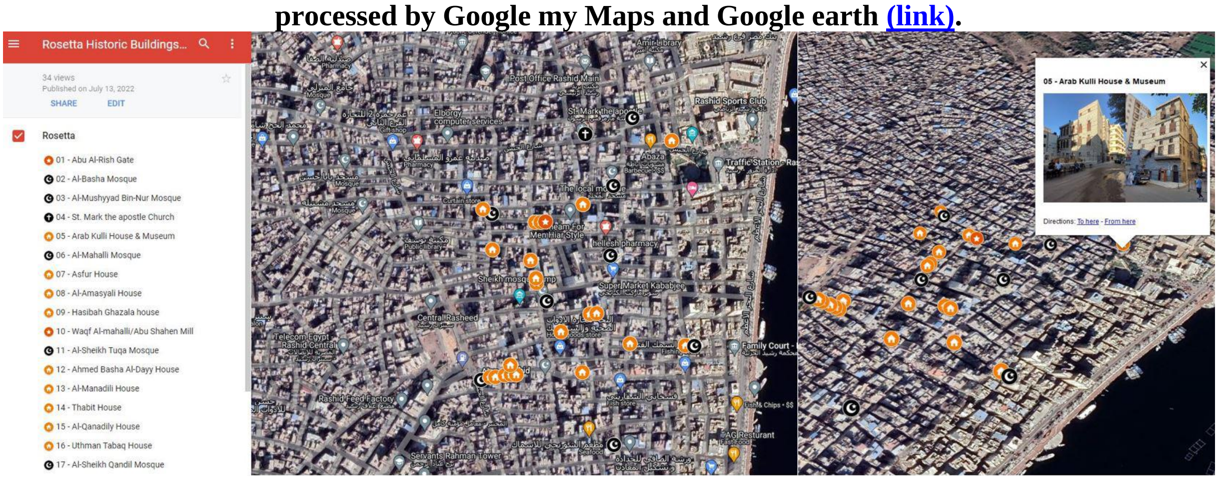
RESULTS

The digital mapping of Rosetta historic urban district and BIM-GIS integration process and results could be summarized as follows:

Heritage buildings and sites documentation using digital tools.

The digital map in Fig. 6 contains the locations and photos of all historic building exists in the historic district in addition to Qaitbay Citadel and Abu Mandour Mosque which are located outside it.

Figure 6- Digital map for Historic Buildings with photos processed by Google my Maps and Google earth [(link)](#).



Source: Authors.

All available documented maps and GIS databases don’t have a recent documentation for the current conditions for the historic buildings with their accurate locations. The digital map is developed using google my maps. The data could be exported form map to Keyhole Markup Language KML/KMZ files which could be imported in GIS platforms. 36 historic buildings are located inside the historic district which are mostly mixed-use residential and religious buildings.

Upgrading the existing GIS data for the historic district of Rosetta City

The GIS database of Rosetta city from the General organization for physical planning (GOPP) in Egypt isn’t accurate, not updated, and different from the reality of the current situation. Field surveys are performed led and managed by the authors with group of architecture students for a week to update GIS data for the current buildings’ features of the historic district. The whole district is divided into 24 zones where a group of 2-3 students update the spatial data for each zone such as building heights, no. of floors, setbacks, building uses, building quality and roads types and width using printed and digital maps as shown in Fig. 7.

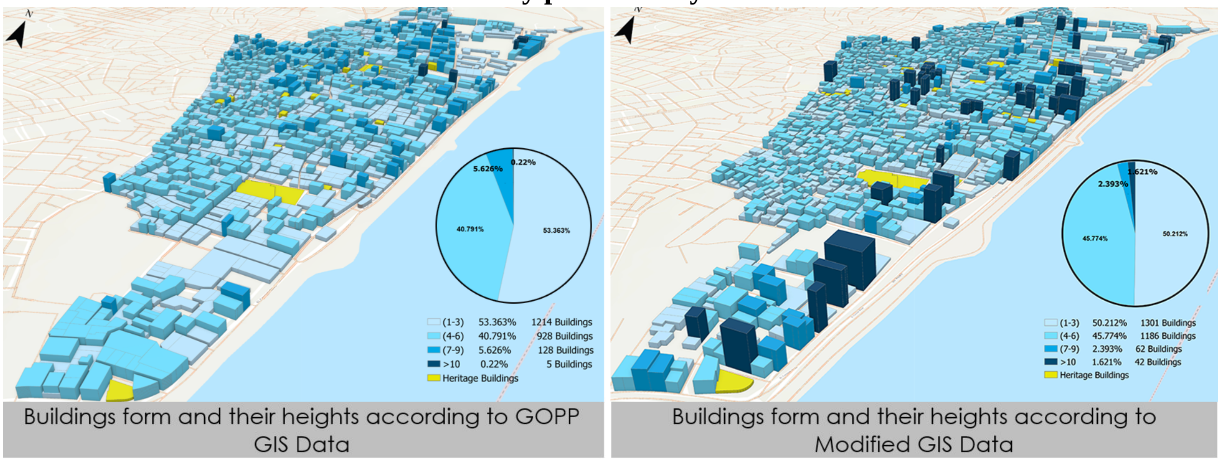
3D GIS modelling for the historic district is developed using Arc Scene to compare current situation with governmental data (LoD01) and to analyze the effect of the built environment on the heritage site.

Figure 7- Survey groups map

Source: Authors.

As shown in Fig. 8, the difference between governmental GIS data from GOPP and modified GIS data by field survey for building heights for example is clearly observed. The no. of buildings and their heights is changed from the GOPP GIS data and its update at June 2022

Figure 8- The difference between governmental GIS data from GOPP and modified GIS data by field survey processed by Arc Scene.

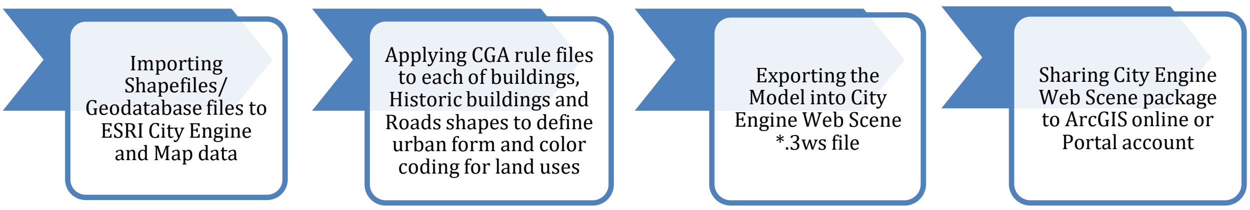


Source: Authors.

Creating 3D GIS interactive model using City Engine online web scene

The process of creating the 3D GIS interactive model using City Engine and sharing the model into public, stakeholders and local authorities is described in Fig. 9.

Figure 9- Process of sharing 3D GIS interactive model using City Engine.



Source: Authors.

The GIS model is imported into ESRI City Engine using shapefiles or geodatabase formats. CGA rule files is applied to each layer to develop the 3d GIS model. The main purpose of CGA rules is to define the urban form of the historic district and the color coding for land uses. The CGA rule is assigned to each building shape to define the use for each floor. Most of buildings in Rosetta historic districts are mixed-use residential use as the ground floor is mainly used for commercial purpose while the rest of floors are residential. The color coding for each building is scripted using python as follows in Fig. 10.

The CGA rule for each building is scripted to define the height which is connected to height field in the layer attributes. It splits the height into “use_ground” and “use_upper” to determine the use of the ground floor in each building which is mostly used for commercial purposes as mentioned before. The main CGA rule file was mainly created by ESRI R&D Center and Devin Lavigne, Houseal Lavigne Associates but it is edited by the researchers to be suitable for the urban context of Rosetta case.

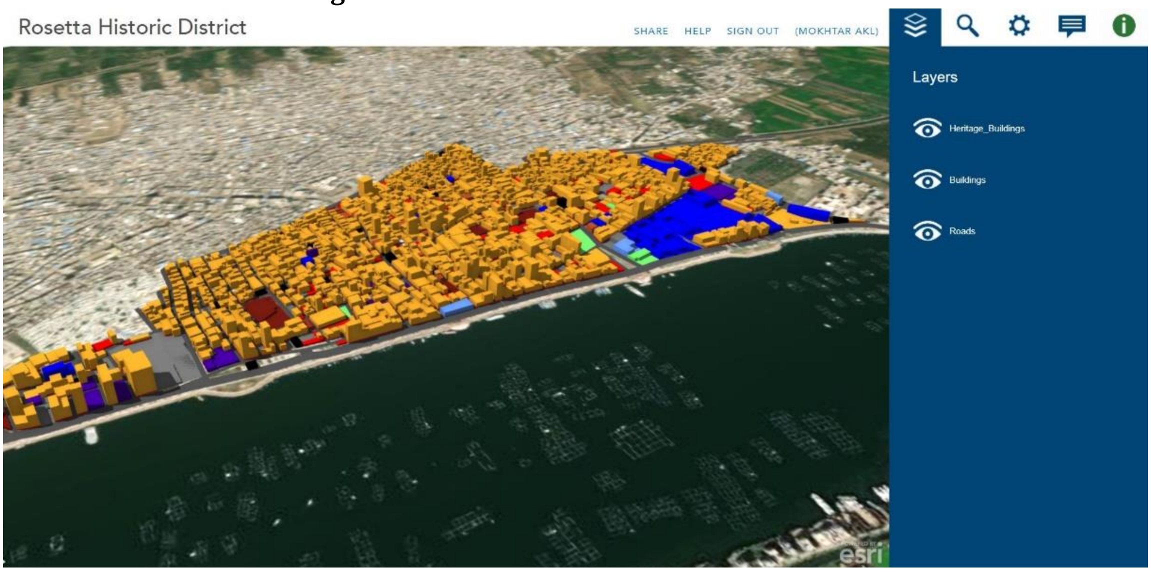
Figure 10- CGA rule for color coding to define building uses.

```
@Group("Land Use")
@Enum("Commercial","Administrative","Residential","Educational","Religious","Industrial","Empty_Areas","Entertainment","Other")
attr use_ground = "Commercial"

@Enum("Commercial","Administrative","Residential","Educational","Religious","Industrial","Empty_Areas","Entertainment","Other")
attr use_upper = "Residential"

getColor(use) =      case use == "Commercial" : "#FF0000"
                     case use == "Administrative" : "#6699FF"
                     case use == "Residential" : "#F5A928"
                     case use == "Educational" : "#0000FF"
                     case use == "Religious" : "#000000"
                     case use == "Industrial" : "#410099"
                     case use == "Empty_Areas" : "#717171"
                     case use == "Other" : "#717171"
                     case use == "Entertainment" : "#70fd6c"
                     else: "#FFFFFF"
```

Source: Authors.

The Historic buildings have different CGA rule as the main purpose is to define the main use for each building in the past which was mainly mixed-use residential family houses or mosques. Fig. 11 shows the Online 3D GIS interactive maps in ESRI City Engine Web Scene platform for the whole historic Urban district.

Figure 11- Online 3D GIS interactive model.

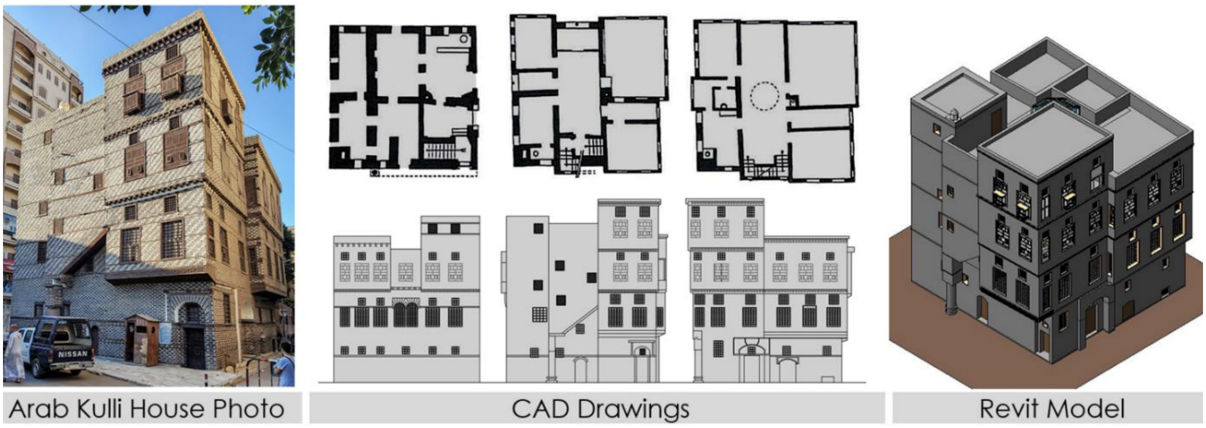


Source: Authors.

Integration of BIM model with GIS platform

Arab Kulli House is selected as It is one of the famous houses in Rosetta which was built in 18th century by the governor of the city (MOC, 2008). The house is now used as the national museum for Rosetta as It reflects the characteristics of the unique Islamic architecture and arts in this period. It is 1st building for tourists to visit as it is located in the entrance and main plaza of the historic district from El Gish Street. Fig. 12 shows Arab Kulli house photo, available plans and facades with the assistance of on-site survey and detailed measurement to create CAD model using Autodesk Revit software for Architectural BIM modeling. The model is exported to Arc GIS Pro geo-referenced with the geodatabase of Rosetta historic district then to ESRI City Engine Software.

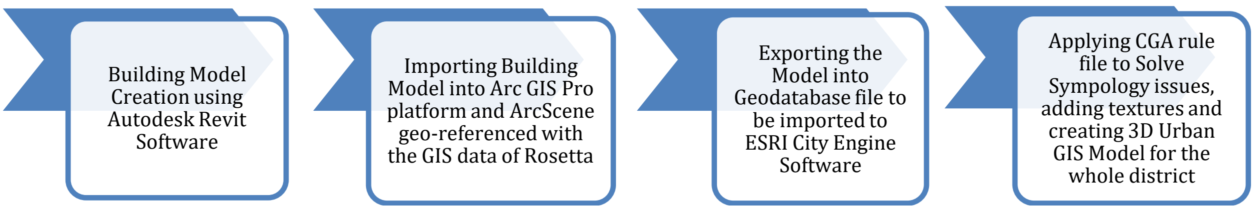
Figure 12- Arab Kulli house & Museum Architectural Drawings



Source: Authors.

Fig. 13 shows the process of importing BIM model into City Engine. The Revit model should be imported firstly to ArcGIS Pro and adjusted into its geographic location. ArcGIS Pro adds automatically symbology and organizes the BIM dataset into familiar Revit grouping structures (ESRI, Higher Education Resources, 2022). The model features are selected and exported into a geodatabase as a multi patch to be imported a City Engine Scene. Fig. 14 shows BIM model in ESRI City Engine Web Scene platform for the building scale with its internal information datasets and its main surrounding features.

Figure 13- Process of importing BIM model into City Engine.



Source: Authors.

Figure 14- BIM model in ESRI City Engine Web Scene platform.

Source: Authors.

DISCUSSION

The models are adjusted with the GIS platform of City Engine. The final step is to select the needed features to be exported into different supported formats and typical uses such as 3D objects formats or 3D GIS formats like Esri File Geodatabase and Keyhole Markup Language or ArcGIS online formats like Esri Scene Layer Package, 360 VR Experience, and City Engine Web Scene (ESRI, Export models overview, 2022). There are three main issues related to the process of BIM-GIS integration used in the case of the historic district of Rosetta city which are:

Accuracy of BIM-GIS data

The accuracy of GIS data mapping for urban districts is required to be updated and sufficient. The problems in Egypt that the GIS data available at the General Organization for Physical Planning isn't accurate with lack of information. The first Egyptian GIS projects were begun in the early 1980s, nowadays ministries and governmental organizations. They were dealing with spatial data through GIS technologies (Darwish, 2009). The GIS databases for each organization aren't the same and there is not a unified governmental source to support spatial data for all organizations. Many of the Egyptian cities have missing data on the online GIS platforms such as "open street maps" compared to the developed cities in the world. Also, the compacted urban fabric and narrow streets of old cities in Egypt makes the digitizing of these cities more difficult and needed mixed methods to collect, survey and digitize the current urban data.

Creating BIM models for existing historic buildings is facing great challenges. Historic buildings outside the main cities in Egypt face severe neglect in terms of documentation, restoration, reuse, tourism revitalization, adequate study of construction methods, used materials, and environmental treatments. Few of the historic buildings in Rosetta city are those that contain architectural drawings and are not sufficient to make a three-dimensional architectural model, and therefore a survey is needed to make the dimensions of the building. Only a few historic buildings in Rosetta have architectural drawings as in the case of Arab Kulli house but not sufficient to make 3D architectural models, and therefore a survey is needed to make the dimensions of the building. In addition to the difficulty of determining the structural details of floors, ceilings and walls and defining their properties and installation within the dataset of BIM model which requires many studies for building details to preserve the historic buildings and their architectural and urban management in an appropriate manner.

BIM models integration in GIS platform

BIM datasets for the building and GIS urban datasets are queued at the same layer list in City Engine which could confuse the user while navigating the model. There are two ways to visualize BIM models in City Engine Web Scene. The first one is to merge building datasets to be shown as one object layer containing all building components without being detailed structured groups. The other way is to express the building scale with its internal information and its main surrounding features by creating a separate scene model in City Engine platform for more detailed building features as in the previous Fig. 13. When multiple buildings are added, it will be more complicated and more structured layer data and details for buildings and urban datasets. Buildings models should be represented as block models reducing their building components and indoor features.

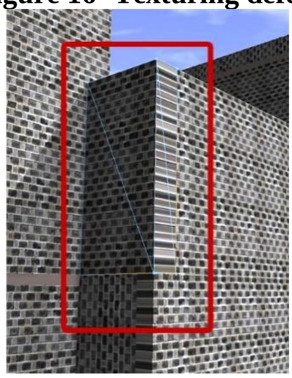
One of the main problems is that the symbology isn't appeared while the multi patch model is imported in City Engine. A rule package is created by David Kossowsky, Esri Canada to allow the features symbology to be customized and appeared correctly (Kossowsky, 2022). The CGA rule "RVT_to_CE.cga "applied offers several settings to adjust surface colors and add textures controlling texture height, width, transparency value and rotation angle as shown in Fig. 15.

Although CGA code used facilitates the process of texturing the building and offers options for modifications and adjustment, there are some defects appeared in dealing with the other sides of the apparent walls and surfaces in adjusting the direction of texture materials as shown in Fig. 16. When exporting the model to City Engine Web Scene, some object faces doesn't appear correctly as shown in Fig.17. More studies should be applied to ensure accuracy of building texturing and visualization quality in different exported modes.

Figure 15- Arab Kulli BIM model in City Engine.

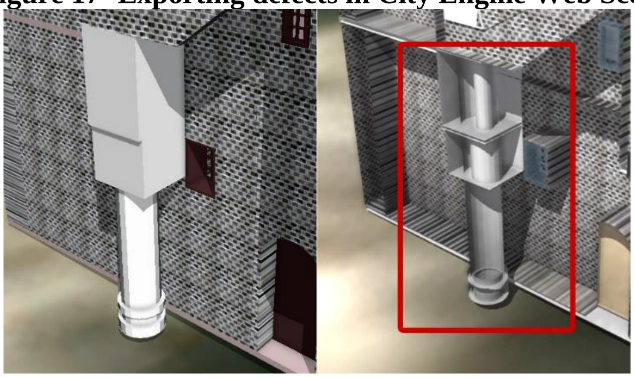
Source: Authors.

Figure 16- Texturing defects.



Source: Authors.

Figure 17- Exporting defects in City Engine Web Scene,



Source: Authors.

In the selected case study, Arab Kulli model was related to LoD200 while the 3D GIS model could reach LoD2 or LoD3 if Landmarks and Historic buildings for example are added with detailed wall and roof structures potentially including doors and windows. This will visualize the historic features and architectural identity of the historic buildings within the surrounding urban features which mainly describe the urban form, land and buildings uses, building quality and roads network.

BIM-GIS models and Urban Policy

BIM-GIS integrated platforms supports the decision makers to develop a comprehensive, integrated, upgrading methodology based on a GIS-based spatial data management framework. This framework could assist efficiently the policies of conservation, protection, and rehabilitation for dealing with historic urban areas which includes:

- Preserving the area, restoring its buildings, and preparing it on the urban scale, and working on reviving its heritage and historic features through the development programs for the urban, social, and economic strength of the area.
- Encouraging the reuse of some heritage buildings with different uses suitable for preservation.
- Encouraging balanced tourism development in the region, based on its richness in tangible and intangible terms.
- Preserving the urban elements that confirms the historic and heritage value, such as: (urban network patterns, spaces).

CONCLUSION

BIM-GIS integration models have become essential tools in digitizing, managing and developing cities. BIM represents micro-level scale for buildings themselves while GIS represents macro-level scale for urban contexts of buildings. BIM and GIS data are complementary to each other for planning the built environment but there are incompatibilities between the two sets of data. There are different integration patterns and platforms used by researchers. The study aims to examine the process of integration of BIM and GIS at the technical level using City Engine platform. City Engine improve the efficiency of 3d GIS models by combining buildings components and features with existing GIS data. The process of collecting data, GIS mapping for a certain historic district in Egypt, upgrading the existing database and the documentation of its historic features for creating 3d GIS urban models is challenging for urban researchers in Egypt. The lack of a unified database with different authorities, the availability and accuracy of GIS data for Rosetta city, and security issues related to survey or photogrammetry process are considered as study limitations and main obstacles for developing 3d-GIS urban models with accurate and sufficient data.

The 3d-GIS urban model could improve further urban development scenarios for municipal projects, increase public participation and their awareness and evaluate urban environment. The integration of BIM-GIS has many advantages to urban governance, social management, disaster prevention and mitigation, and preserving historic buildings and urban cultural heritage. It supports also energy and environmental management as it could manage the behavior of buildings and visualize the results for specialists, planners and decision makers.

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