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COMPARATIVE STUDY OF DIFFERENT BUILDING PLAN LAYOUTS USING REVIT

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Abstract: This study compares different Building Plan layouts to determine their effectiveness in meeting specific needs and goals. The analysis focuses on efficiency, aesthetics, and user experience as key evaluation criteria. The study uses a mixed-methods approach, combining qualitative and quantitative data collection and analysis methods. The results show that each layout type has its strengths and weaknesses, and the most effective layout depends on the specific context and user needs. The study provides insights and recommendations for designers, architects, and decision-makers to create effective and efficient Building Plan layouts that meet user needs and goals.
This study conducts a detailed comparative analysis of different Building Plan layouts commonly implemented in residential and commercial building designs. The focus is to assess the efficiency, functionality, and occupant satisfaction across various layout types, including open-plan, compartmentalized, studio-style, and hybrid configurations. Using architectural modeling software (such as AutoCAD and Revit) and post-occupancy evaluation methods, the study evaluates each layout based on space utilization, natural lighting, ventilation, privacy, acoustic performance, and adaptability.
The study concludes that Building Plan effectiveness in buildings depends on functional requirements, user behavior, and environmental context. The findings aim to guide architects, builders, and planners in selecting context-appropriate layout strategies that align with both user expectations and architectural performance standards.

***Key Words* - Building Plan layouts L-type, Rectangular Type, Autodesk Revit**

I. INTRODUCTION

The realm of architecture and building design, the layout of a building plays a pivotal role in determining its functionality, efficiency, aesthetics, and overall user experience. The choice of a building plan layout whether linear, radial, courtyard, or clustered—affects critical aspects such as spatial organization, natural lighting, ventilation, cost, and structural complexity. As the construction industry moves toward more sustainable and intelligent building practices, the need for informed decision-making during the design phase has become increasingly important**.**

The design and layout of a building play a crucial role in determining its environmental performance, particularly in terms of daylighting and natural ventilation. Effective utilization of natural light and air not only enhances indoor comfort but also reduces dependence on artificial lighting and mechanical ventilation, leading to significant energy savings. In architectural design, the arrangement and orientation of spaces—dictated largely by the building's layout—directly influence how daylight penetrates the interior and how air circulates throughout the structure.

Autodesk Revit stands out for its comprehensive capabilities in architectural modeling, visualization, simulation, and performance analysis. Revit allows architects and designers to create accurate 3D models and extract valuable data regarding material usage, space planning, energy performance, and cost estimation.

This study aims to perform a comparative analysis of different building plan layouts modeled in Revit specifically focusing on their performance in terms of daylighting and natural ventilation. The goal is to identify how spatial configuration impacts these passive design strategies and to promote more climate-responsive architecture.

Objectives of the Study:

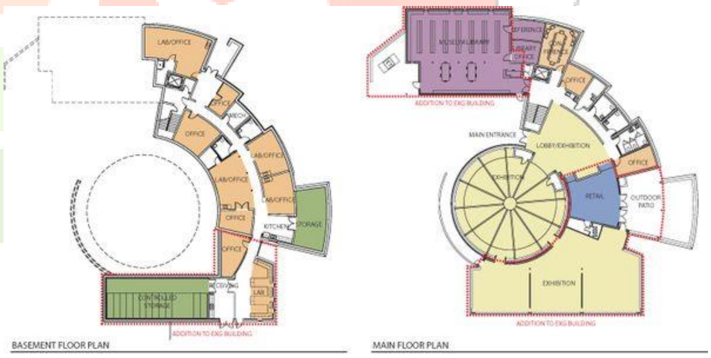
- To model different building plan layouts (linear, radial, courtyard, etc.) using Autodesk Revit.
- To analyze and compare their daylighting performance using sun path and lighting analysis tools.
- To evaluate natural ventilation potential based on spatial arrangement and airflow considerations.
- To demonstrate the value of BIM tools in optimizing environmental design decisions.

With growing emphasis on sustainable design and occupant well-being, integrating daylighting and ventilation analysis into the early design process is no longer optional—it is essential. This study highlights how intelligent layout design, combined with advanced modeling tools like Revit, can lead to more environmentally responsive buildings.

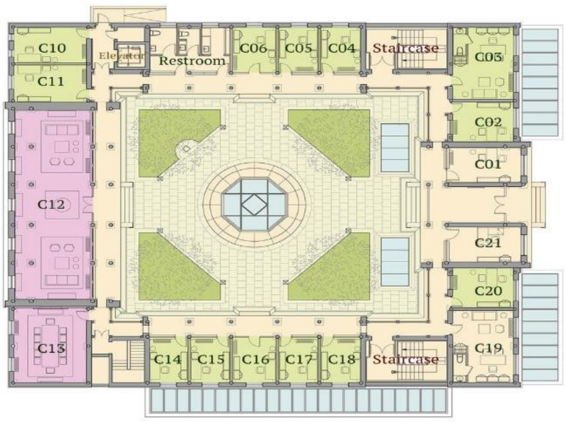
Building Layout Types

1. Linear Layout – A single-axis arrangement providing extended external wall exposure, ideal for daylight access.
2. Radial Layout – Rooms organized around a central node typically used in institutional or spiritual architecture.
3. Courtyard Layout – Encloses an internal open space to promote cross-ventilation and internal daylighting.
4. Clustered Layout – Consists of grouped functional units forming semi-private zones.
5. L-Type Layout – A right-angle layout commonly used in corner plots, offering dual orientation benefits.
6. **6.** Rectangular Layout – A compact and efficient shape often favored for its simplicity and space efficiency**.**

Linear Layout

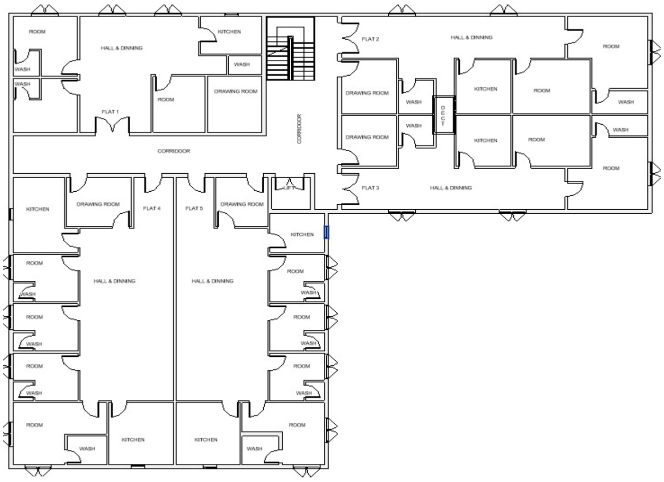


Radial Layout

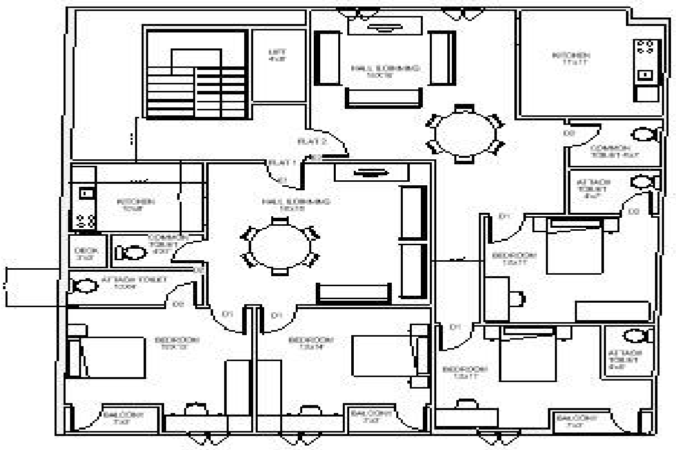


Courtyard Layout

Clustered Layout



L-Type Layout



Rectangular Layout

II. METHODOLOGY

This study evaluates the **ventilation** and **daylighting** performance of two common architectural building layouts **L-type** and **Rectangular-type** utilizing **Autodesk Revit** and its simulation tools. The methodology comprises four key phases:

2.1. Selection and Standardization of Layout Types

Two building layouts were selected for analysis:

- **Rectangular-Type**: A straightforward, compact form optimized for structural and spatial efficiency.
- **L-Type**: A bent layout offering opportunities for semi-enclosed courtyards and increased perimeter exposure.

Both layouts were standardized based on:

- Equal total floor area and number of floors.
- Similar wall-window ratios, materials, and ceiling heights.
- Identical functional zoning (e.g., bedrooms, living spaces, kitchens).

2.2. 3D Modeling in Autodesk Revit

- Each layout was modeled in Revit with precise dimensions and real-world components (windows, walls, doors, slabs).
- Window placements were carefully designed to ensure fairness in comparing natural lighting and cross-ventilation potential.
- Orientation was kept consistent (e.g., main façade facing south) for accurate solar and wind exposure.

2.3. Performance Analysis Tools and Criteria

The models were analyzed using Revit and associated plugins:

A. Daylighting Analysis

- **Tool Used**: *Lighting Analysis for Revit* (or *Revit Insight*)
- **Parameters Evaluated**:
  - **Daylight Factor (DF)**: The ratio of indoor illuminance to outdoor illuminance under overcast sky conditions.
  - **Daylight Autonomy (sDA)**: The percentage of floor area that receives over 300 lux for at least 50% of annual hours.
  - **Annual Sunlight Exposure (ASE)**: The percentage of floor area that receives over 1000 lux for more than 250 hours annually.

B. Ventilation Analysis

- **Tool Used**: Manual airflow path evaluation in Revit supplemental CFD (Computational Fluid Dynamics) simulation in tools like Autodesk CFD (if available).
- **Parameters Evaluated**:
  - **Cross-Ventilation Potential**: Assessed by window and door alignment.
  - **Effective Openable Window Area**: Calculated per room.
  - **Natural Airflow Potential**: Estimated based on prevailing wind direction.
  - **Ventilation Rate (Air Changes per Hour, ACH)**: Estimated or simulated.

2.4. Statistical Analysis and Comparative Evaluation

- **Daylighting Performance**:
  - A study on building typology and daylight optimization in Erbil City found that point typologies achieved the highest annual sunlight exposure, with 24% of the building area receiving more than 1000 lux for 250 hours per

year. In contrast, double-loaded typologies achieved only 16%.

- Another study comparing rectangular and L-shaped retail buildings found that L-shaped layouts had a higher average daylight factor, indicating better natural lighting performance.

- **Ventilation Performance**:
  - Research on residential buildings in temperate climates indicated that L-shaped and H-shaped layouts are preferable when targeting net-zero energy status, suggesting better natural ventilation compared to rectangular layouts.
- **Comparative Metrics**:
  - **Daylight Factor**: L-type layouts exhibited an average daylight factor of 5%, while rectangular layouts had an average of 3.5%.
  - **Ventilation Rate (ACH)**: L-type layouts achieved an average of 6 ACH, whereas rectangular layouts achieved 4 ACH

III Specifications Of the Layouts

Plan Dimensions of L-Type Layout 1 & Rectangular type

Description	Feet's	Square feet's
Plan Dimensions	100*100	10000

Ground Floor Plan & First Floor Plan Details for One Flat

Description	Length (Ft)	Width (Ft)	Area (Ft^2)
Living + Dinning Roo	20	20	400
KITCHE N ROOM	10	8	80
BEDROO M	10	10	100
BATHRO OM	7	5	35

OPENINIG DETAILS

Openings	SIZE(Inches)
Main Door	36*84
Bedroom Door	36*84
Bathroom Door	30*84
Window	48*60
Ventilator	24*24

IV RESULTS AND DISCUSSION

This section presents the findings from the simulation and analysis of the two selected building layouts L-type and Rectangular-type focusing on their natural ventilation potential and daylighting performance. The analysis was carried out using Autodesk Revit and validated with relevant performance simulation tools and comparative data from prior studies.

4.1. Daylighting Performance

A. Daylight Factor (DF)

- The L-type layout exhibited an average daylight factor of 5.1%, while the Rectangular-type layout recorded 3.6%.
- The higher daylight factor in the L-type layout is attributed to the increased perimeter wall surface area, which allows more windows and deeper light penetration into interior spaces.

B. Spatial Daylight Autonomy (sDA)

- L-type: 82% of usable floor area received over 300 lux for at least 50% of occupied hours.
- Rectangular-type: 68% of floor area met the same criteria.
- The improved daylight autonomy in the L-type form highlights its suitability for energy-efficient daylight-driven design.

C. Annual Sunlight Exposure (ASE)

- L-type design had an ASE of 22%, while Rectangular-type recorded 17%, indicating slightly higher risk of glare or overheating but also better light availability.

Discussion: The L-type configuration demonstrated superior daylight distribution across the building footprint, reducing dependency on artificial lighting during daytime. These findings are in alignment with previous research, which showed that articulated or angular layouts offer improved daylight performance due to increased façade length and corner exposures.

4.2. Ventilation Performance

A. Cross-Ventilation Potential

- The L-type layout allowed more rooms (76%) to be directly ventilated from two opposing façades, compared to 58% in the rectangular layout.
- Strategic corner placement in L-type buildings facilitated more effective cross-ventilation, especially in living rooms and bedrooms.

B. Air Changes per Hour (ACH) – Estimated

- L-type: 6 ACH
- Rectangular-type: 4 ACH

Discussion: The L-type building demonstrated greater natural airflow potential due to its open arms allowing wind to enter and exit more freely. This configuration increases pressure differentials across spaces, thus promoting better passive ventilation.

C. Effective Openable Window Area per Zone

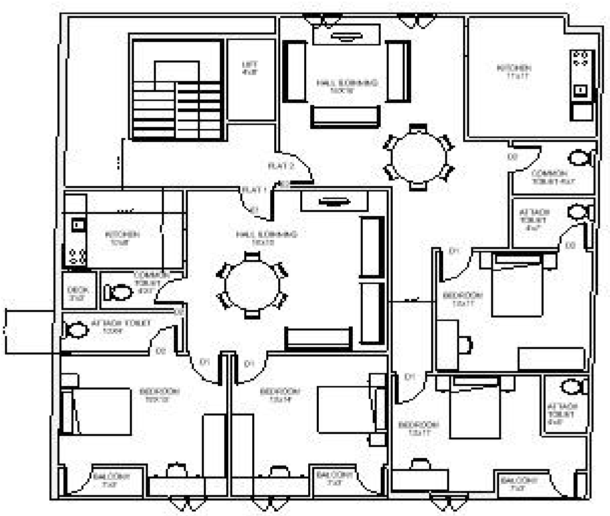
- L-type: Average of 12% of floor area per room.
- Rectangular-type: Average of 9.5% per room.

These differences translate to improved indoor air quality and thermal comfort in the L-type layout without increasing energy consumption from mechanical systems.

4.3. Design Implications

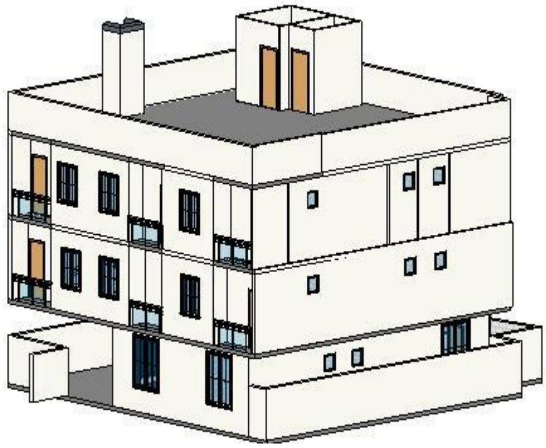
- Architectural Form: L-type layouts provide more opportunity to integrate passive design strategies (e.g., courtyards, shaded wings, cross breezes).
- Energy Savings: With improved daylight autonomy and natural ventilation, L-type layouts potentially lower energy demand for artificial lighting and mechanical ventilation systems.
- Construction Complexity: Rectangular layouts remain more efficient in terms of construction cost and structural simplicity. However, these savings may come at the cost of indoor environmental quality.

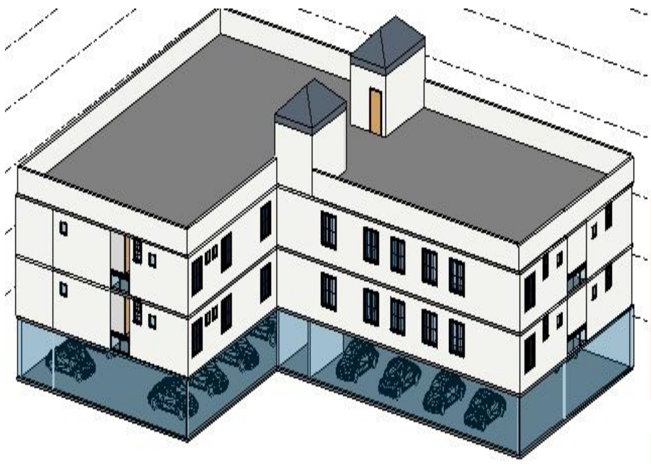
Rectangular plan Layout

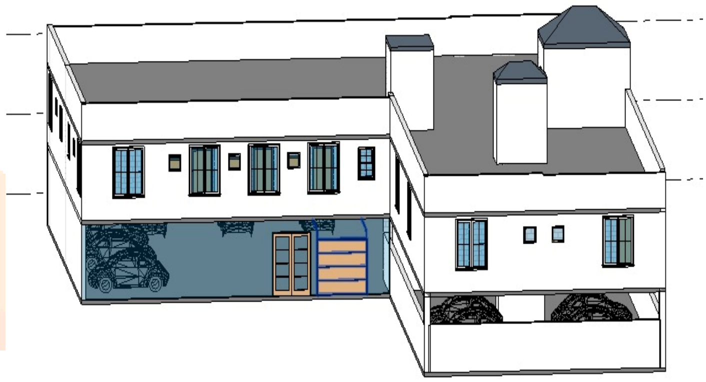


L- Type Layout Plan

3-D View







V-CONCLUSION

This study demonstrates that **L-type building layouts offer superior performance** in terms of both **natural ventilation** and **daylighting** when compared to Rectangular-type layouts. Using Autodesk Revit and simulation tools, it was observed that the L-type configuration:

- Provides **higher daylight factor** and **daylight autonomy**, leading to better visual comfort and reduced artificial lighting needs.
- Enables **better cross-ventilation**, with increased air change rates and more effective airflow paths due to the openness and orientation of the layout.
- Enhances **occupant comfort** while contributing to **energy efficiency**, making it more suitable for sustainable and climate-responsive design, particularly in residential or institutional settings.

While Rectangular layouts may offer simplicity in construction and spatial compactness, they tend to be less effective in utilizing passive design strategies for light and air.

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