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Use of Construction Information Modelling Technology to Study the Relationship between the Shape of the Public Hospital Building and the Economic Feasibility

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ABSTRACT: With the great development that is taking place in the methods of treatment and diagnosis, it had to be accompanied by a similar development in the planning and design of hospitals and management, and with this development it must be emphasized that there is no single fixed direction for the design of hospitals, if the hospital for the doctor is a place of work, experience and research, it is for the patient the refuge and shelter where he hopes to heal, and therefore the humanity of the hospital building is considered a necessity of treatment and therefore it is a basic design, In view of the continuous development in health and medical care, which requires the use of different spaces depending on the development of its equipment and machinery, the design of the hospital should allow sufficient flexibility to change and replace the use of vacuums as needed, by studying the design standards of hospitals it was noted that the distribution of areas of the hospital elements and the functional relationships described and the nature of communication between them, from departments (internal residence - clinical departments - departments of support services) Affecting the shape of the building and the shape of the building affects the technical feasibility study that affects the final decision on the economic feasibility of the hospital and through this study we will analyse the shape of the building and its impact on the reduction of cost by knowing the feasibility study and analysis of the impact of the form on the cost and from there to the knowledge of the elements of the cost of the building and to apply this analysis through an applied study in two different forms in distribution and have the same survey program and comparative work in terms of the most cost stages of the building From (tiles - columns - interior and exterior walls) and knowing the best form in terms of horizontal and vertical distribution by using BIM technology to draw and account for both growths through the program Revit where it is the latest technology used in the preparation of architectural drawings and the work of inventory of all construction elements.

KEYWORDS: Public Hospitals- Economic Feasibility Study- Healthcare- survey- BIM- REVIT.

I. INTRODUCTION

In this research, the elements and standards of the general hospitals were studied design and economic feasibility study and found that in the stage of the technical feasibility study through which the architect to develop the design drawings and choose the best form of the hospital building that achieves the desired function of building it and maintain the relationship of the elements with achieving saving in terms of feasibility study of the building, Therefore, through the study of design standards, it was found that the distribution of these elements in different forms leads to an increase or reduction in the number of walls, whether internal and external walls while maintaining the spaces and functional relationships between them, which affects the feasibility study by reducing the cost by reducing the number of walls in the building, tiles and columns, and therefore the distribution of elements of the building has an impact on the shape of the building. In this research, we discuss the knowledge of the economic feasibility study, which is one of the types of technical feasibility study through which the beginning of the design of the architectural drawings of the project, from which the ideas that return positively and the desired results of the design come out in terms of achieving the project in savings and the success of the economic feasibility of the project.

1. Economic feasibility study:-

Feasibility studies are a practical translation of investment policies, a larger and more accurate study of all aspects of investment in projects, whether to serve the investor or to serve development at the state level as a whole [1], which is to collect information on a proposed project and then analyse it to see the possibility of implementing and reducing risks and profitability of the project or losing it compared to the local real estate market and its needs [2] The feasibility study aims to analyse the productive

efficiency of the project away from any external interventions that may limit its ability to raise its profitability to the potential level, or may help it to continue despite its low performance. Hence, a study of the local market in terms of its needs and requirements should be done by studying the elements and types of economic feasibility as described

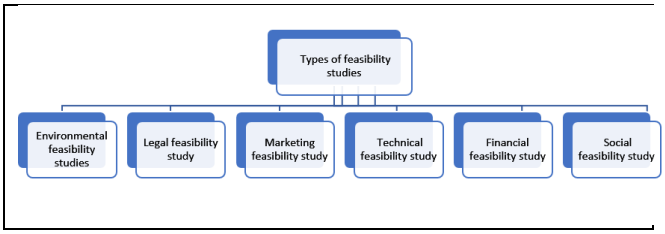


Fig.1. *Types of feasibility studies*

Types of feasibility studies:-

A. ***Preliminary feasibility study:*** **-** It itself determines the cost of conducting detailed feasibility studies and then determines its suitability with the size of the capital allocated to the investment and thus indicates whether the issue needs adjustments to bring about the required proportionality and balance, as well as the decision to end the initial studies either to continue preparing detailed feasibility studies for the project or reject the project.

B. ***Social feasibility study***:- In this study, the impact of the project on the national economy is assessed in terms of its contribution to achieving the overall economic objectives of society, where the impact of the project on employment, national income (value added) and balance of payments, as well as on currency value stability and finally environmental impact.

C. ***Financial feasibility study:*** **-** They include estimating cash inflows, estimating and analysing investment costs, estimating annual operating costs, estimating net cash flows before and after taxes, and establishing the project's financing structure.

D. ***Technical feasibility study:-*** In this study, the production capacities of the project are planned and prepared based on the results and estimates of the previous marketing feasibility study and ultimately determine the size of production and production capacity and the appropriate alternative to the size of the project and the appropriate location, the appropriate production method, the identification of production processes and the appropriate internal planning of the project and the identification of the needs of materials, employment and production requirements, and finally the availability of data and estimate investment costs and annual operating costs.

E. ***Marketing feasibility study:- I***n this study, the production capacities of the project are planned and prepared based on the results and estimates of the previous marketing feasibility study and ultimately determine the size of production and production capacity and the appropriate alternative to the size of the project and the appropriate location, the appropriate production method, the identification of production processes and the appropriate internal planning of the project and the identification of the needs of materials, employment and production requirements, and finally the availability of data and estimate investment costs and annual operating costs.

F. ***Legal feasibility study:*** **-** The relationship between the project and the laws and legislation affecting it and the organization of its activity is determined, so the legal feasibility study answers the question of whether the project is useful or not.

G. ***Environmental feasibility studies:*** **-** It is a study and analysis of the environmental feasibility of the proposed project as the implementation and operation of this project may affect the safety of the environment, natural resources and human health or both from the perspective that the project is (an open system that affects and affects the environment).

The relationship of the feasibility study and its elements to the project of a public hospital:-

Through the study of the feasibility study where the role of the architect comes in the stage of the technical feasibility study by producing a design that achieves the success of the feasibility study through the accuracy of the distribution of the elements of the hospital and its three main sections (internal residence - clinical departments - support services departments) and the spaces allocated to each of them and their functional relationship affect the shape of the building form 2, which affects the cost and shows through the relationship form 1, and study the horizontal distribution and head of the hospital elements.

In this research we will be related to the study of the feasibility of the project to establish a public hospital through the technical feasibility study through which the architectural study of the project is carried out through the technical feasibility study which is:

The study is carried out on planning and preparing the production capacities of the project based on the results and estimates of the previous marketing feasibility study and ultimately determine the size of production and production capacity and the appropriate alternative to the size of the project and the appropriate location, the method of production, the identification of production processes and the appropriate internal planning of the project and the identification of the needs of materials, employment and production requirements, and finally the availability of data and estimate investment costs and annual operating costs, through which we obtain the following information:

- Architectural design of the elements and components of the project from functional and spatial spaces and their composition to the shape of the building.

- Study the impact of the shape of the building on the economic feasibility of the project by knowing the inventory of the quantities of concrete tiles and roofs and limiting the interior and exterior walls between two models through the application of BM technology and architectural rivet programs to obtain accurate inventory results of the project, where it appears through form 2.

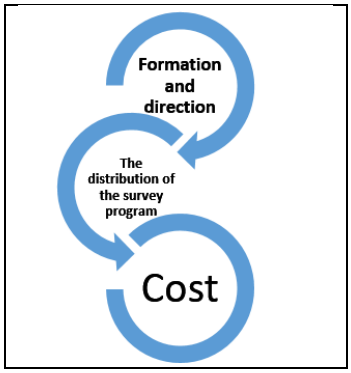


Fig.2. The relationship between economic feasibility and surveying programs.

Analytical study:-

Identify the shape of the hospital building and its impact on the technical feasibility study, which in turn affects the feasibility study as one of its elements: the shape of the hospital building:-

The shape of the building is generally determined by the relationship between the three sectors that make up it, namely form 3.

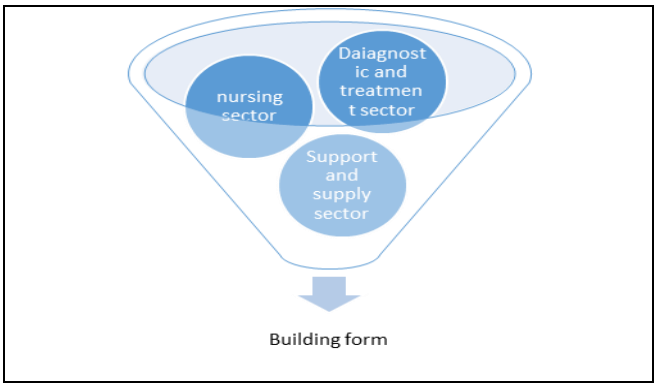


Fig.3. the relationship of the hospital personnel.

The forms of hospital buildings have evolved and are represented by

-Vertical hospitals in the distribution of elements

- Horizontal hospitals in the distribution of elements

Horizontal distribution:-

The elements are distributed in this way where the therapeutic services and screening and diagnosis services are distributed with the nursing departments and internal residence horizontally, where the hospital is grouped in its three areas in two main buildings, one of which is dedicated to the area of residence of patients in a number of frequent roles and the building is horizontally extended and rises for several roles (4-5 floors) and connects horizontally and vertically to the second building which includes the clinical area, The supporting services area comes under the two buildings at the base, and the buildings are confined to closed or open courtyards used as green flats, and take forms as described in the form4 of them[3]

A. Independent Linked Slabs.
B. spine & Pavilions
C. Extended Courtyard.
D. Compact courtyard
F. Horizontal Monolith

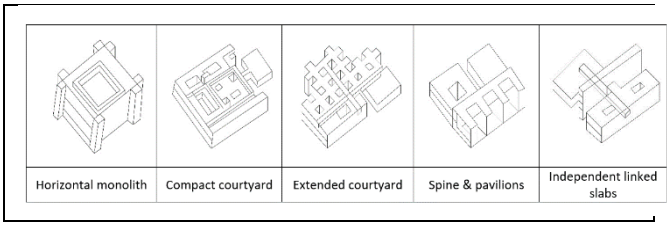


Fig.4. Horizontal distribution forms of hospitals

Vertical distribution:-

The elements are distributed in this way where the therapeutic services and screening and diagnostic services and the reception and emergency department are collected horizontally, and their contact with the nursing departments and internal residence vertically, an example of these forms as described in form 5**[3]**

A. Simple Tower on Podium
B. Complex Tower on Podium
C. Radial Tower on Podium
D. Articulated Slabs on Podium
F. Vertical Monolith

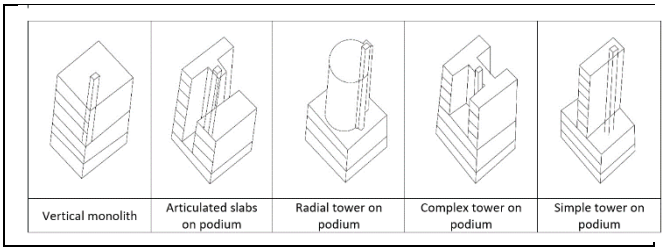
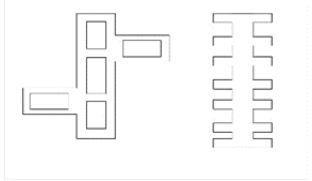


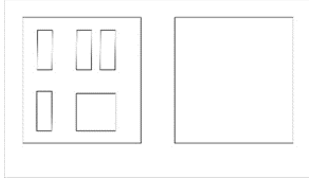
Fig.5. Forms of vertical distribution of hospital building

Impact of the shape of the hospital building on total costs:-

The London Department of Health and Health Care has carried out an analytical head for the forms of hospital buildings to see the impact of the shape of the hospital building on costs (construction costs - engineering costs) where engineering costs are the costs of works and connections both (electricity - adaptation and water) and four different forms have been selected in terms of architectural design and equal in the total flat which is (37.161 m2).



Horizontal building with fingers
1. Horizontal building
2. With the inner yards.



Deep silent block
1. Deep block
2. With the inner yards.

Fig.6. Horizontal and vertical distribution. [4]

And it shows in this way this relationship:-

It is clear that the shape of the building and the formation of blocks and guidance affects the cost in various types through the study carried out by the Department of Health and Health Care in London with an analytical head of the forms of hospital buildings to see the impact of the shape of the hospital building on costs (construction costs - engineering costs) where engineering costs are the costs of work and connections both (electricity - adaptation and water) Four different forms have been selected in terms of architectural design and are equal in the total flat of 37,161 m2. [4]

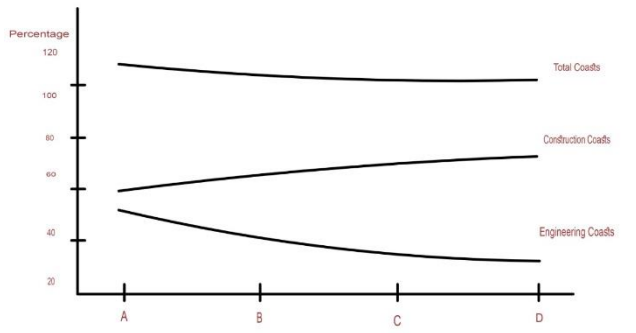


Fig.7. Comparative study of different-format blocks and the impact of their form on both construction costs, engineering costs and total costs. [4]

Cost of hospital buildings:-

Hospital buildings are considered to be complex designed and in the planning of all their different stages, from the beginning of design, finishing and processing to the management and operation phase, and expensive at all the above stages. It is a major economic burden and some countries face many problems, even developed ones, and therefore more influential than developing countries with limited sources. The cost of hospital buildings is divided into four types of cost.fig.8.

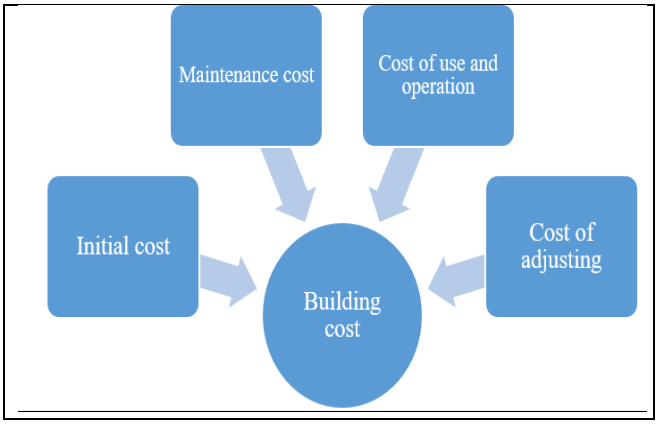


Fig.8. Types of cost of hospital buildings.

Types of cost, stages and ratios of design and construction of the hospital building affecting it:-[5]

A. initial cost:- And there are the costs of the hospital from the beginning of the design idea of the project through the costs of construction and finishing to the costs of equipment and medical equipment i.e. to before the operating stage of the building.

B. maintenance cost-: These are the costs of maintaining the hospital's equipment throughout its life, which appear with the beginning of the use of the building.

C. *operating cost:* - The costs of managing the operation of the building, from the consumption of tools, equipment and equipment, its auxiliary services, and the wages of the workers.... etc.

D. adaptation cost:- This cost for changes taking place in the hospital to accommodate future changes in the field of health care and this cost is known as adaptation cost, which is currently under the name of the cost of use, operation or maintenance cost, and this cost is important and should be considered in the design phase, as the cost of doubling the number of beds in the hospital is almost equal to the cost of a new building for this additional number, also the cost of use reaches the same cost of construction within three years of operation.

Since the construction phase represents the most expensive phase in the initial cost as described (fig.9.)[7], two models are studied with the same architectural program and are involved in the formation and distribution of elements and are illustrated in methods and tool.

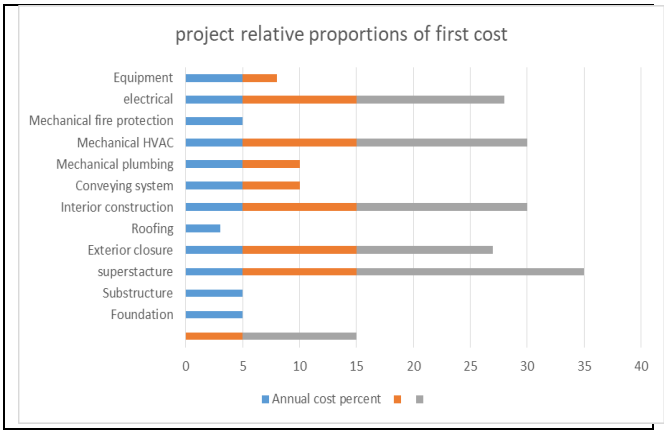


Fig.9. the cost of the construction structure represents the highest cost.

Applied study

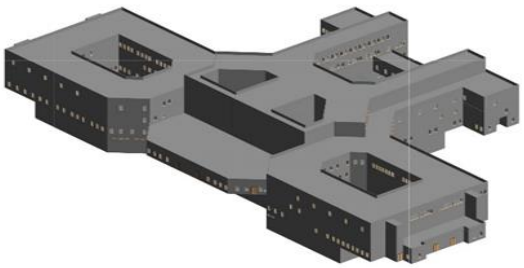
Modern techniques to study the impact of the shape of the building on economic feasibility:-

Since the stage of construction of the structure of the building represents the highest cost in the stages of the establishment of a hospital project as described in the form (fig.6), therefore one of the elements charged in the construction phase are both external and interior walls and concrete tiles and columns, which are influenced by the formation of the block of the building by reducing or increasing their number in square meters and cube.

Through this research, it was assumed that the design of two models would work in both horizontal distribution and vertical distribution and comparison by calculating them and through the use of BIM technology through Revit. In terms of:-

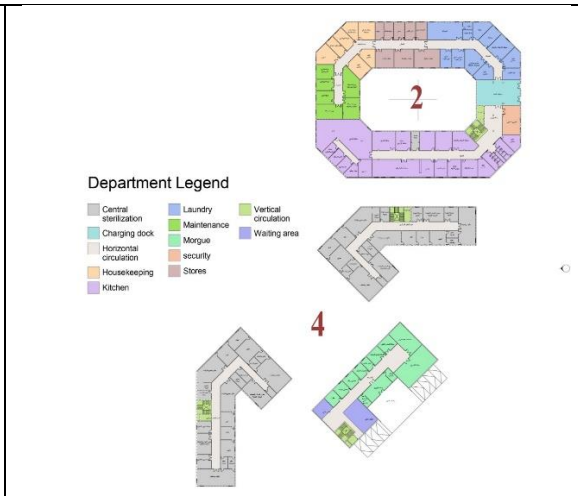
- Limit the interior walls to square meters and the outer walls to the cubic meter.
- Limiting the sizes of tile concrete to the landfill.
- Limit the sizes of column concrete to cubic meters.

Two models are made with the same surveyor program and different in the formation and distribution of elements and spaces forming the building and compare the number of walls in both models and know the model that achieves fewer walls, which works to reduce the cost of the building in the construction phase and limit the quantities of concrete columns and tiles, as shown in the following table:-

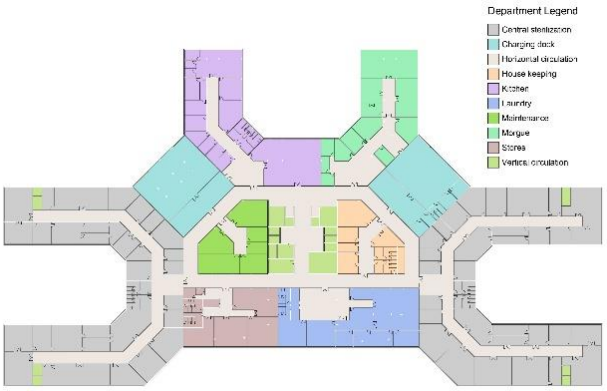
And the comparison.	*case(A)*	*case(B)*
The general shape of the building block	 **(Fig10)**	 **(Fig11)**
Distribution of the basic sectors of the hospital building	In this model, the basic elements of the hospital (nursing sector- diagnostic and treatment sector - support and supply sector were distributed horizontally to a number of separate buildings as described in paragraph 1-3 in the horizontal distribution explanation, where the architectural composition of the hospital building block appears in form A, a perspective snapshot showing the formation through the Revit program, (fig.10.) **Basement role:-** Supplies and support elements were distributed where both (central sterilization - morgue) building (4) and (laundry - kitchen - maintenance - cleaning services - warehouses) building (2) as shown in the horizontal projection of the basement role. *(fig.12).* **Ground floor:-** The diagnostic and treatment sector was distributed in the ground floor where both (management - pharmacy - restaurant, café, gift shop and roses) in building (1), distribution (educational parts of classrooms - part of nursing) in building (2), distribution (outpatient clinics) building (3), distribution (laboratories - radiology - emergency) building (4) as shown in the horizontal projection of the ground floor*(fig.13).* **First round:-** The elements of diagnosis, treatment and nursing were distributed where both (operations - deliveries and cesarean operations) in the block of building (4) and elements (nursing and intensive care) building (2) and elements (nursing birth and caesarian) building (3) as described in the projected horizontal for the first round *(fig.14).* **Second round:-** Nursing and classrooms have been expanded in each of the two blocks of the building (2-3) as shown in the horizontal fall of the second round**.** *(fig.15).*	In this model, the elements of the hospital were distributed both (nursing sector - diagnostic and treatment sector - support and supply sector) vertically as described in the explanation in paragraph (2.3 vertical distribution) of the elements and components of the vacuums of the hospital building in one block showing the shape of the block of the building as (fig.11.)Where it is shown in the following horizontal spaces. **Basement role:-** Elements of both (central sterilization - cleaning services - kitchen - laundry - maintenance - morgue - warehouses) were distributed from the components of the support and supply sector as shown in the horizontal project. *(fig.16).* **Ground floor:-** Elements of both (central sterilization - cleaning services - kitchen - laundry - maintenance - morgue - warehouses) were distributed from the components of the support and supply sector as shown in the horizontal project *(fig.17).* **First round:-** Laments of both (management - emergency - laboratories - radiology - pharmacy - outpatient clinics) were distributed from the diagnostic and treatment sector as shown in the horizontal projection of the ground role *(fig.18).* **Second round:-** Elements of both (operations - birth and short) were distributed from the diagnostic and treatment sector and elements (ICU intensive care) from the nursing sector as described in the horizontal project *(fig.19).* **Third round:-** Distribution of elements of both (nursing - individual patient residence rooms) and waiting as described in the horizontal project *(fig.20).*

Horizontal probes

Horizontal projected for basement role

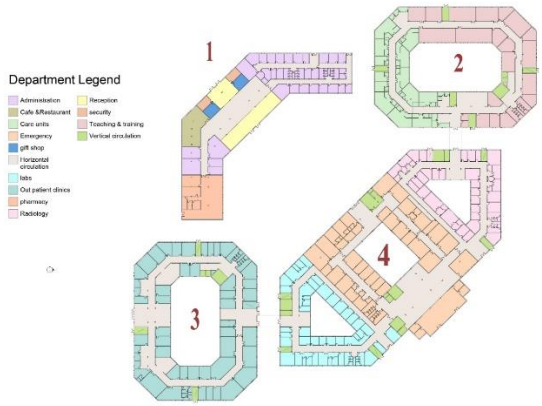


(Fig12)

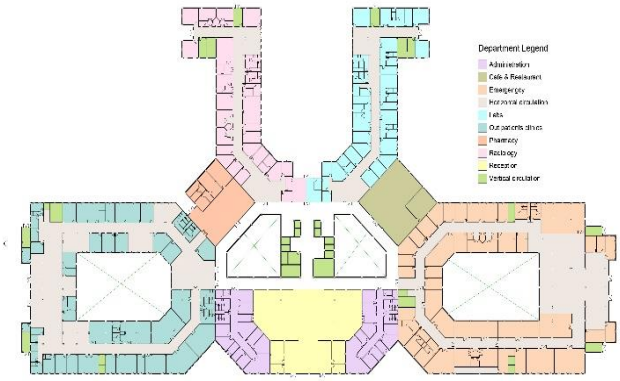


(Fig16)

Horizontal projection of the role of satisfaction

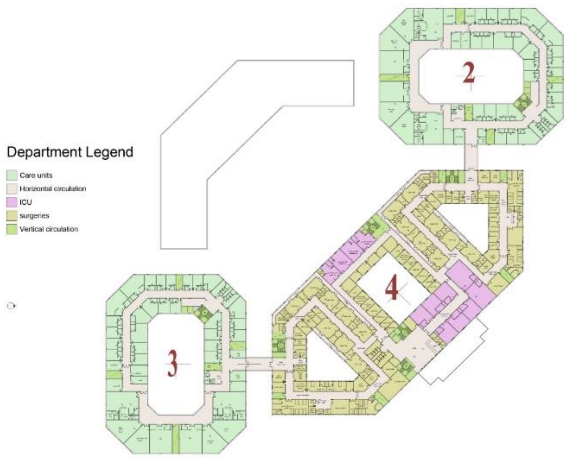


(Fig13)

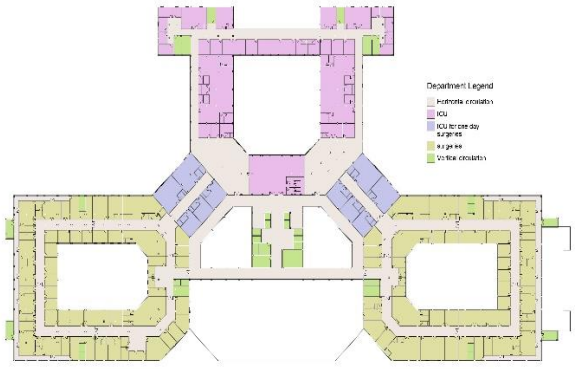


(Fig17)

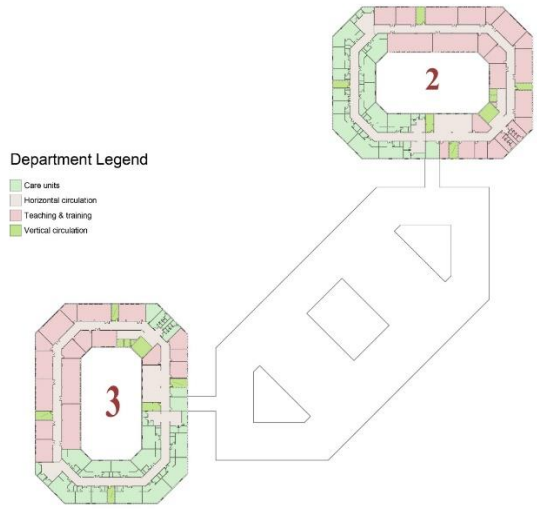
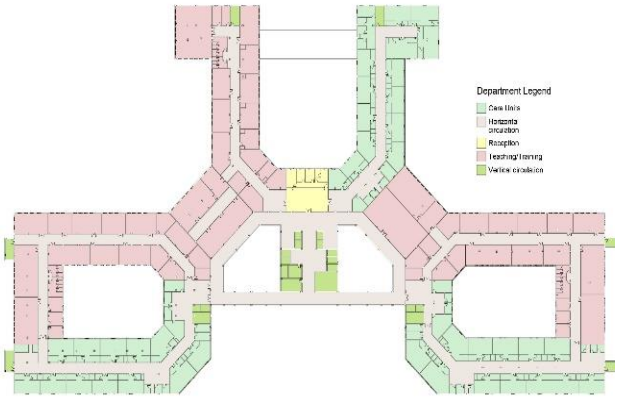
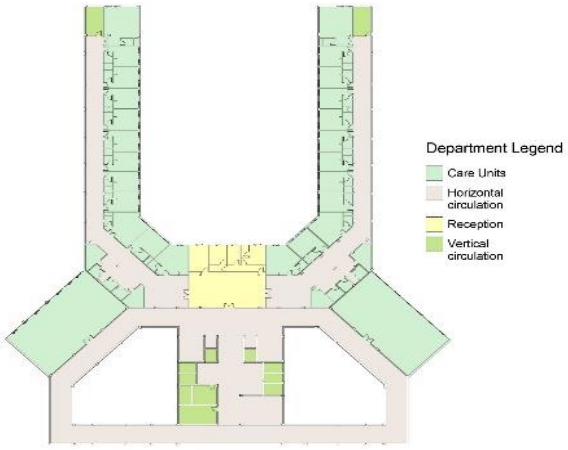
Projected horizon for the first round



(Fig14)



(Fig18)

	Horizontal projected for the second round	 **(Fig15)**	 **(Fig19)**
	Horizontal projected for the third round		 **(Fig20)**

RESULTS

After designing and preparing the drawings through the use of the Revit program, an inventory of the outer and in-house walls was made showing the figure planned in yellow, the total total of the walls, and the inventory of the quantities of concrete tiles and columns.

For Model A:

-The horizontal distribution of hospital elements shows the following results:

- Appeared in this model after the work of inventory and calculation of walls where the total number of walls empty ym cubic meters (5024.769 m3), and the total number of interior walls (37380.258 m2) fig.21

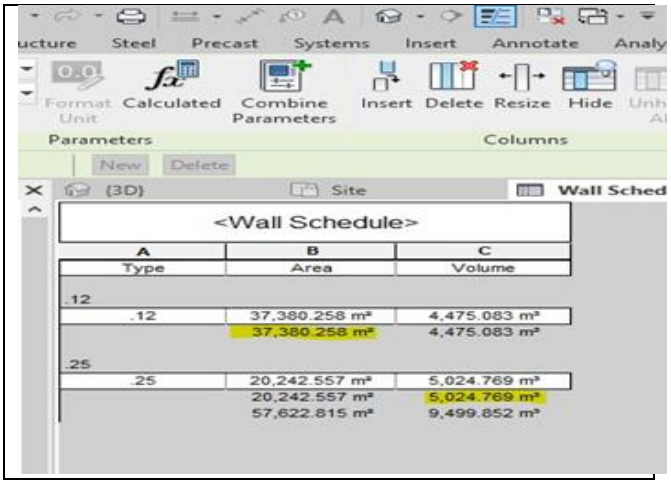


Fig21. Inventory of interior and exterior walls.

Limiting the size of tile concrete:- 7392.31

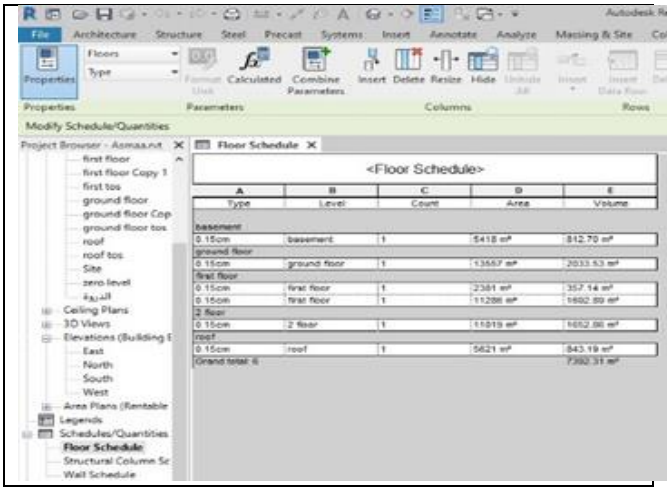


Fig.22. Limiting the size of tile concrete.

Limiting the size of column concrete: - 688.8

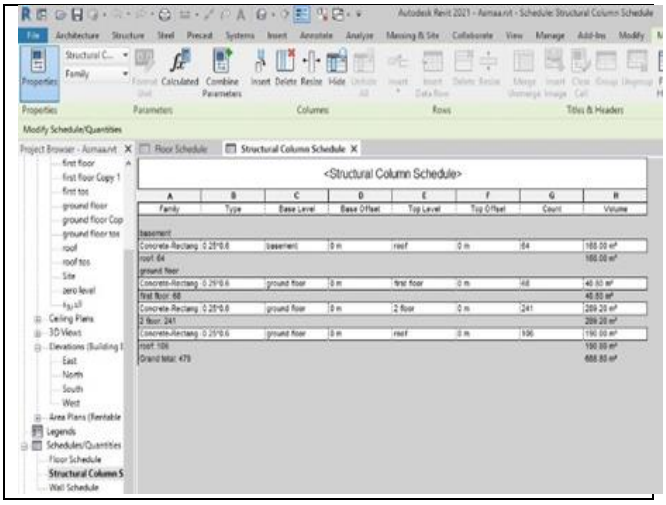


Fig.23. Limiting the size of column concrete.

Explain the total total of all inventory for both interior and exterior walls, tiled concrete and columns by transferring results from Revit to Microsoft office excel to compare the two models then in the discussion of results:-

case (A)	Total sum
Total wall type 12 cm	37,380.26
Total wall type 25 cm	5,024.77
Floor TVQS	7392.31
Column TVQS	688.8

Table2. Total inventory of construction elements of Model A

<u>For Model B:-</u>

Vertical distribution of hospital personnel:-

- This model shows the total number of exterior walls (5123.327 m3) and the total number of interior walls (44,452.67 m2).

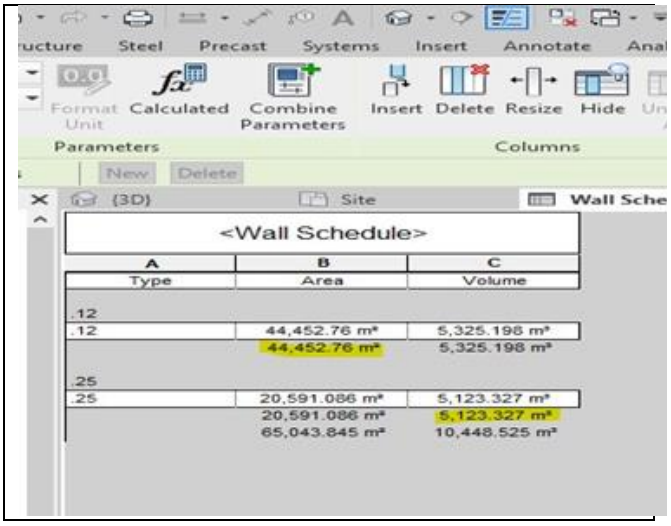


Fig24. Total total exterior and interior walls.

Limiting the size of tile concrete:- 14126.47

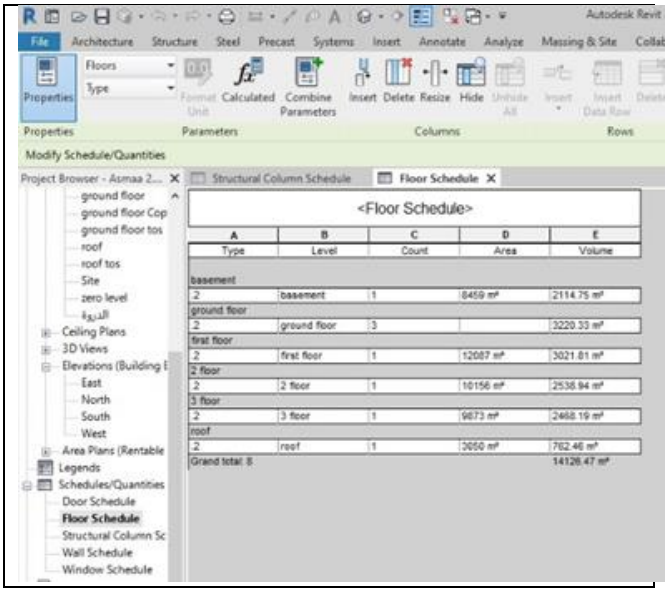


Fig.25. Limiting the size of tile concrete.

Limiting the size of column concrete: 1650.69

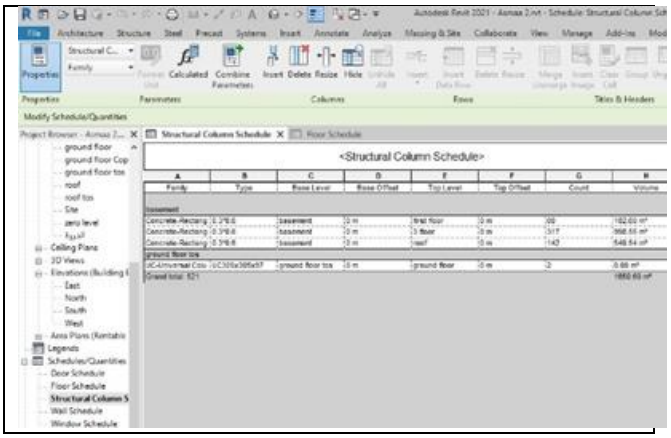


Fig.26. Limiting the size of column concrete.

Explain the total total of all inventory for both interior and exterior walls, tiled concrete and columns by transferring results from Revit to Microsoft office excel to compare the two models then in the discussion of results.

case (B)	Total sum
Total wall type 12 cm	44,452.76
Total wall type 25 cm	5,123.33
Floor TVQS	14126.47
Column TVQS	1650.69

Table3. Total inventory of construction elements of Model B

DISCUSSION OF RESULTS

-After the work of the inventory and knowing the total number of external and interior walls we found that the horizontal distribution of model (a) of the elements of the hospital building achieves a smaller number in terms of the total external and interior walls than the total number of external and interior walls of the hospital building in form (b) which represents the vertical distribution of the elements of the hospital building, where we found through the form to analyze the difference between the first model (a) and the second model (b) The first model represents the lowest total number of outer and interior walls by a difference **(98.558m^3)** for the outer walls thickness **(25cm)** and a difference **(7072.502m^2)** for the thickness interior walls **(12cm)** and appears*(fig.27).*

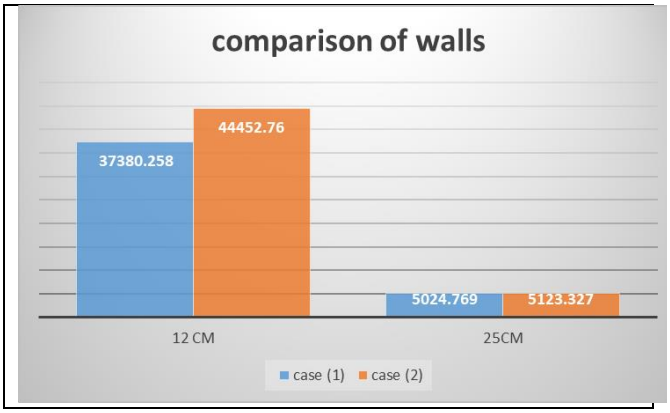


Fig.27. the difference between the total interior and exterior walls of both study models.

-After limiting the amount of concrete to tiles all roles between the two models, the results of the first model showed the amount of consumption of few beads from the second model by about **50%.** *(Fig28).*

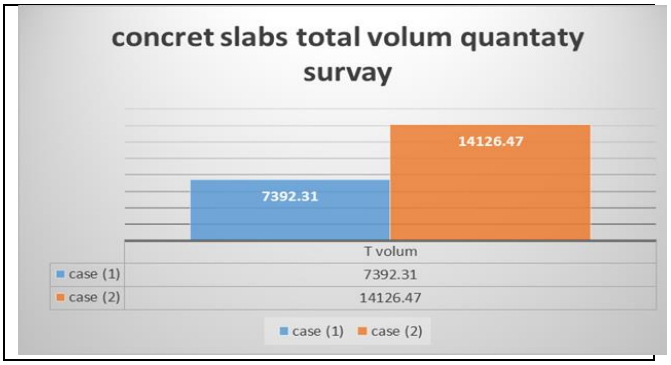


Fig.28. shows the difference between the total inventories of concrete sizes for tiles.

-After limiting the amount of concrete to columns between the two models, the results of the first model showed a lower amount of concrete consumption than used in the second model by about **50 %** *(fig29).*

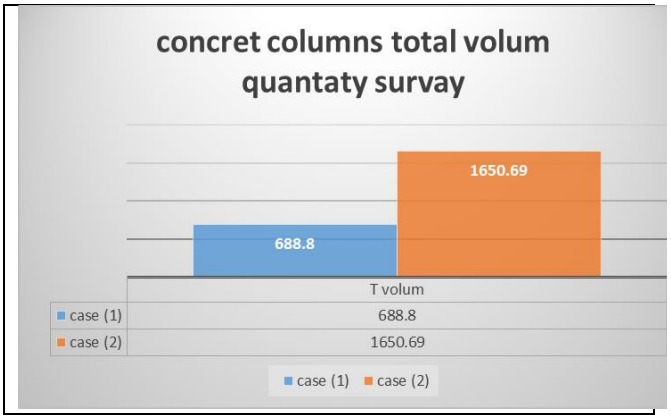


Fig.29. shows the difference between limiting the sizes of column concrete.

CONCLUSIONS AND Acknowledgements

1. The standards and spaces of the hospital elements are constant in order to achieve the function of the vacuum and it varies in composition and distribution.
2. Formation and distribution through which the value of the cost of the building can be changed, which has an impact in the economic feasibility study.
3. Horizontal distribution is desirable for use in terms of achieving a lower cost in terms of showing by limiting the number of external and interior walls, and limiting the size of concrete tiles and columns to the models of the study described.
4. When placing more than one element grouped in one block leads to a difference in the places of guidance, which consumes more walls and consequently more columns and slabs, than the distribution of one or two elements with the same design criteria in their horizontal distribution or on the number of adjacent buildings that are simple and uncomplicated blocks It is more efficient than assembling them in a single

block and distributing vertically, as explained in previous results.

5. Vertical distribution represents the highest percentage of walls of horizontal distribution of hospital elements.
6. Take into account the planning when determining a land area that serves a certain number of breezes that allows the choice of horizontal distribution design for the hospital elements.

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