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Comparative Study on New lighting Technologies and Buildings Plans for High-performance Architecture

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Abstract

Day lighting has usually been the relevant recognition of designers. Nowadays, due to economic, fitness, and environmental concerns, day lighting has taken on paramount significance. However, due to location and architectural regulations, using natural mild in all indoors spaces is a challenge dealing with architects. Today, although the development of contemporary lighting fixtures structures has contributed to a solution to this trouble, the provision of essential conditions for extra efficient day lighting necessitates a radical knowledge of all varieties of lighting structures and plans. This study aimed to further hyperlink technology and architecture to take the desired steps to resolve the shortage of indoors daylight hours with the aid of evaluating and selecting suitable daylighting systems and plans. To this give up, we first studied diverse modern-day lighting fixtures structures and analyzed their characteristics to prioritize and pick their maximum efficient elements and elements. On this regard, the FGD method became used to become aware of criteria and sub-standards. Then ANP became used to research and in comparison to pick out the most surest ones. in the subsequent step, we studied unique varieties of workplace plans to prioritize them based at the aforementioned elements. it is worth noting that to validate the results, we surveyed specialists in the field. In the closing step, we studied in comparison the compatibility of various plans and systems to obtain the most well matched ones

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1. INTRODUCTION

Improvement of indigenous fossil fuel sources, conservation applications, improvements in electricity conversion, and efforts to make use of renewable sources were delivered in reaction to the electricity disaster[1], [2]. Renewable power could be the plain destiny of mankind, in which the usage of gas desires is involved [3], [4]. Sun electricity has continually been considered as the primary supply of renewable energy [5], [6]. The organic significance of sunlight to humans has caused the sober utilization of natural daylight hours to illuminate the indoors of the constructing [7]–[9]. Day lighting is taken into consideration one of the fundamental layout features of power-efficient homes [10]. In line with the economic revolution on the end of the 18th century, the arrival of synthetic light furnished a uniform illumination throughout the daytime and marginalized herbal daytime. As a end result, the homes progressively reconciled themselves to new situations and synthetic lighting diverted the attention far away from the effect of building orientation [7]. This negligence ended in a health disaster, scarcity of power sources, and environmental pollution, highlighting the importance of renewable energies[10]–[12].

one of the influential elements to energetic and environmental is buildings' electricity consumption[13]. The architectural layout has outstanding capability to remedy this hassle[7]. In the usage of sunlight hours in a constructing for the visual comfort and properly-being of its residents, several factors ought to be considered, consisting of the composition of the light spectrum and think about to the outside. Negligence in using sunlight hours not only reduces the quality of indoors areas however also is associated with economic, health, and environmental problems as real challenges facing architects [8], [14]. The substitution of daylight for synthetic lighting fixtures can also reduce the software invoice[15], [16].

In latest years, special attention has been given to sunlight hours to lessen dependence on artificial mild, turning in electricity consumption performance[6], [16], [17]. concerning that, 90% of all daily sports at the moment are in closed spaces lighting are very important factors. According to studies, the use of natural light in all interior spaces of an office building increased the productivity of employees of about 15% [20], [21].

Economic analyses of energy consumption have shown that lighting accounts for approximately 30 % of electric energy consumption[22]. Although Tehran is a city with an average of 300 days of sunlight per year, a high percentage of buildings suffer from daylight deprivation. The country has total average electricity consumption of 2000 kW per year, which is considerably higher than in other countries [23].

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Today, there are several reasons for terrible day lighting in urban homes consisting of high-density urban sites, choppy building layouts, poorly designed spaces, inefficient windows and openings, and areas designed with low day lighting best and amount[22]. The changing needs for brand new constructing paperwork via new users have resulted in the construction of high-upward push, deep-plan, and compact homes[16]. Consequently, the high floor region to volume (S/V) ratio, which permits for daylight to attain maximum constructing areas, is now not an crucial factor [24]. Normally, the proportion of strength used by homes for lights is rising [25].
consequently, opportunity power resources, along with renewable power resources, need to be taken into consideration to generate electricity for lighting[26]. synthetic lighting strength use may be reduced by increasing indoor sunlight hours availability, thereby keeping the human circadian rhythms[7]. The improvement and usage of sun strength, as a clean electricity resource, have attracted a lot attention round the sector. The mechanisms for admitting sunlight hours into space are getting more and more popular [27]. Daylighting systems allow for redirecting daytime to the rooms far from sun radiation and offer a more dependable source of herbal light to indoor areas. Any effort to distribute daylight to deep spaces is useful. The minimum stage of three hundred lux is usually recommended for building cores and rooms with out windows to sense the actual sunlight hours presence [28].

2. RESEARCH METHOD

the thing focuses on various daylighting systems to adopting a technique to evaluate the compatibility of daylighting technology with established office plans, that could redirect and admit sunlight hours into areas as options to daylight hours penetration thru façade systems, wherein ground plans are deep, or elements of ground regions are disconnected from an outside facade. For this cause, a few articles, which related to the evaluation of different forms of systems one at a time, have been reviewed. additionally, it recommended a choice-making analysis approach. To this cease, we tried to prioritize daylighting systems with the aid of examining their most vital residences. in this regard, the FGD (consciousness institution discussion) turned into used to discover and gain important criteria and sub-criteria to charge daylighting structures. Then, we evaluated distinct styles of office-constructing plans based on essential layout elements with this method. ultimately, with the usage of the ANP technique and experts' evaluations, the strengths of every system and plan have been analyzed, assessed, and in comparison to perceive the most premiere ones.
It turned into estimated that using this technique/statistics in the early layout section ought to make a contribution to enhancing daylighting overall performance outcomes for workplace homes, which can, in turn, lessen energy intake and operating expenses.

OVERVIEW OF OUR APPROACH

consequently, this observe was performed to deal with the importance of strength crisis for lighting fixtures, because the number one situation of the present take a look at, and to fill the research gap in Iran. This observe was typically made out of three steps (Fig 1):
• First, finding appropriate solutions to cope with the power disaster and growing new daylighting structures.
To this give up, writers studied a unique sort of daylighting systems and then acquired criteria and sub-criteria, which can be essential elements to charge those structures, based on effects from the FGD approach and surveying the experts' opinions.
• 2d, reading existing workplace constructing plans and studyingtheircharacteristics.

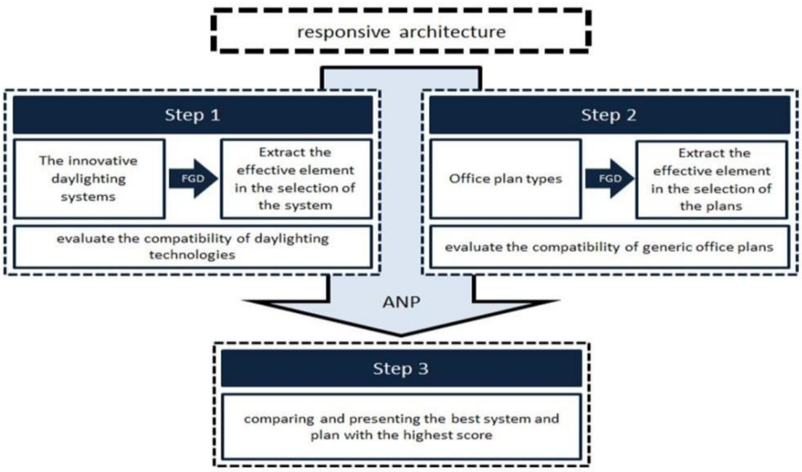

Fig 1 Liner Diagram of the present research structure and its three steps

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To this end, writers investigated and evaluated existing office building plans and their specific characteristics.

- Third, the ANP method was used to prioritize criteria and sub-criteria for compatibility of the tools with the buildings. Then the strengths of each system and plan are analyzed and compared to identify the most optimal ones.

To this end, writers investigated the results from previous steps and compared all scorers with each other.

STEP 1

Innovative Daylight Systems (IDS)

Considering the potentials of IDS, we first needed to examine the challenges in selecting the appropriate daylighting elements. The literature review resulted in four categories [23].

The first category concentrated on innovative assessment techniques [29]. The second category focused on efficiency improvement. The third category was based on adopting an appropriate scheme [30]. The fourth category included controlled studies into the adaptation of daylighting systems to specific physical characteristics of a building [31]. The results from the literature review showed that adaptability is one of the most essential characteristics of the system. Therefore, a quantitative estimation of the system performance does not necessarily draw a firm conclusion [32].

This step showed that other parameters are also involved in the interaction of IDS [33]. Based on the significance of integrated design for architects, an in-depth analysis of daylighting technology and its elements can show the factors affecting the selection of an appropriate building system [34].

A comprehensive classification is required due to great variations in the DGS. They can be classified based on the work function of their components. Each system consists

Table 1 Types of innovative daylight systems, their three components and their performance

		System type	advantages	disadvantages
Light collection - collector	Concentrating collectors	• Anidolic concentrators	• Increase the optical efficiency by up to 5 times in cloudy skies • Thermal control • Glare control • high reflection coefficient • Suitable for high density • Ability to combine with canopies • Low light absorption	• Functional interference with technical systems • Reduce the internal height • Suitable for indirect light • Suitable for cloudy climates
		• Light concentration system	• Focus light • Reduce light carrier space	• High cost • Need expert force to build and install
		• Luminescent solar concentrators	• independence on the angle, direction, and height of the sun • performance of collector and distributor • Reduce the dimensions of the light tube	• Fluorescent carcinogenicity • Proper performance up to a depth of 10 meters • Low efficiency Inadequate Color Rendering *Index*
		• Laser-cut panel	• Inactive system • Input light control • Heat control • No need for specialists	• Functional constraints • independence on the angle, direction, and height of the sun
	Light redirecting collector	• Light redirection system	• high efficiency • Proper penetration depth	• High construction and maintenance costs • large scale • Occupy a lot of space for the transmission of light • Active system
		Heliobus	• high efficiency • Proper penetration depth	• High construction and maintenance costs • large scale • Occupy a lot of space for the transmission of light • Active system
Light transport systems		• Lens system	• Easy installation • Not occupy a lot of space	• Need to clean the lens • Need to adjust the lens • Need parallel lights
		• Mirrored light pipes	• Cheap and affordable • Integration of natural and artificial light • Integration with the ventilation system • Efficient in cloudy weather • Easy maintenance • Simple structure	• limitation of Dimensions and diameters • Depth limitation • Lack of flexibility in installation • Low efficiency • The maximum transfer depth is 30m
	Hollow prismatic pipes	• Natural light	• performance of transport and distributor • Horizontal and vertical performance • High efficiency • Appropriate visual quality	• Low flexibility • Possibility of light leakage
		• artificial	• Ability to integrate with artificial light • Ability to work at night	
		• Solid core systems(fiber optics)	• flexible • High efficiency • Easy installation • Minimal changes in the building • High volume light transmission	• Need a complex collector • Possibility of light leakage • Inefficiency in cloudy weather • High repair cost • The maximum depth of light transmission is 30m
Light distribution		• Light extraction	• Management of light output Distribution uniformity	
	Light emission	• Combined transport & emission	• Continuous light output along the pipe • Synchronous process of transmission and distribution	• Not controlling each section separately
		• Discrete emitters	• Abilty to distribute light separately	
		• Other emitters	• Uniform distribution of light in space • Inactive system	

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of three essential components, namely solar collector, transporter, and emitter [6][35][36]. Each component has different types, the combination of which produces different systems [8], [9], [12], [16], [23], [35], [37].

For this purpose, in the following, a table of different types of innovative daylighting systems has been analyzed, in which the advantages and disadvantages of each system have been described separately(Table 1).

Regarding what was mentioned earlier and constituent parts of the IDMs (collectors, transporters, and emitters), there are other effective factors and components, except effective factors of quantitative estimation of the tools, which play an effective role in higher compatibility of the tools with the buildings. Method FGD has been used to obtain effective criteria for selecting and adapting systems.

Focus Group Discussion (FGD)

the focus organization dialogue is used as a systematic way to expertise troubles and locating intervention techniques via asking particular questions with formal and casual orientations[38][39]

Attention institution dialogue is one of the beneficial and suited strategies in the field of difficult [40]. Maximum researchers use this technique to get ideas, reviews, and issues related to the motive of their researches [41]. FGD enables researchers to assess their desires before design and also after implementation in the end. on this method, interviews and meetings with target organizations are conducted in accordance to research expectancies. To achieve records in this method, a purposely organization of individuals is chosen. There

Frequently FGD is used as synonymous with interviews (“group interviews" and “one-to-one”)[39]. but, the role of the researcher and also the verbal exchange with the contributors is a essential diversity of evaluations among the 2 methods [43]. Interviews involve a qualitative, in-intensity, and one-to-one discussion. on this approach, the researcher is much like “investigator it method that the researcher communication with a sure man or woman and asks some questions so he controls the dialogue’s dynamics at a time. however, the researcher is inside the function of a “moderator” or “facilitator” in a focused organization dialogue. in this technique, a set dialogue between contributors is facilitated or moderated via the researcher [44][45][46].

by using inspecting functions of daylighting systems and the use of the FGD approach, the following conceptual version became advised as green factors of machine compatibility with constructing, presenting a new framework for expertise the interactions among these equipment and the building. similarly, all components have been analyzed and prioritized to select the most compatible mild transmission device. on this step, a conceptual model turned into created as a new framework to decide the combination additives of the IDS: lighting overall performance, utilization, building compatibility, and social area (Fig 2).

lights performance

The lights overall performance of IDS refers to the share of light gathered from the supply and transmitted into the building [47]. it is an critical component of the pleasant and amount of light with their particular

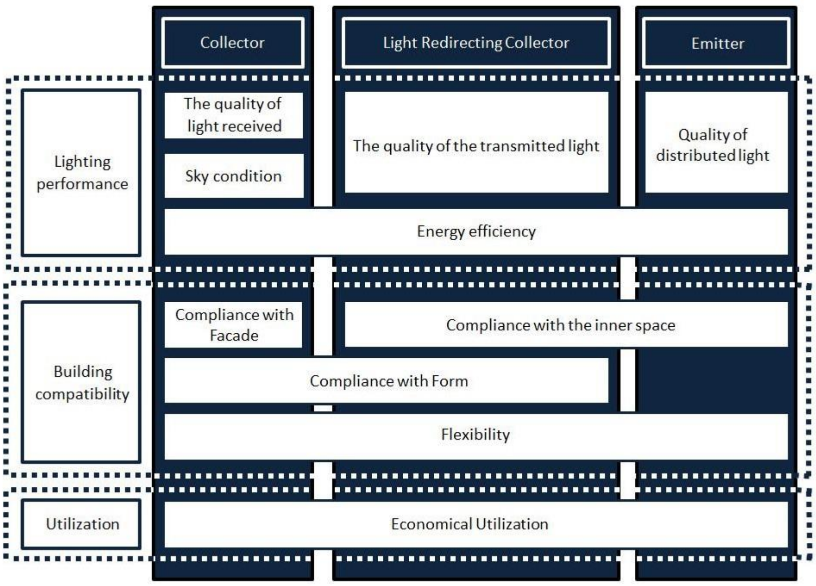

Fig 2 Classification of Effective Components in the selection of the appropriate

are no critical evaluations of the application of the technique [38].

One application of FGD is system development. In this technique, different methods can be evaluated. Also, the needs of designers and users can be understood. by this method, the researcher can be obtained the way of thinking, priorities, specific points, and other unique characteristics of groups[42]. Finally, this method can be considered as organized discussions with selected and

specific groups to know their views and experiences about a specific topic.

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criteria. The quantity of light is one of the most common assessment criteria.

In IDS, the quantity of light quantity is measured with the following three criteria: the amount of collected light, the amount of directed light, and the amount of emitted light. Based on the component technology, these systems differ in the level of efficiency [48].

There are few clear definitions for the indices of light as a physical phenomenon including architectural space, space perception, and visual, physical, and mental effects. Among the quality components of light are maintaining daylight color and ultraviolet ray resistance.

Building compatibility

In this area, the main focus is on the relationship between modern systems of light and building for higher system efficiency. It includes such indices as compliance with form, façade, and internal space, and flexibility. Each of these indices has a different significance and coefficient.

Compliance with Form

This criterion shows the physical relationship and compliance of systems with the building, which depend on a system's mechanism. Due to the physical interference of systems with the collection, transportation, and emission processes, it can be assessed based on the required space and dimensions. According to aforementioned criteria, it is needed to determine the required degree of change in a building to make it compatible with a given system and to examine whether the building has required physical potential for the installment of the system[49]–[56].

Another aspect of interaction with the building is the compatibility of a system's form with a building, which

the other hand, some tools will not be capable of integration with the interior space and require redesign considerations inside space [24], [49]

Compliance with the facade

Facade compatibility refers to the visual effect of the system on the facade. The effect of optical collectors on the cityscape changes the skyline and the roof view, as significant factors in the urban scale[32], [49].

Areas of Utilization

This study proposed a new technique based on the system's design. The original cost involves all production and shipping expenses.

The criteria in energy

This criterion in energy systems is among the most important factors for efficiency assessment. Regarding the use of different technologies and/or the replacement of costly attachments, it tries to reduce its role in selecting an appropriate system[47], [57]–[59].

The cost of setting up

This criterion includes all of the fees, government energy incentives, and costs of the system operating. The

can be applied to a range of additional elements. The above aspect explained the conformity with the internal space and façade of the building.

Compliance with the internal space of the building

It refers to a set of visual effects of the system on the interior space of the building. Optical interference is created within the interior space according to visual quality. It affects the visual quality of the internal space and thus is a challenge facing the architects and interior designers. Some of the light transmission and distribution tools can be used as interior elements and provide favorable feedback to be integrative and adaptable to the internal space without causing the visual obstruction. On cost of setting up has a lower priority than the initial cost [58]. The cost of maintenance of the system includes the cleaning and replacement of parts of the system, which varies depending on the static nature of the system [47], [60].

According to the above description and the role of active components in selecting an appropriate system for all three parts of the system (collector, light transporter, and distributor), first, writers should determine the effectiveness of active components then prioritize each system based on their critical features.

therefore, writers used the method to measure the important coefficients of each indicator and prioritized.

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Table 2 Properties and performance indicator of Light Redirecting Collector with the significance of them

	Properties	Total importance coefficient	Assessment indicator	Importance of indicators
Collector	The quality of light received	7	Maintaining daylight color	10
			UV resistance	9
			uniform light	8
			Excessive focus and fire creation	7
			Understanding light in all directions and angles	6
			The density of light	5
			IR resistance	4
	Economic exploitation	6	The proper initial cost	8
			Ease of installation - not requiring expert force	7
			Ease of maintenance	6
			not requiring special cases	5
	Energy efficiency	5	The received light is equal to the light	6
			Lack of dependence on the dimensions and properties of the system	5
			Not attracted much of the incoming light	4
	Adaptability to the facade	4	Facade compatibility	6
			Facade shape compatibility	5
			Opening Arrangement	4
			Lack of sight and view	3
			Compliance the proportions of the building facades	2
	Building shape Compatibility	3	Lack of high space occupation	5
			the lack of need to change the physical	4
			Uniform distribution of light	3
			Compliance with the form of a building	2
			Compliance the proportions of the building components	1
	Flexibility	2	High - level technical harmony with the building	3
			Possible to change the size and size according to the constraints of the plan	2
			Possible to connect with different types of light redirecting collector	1
	Sky condition	1	The orientation of the sun and the maximum light.	3
			The right efficiency in the favorable weather conditions	2
			The possibility of using a cloudy climate	1
			No use in overcast weather	0.5

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Table 3 Properties and performance indicator of Light Redirecting light transporter with the significance

	Properties	Total importance coefficient	Assessment indicator	Importance of indicators
Light Transporter	The quality of the transmitted light	6	Flat light transfer	9
			Maintaining daylight color	8
			The combination of natural light and artificial light	7
			UV resistance	6
			IR resistance	5
			the possibility of using the light on the path	4
			Glare Prevention	3
	Economic exploitation	5	The proper initial cost	6
			Ease of installation - not requiring expert force	5
			Ease of maintenance	4
			not requiring special cases	3
	Compliance with the inner space	4	Compliance with the form of the internal space of the building.	6
			Non - occupation of the interior	5
			Flexibility with internal space	4
			The aesthetic of Interior Space	3
			The absence of need for isolated internal space	2
	Flexibility	3	High - level technical harmony with the building	4
			Possible to change the size and size according to the constraints of the plan.	3
			Possible to connect with different types of light redirecting collector	2
	Energy efficiency	2	The received light is equal to the light	4
			Lack of dependence on the dimensions and properties of the system	3
			Not attracted much of the incoming light	2
			Lack of impact of transmission length with productivity	1
	Building shape Compatibility	1	Possible vertical and vertical transmission of light	4
			Compliance with the form of a building	3
			Lack of high space occupation	2
			Lack of limitations on the scale	1

Table 4 Properties and performance indicator of Light Redirecting distributor with the significance

	Properties	Total importance coefficient	Assessment indicator	Importance of indicators
distributor	Quality of the output light	5	Uniform distribution of light	7
			Having natural light properties	6
			Glare Prevention	5
			Create shadow and light	4
			The control of the light and the aristocracy	3
	Compliance with the inner space	4	The aesthetic of Interior Space	6
			Lack of visibility outside the urban landscape	5
			Opening Arrangement	4
			Compliance with the form of the internal space	3
			Flexibility in dimensions with respect to the interior space.	2
			Compliance with the proportions of the interior components	1
	Energy efficiency	3	The received light is equal to the light	4
			Lack of dependence on the dimensions and properties of the system	3
			Not attracted much of the incoming light	2
	Economic exploitation	2	The proper initial cost	3
			Ease of installation - not requiring expert force	2
			Ease of maintenance	1
			not requiring special cases	0.5
	Flexibility	1	Possible to connect with different types of light redirecting collector	2
			High - level technical harmony with the building	1
			Possible to connect with different types of light redirecting collector	0.5

components based on the opinions of the experts, which had been obtained by the FGD method (Table 2, 3, 4).

STEP 2

The office patterns

Several factors affect the applicability of a building. These factors are divided into two categories related to the outside environment or associated with the building itself [61].

Different approaches have been used to design typologies of office space. In general, there are two key approaches in designing office buildings: inside-out and outside-in [62].

Different programs have been proposed for designing office buildings with a primary focus on the surrounding landscape, geographical directions, the ability to receive light from each direction, and the ability to reduce the influence of daylight penetration in the building. According to the primary approach of this study, the components related to the index of organizational space

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typologies will be considered to be general and permanent. Therefore, the variables and main componentsof the research are related to the shape and spatial arrangement of the inner space.

The patterns of the floor of the building/shape of the plan

The shape of the building floor or the plan is one of the essential features of an office building in terms of daylighting efficiency. In a study conducted in the research center and building of Iran on office building typologies, the overall building plan was considered. These types of office buildings are classified based on the Krum's capabilities.

A study published in "The Design Code of Administrative Buildings"[61 showed that the majority of four general, linear, radial, radial, and central squares models present 10 major generating typologies and 15 optimal shape typologies in general. In another study, the prevailing typologies of the office building plan were analyzed in terms of total energy consumption [61], [64]– [66]. In some cases, geometric criteria for describing typologies are presented. Moreover, some studies are, typologies focused on the geometrical features of the plan. In some other studies, the typologies concentrated on the common factors influencing the formation of office buildings. As a result, regarding different distinguishable capabilities of plan typologies, such typologies as L, T, U, H, and cross-like (Y) were analyzed[67].

By adjusting the typologies given in previous studies, seven typologies of L, T, Crusades, O, and Y, and three arms were selected as the typologies studied in this paper (Fig 3).

It is worth noting that the typologies of the office plans used for the analysis were extracted previous studies on the office plan typologies[64], [65].

As the first step, an appropriate criterion was selected for the assessment of the components and features. To this end, we extracted five major factors for the selection and design of a plan and their vital role in the following table. In the second step, these factors were discussed one-by-one.

Effective Components in Plan Selection

The depth of plan: the most crucial element about the collection of daylight the depth of the plan. The focal length of the building, or the non-front to the outer wall or atrium, is defined as the depth of the plan. Duffy has divided the depth of office typologies into shallow, medium-depth, deep, and very deep [68].In all typologies, according to the results of this thesis, the optimal depth of plan is maximally 12 meters. It is because of the higher angle and lower depth result in better view quality in the workspace. According to the results[67], the maximum daylight is used when the mean depth of the plan is less than the sidewalls.

The ability to use daylight: It is necessary to change architectural design considerations as a fundamental and essential source. A sound system provides the proper distribution of light from one or more directions, providing sufficient light surfaces for daily activities[69]. Researchers found many design factors of daylight in office spaces. Electric energy consumption level is an internal lighting factor, which depends on the form of the building. Studies have shown that the efficient use of daylighting is achieved when it provides light to 75% of the interior space [70].

*Interior flexibility***:** The internal composition of spaces is among other active plan elements. To design office spaces with higher performance, some studies classified them into cell offices, shared-room offices, and open-plan offices. Some previous studies have analyzed different types of workspace in terms of employees' satisfaction with natural lighting. In terms of daylight visibility, the flex offices performed better than open-plan offices [71].

*Proportions***:** The component proportion depends on the ratio of plan kurtosis, width, and overhang. In this study, the results from a doctoral thesis by Morteza Malek were applied. By change the aforementioned components, we achieved optimal performance of each plan based on the experts' optimal scoring schemes.

*The compression or circular ratio***:** this criterion is calculated based on the length of the circumference of the reference plan to that of the desired plan. For the relationship between the relative compression ratio and energy consumption, we found that the energy consumption factor increased with reducing energy consumption, and Energy dissipation increases and its management gets more difficult with reducing the compression ratio to lower than 0.55[67].

According to the aforementioned explanations about useful elements in the design and selection of the appropriate plan, we drew the following table to represents the important coefficients of each indicator and prioritize the components based on the experts' opinions (Table 5).

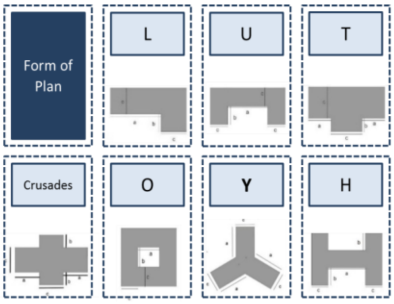

Fig 3 The patterns of the office patterns investigated in the

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Table 5 The properties and indicators of the plan evaluation and their importance

	Properties	Total importance coefficient	Assessment indicator	Importance of indicators
Plan	Depth of plan	5	Keep the quality and quantity of light in the depth of the plan.	6
			desired, from the furthest away distance	5
			Optimal depth = 12m	4
	The ability to use the light of day	4	Make maximum use of daylight due to weather conditions and conditions	6
			Uniform distribution of light day	5
			Ability to save electricity (artificial lighting)>75%	4
			Understanding the brightness of daylight in space>75%	3
			Ability to receive light in all directions	2
			A dazzled state of light from the direct light of the day.	1
	interior Flexibility	3	effectiveness different types of internal space (Cell - Open – Combined)	4
			variable of the location of spaces with respect to view and light	3
			Possible to change the interior spaces	2
	proportions	2	a defined relation between kurtosis, width, and ledge	3
			balance in plan	2
			Modula	1
			The aesthetic of Plan	0.5
	Compression ratio	1	The optimum ratio of the shaft to the level of the whole space.	2
			The absence of non - rational proportions	1
			The compression ratio of the compression ratio is 0.55 = optimal compaction.	0.5

2.3. STEP3

This step aims to identify the most compatible tools and office plans. For this purpose, the results of previous steps were used to analyze.

The related tables (table2, 3, 4, 5), which were drawn based on the literature results and experts' opinions, were used to analyze and compared all scores to identify the most optimal one.

In Fig 4,5,6,7, the scores of different types of systems were displayed separately in 3 parts (collector, Carrier, and distribution). It should be noted that the final score is the sum of the total score, which was obtained considering the system's components and the effectiveness of these active components. The following results were extracted from these tables:

***Collectors** (Fig 4):*

- Sundolier system has the highest scores in the quality of light.
- Parabolic linear system has the highest score and the most economical system, followed by the laser cut panels system.
- Linear Anidolic collector systems and Sundolier systems with a score of 50 have the highest energy efficiency score among.
- SunCentral systems have the highest score and the Linear Anidolic collector systems have the lowest scoring in terms of compliance with the facade and the body.
- Solar canopy system has the highest flexibility score.
- Solar canopy system has the highest scores and Helibus and Heliostat systems had the lowest scores regarding weather conditions

***Carrier** (Transporter) (Fig 5):*

- Mirrored light pipes system has the highest score and the Prismatic light pipes system has the lowest scores in quality of the transmission light.
- Light duct system has the highest score in economic efficiency.
- Solid core systems and Fiber optics have the highest harmony with the interior space, and the Light ducts system has minimal harmony.
- Solid core system has the highest score flexibility.
- Fiber optics system luminescent system has the highest and lowest scores in the optical efficiency, respectively.
- Solid core systems and fiber optics systems have the highest score in physical compliance

***Distributors** (Fig 6):*

- Paran systems have the highest score in the quality of the output light.
- Fiber optics system has the highest score in compliance with the inner space.
- Fiber optics systems and Parans have the highest score in energy efficiency.
- Prismatic light pipes system has the highest score in economic efficiency.
- Conductivity system has the highest score in flexibility.

In conclusion, the Sundolier system, followed by SunCentral and Paran systems had the highest total score in light collection efficiency. The HIMAWARI solar lighting system had the lowest score. The Fiber-optic systems, followed by the Solid core systems and the Luminescent system had the lowest total score in light transportation. The fiber optic system has the highest total score in the distribution of light.

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	systems	The quality of light received (10 9 8 7 6 5 4)	Economic exploitation (8 7 6 5)	Energy efficiency (6 5 4)	Adaptability to the facade (6 5 4 3 2)	Building shape Compatibility (5 4 3 2 1)	Flexibility (3 2 1)	Sky condition (3 2 1 0.5)
Collectors	Linear Anidolic collector	203	126	50	0	9	4	3.5
	parabolic collector	161	114	20	28	9	2	2
	Luminescent	126	78	0	28	15	2	5
	Parabolic dish	203	0	20	28	20	6	5
	Parans system	221	108	20	28	36	2	5
	Sundolier system	252	108	50	48	42	10	6.5
	Himawari system	42	78	0	28	9	2	5
	Helibus	210	0	20	28	9	2	0
	Heliostat	252	30	20	12	9	2	0
	Laser cut panels	189	120	20	28	15	0	2
	SunCentral	245	84	20	52	45	2	5

Fig 4 The prioritized list and scoring for each indicator in the collector variety

		systems	Quality of the output light (7 6 5 4 3)	Compliance with the inner space (6 5 4 3 2 1)	Energy efficiency (4 3 2)	Economic exploitation (3 2 1 0.5)	Flexibility (2 1 0.5)
carrier (Transporter)	Continuous Emitters	Prismatic light pipes	30	36	6	12	2
		Fiber optics	35	84	27	9	0.5
		Luminescent	40	36	9	0	0
		Double light pipes	40	36	18	0	0
		Conductalite	15	36	6	7	2
	Discrete Emitters	Parans system	70	44	27	7	0

Fig 5 the priority table and the scoring for each indicator in the distributors

		systems	The quality of the transmitted light (9 8 7 6 5 4 3)	Economic exploitation (6 5 4 3)	Compliance with the inner space (6 5 4 3 2)	Flexibility (4 3 2)	Energy efficiency (4 3 2 1)	Building shape Compatibility (4 3 2 1 0.75 0.5 .025 0.15)
Light Transporter	Guiding Transport	Luminescent	203	0	28	15	0	1
		Lens system	102	15	28	6	4	1
		Prismatic light pipes	66	75	12	6	12	4
		Solid core systems	144	75	120	27	6	10.5
		Mirrored Light pipes	174	50	71	21	4	1.5
	Redirecting Transport	Double light pipes	144	30	28	6	12	4
		Fiber optics	168	70	120	9	12	10.5
		Light ducts	120	90	0	6	10	4

Fig 6 the prioritized list and scoring for each indicator in the Light Transporter variety

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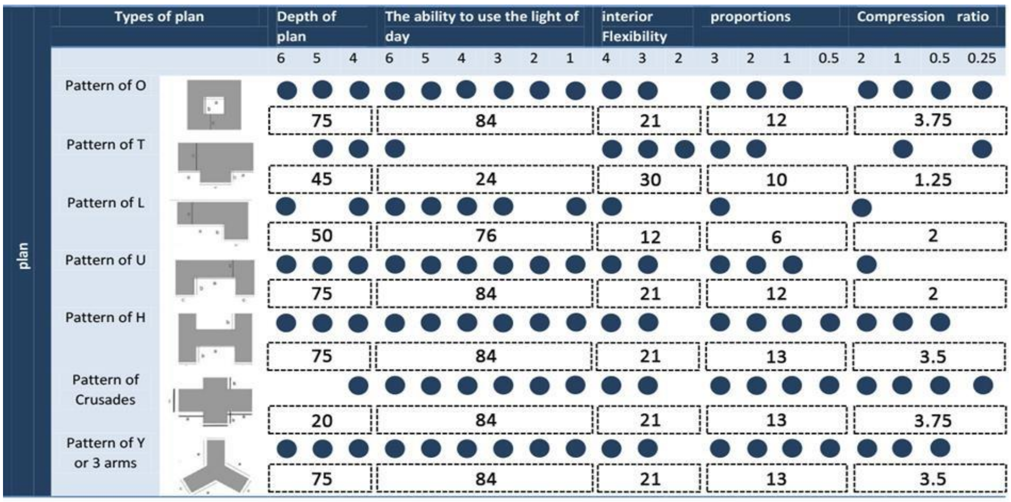

Fig 7. The prioritized list and scoring for each indicator in the plans variety

***Plan** (Fig 7):*

- The following results can be obtained from the corresponding table with respect to plans:
- Typologies O, U, and H have equal points in the depth of the plan and the usability of the daylight.
- Typology Crusade has the lowest score in the depth of the plan
- Typology L has the bottommost score in flexibility.
- Typologies Y, H, and Crusade have the highest scores in proportions, and the typology L has the lowest score in this criterion.
- Typologies Crusade and O have the highest scores and typologies L, U have the lowest scores in compression ratio
- It can be concluded that typologies H, Y have the highest total score and typology T has the lowest scoring.
- The following tables represent the comparison results between the scores of typology in each area. These tables also present the comparison results between the scores of each typology in each area (lighting performance, building compatibility, and utilization).

3. RESULT

This phase gives the experimental layout, datasets, assessment strategies, and consequences in element. Due to the high diversity of daylighting systems, the components of each system (collector, carrier, and distributor) were assessed separately for better system analysis and assessment. Tables 2, 3, 4, and 5 present the assessment criteria for each part of the lighting systems and office-building plans. These tables were assessed by interviewing experts in this field using the FGD method.

As a end result, the significance of the effectiveness of these lively components turned into decided using the FGD approach and ANP approach. The distinctive elements of each system had been scored based at the statistics obtained about its characteristics.

each attribute has a particular coefficient shown within the desk derived from the FGD method. After completing the rankings for every segment, the subsequent diagrams had been drawn for better system analysis (Fig 8, 9, 10). As changed into cited in step 3, the subsequent effects have been obtained:

• Soundolier machine had the very best score in the collector phase

• Optical fibers had the best rating within the provider and distributor sections

similarly to the daylighting structures, the office-building plans were examined and prioritized. Fig three gives these office-constructing plans. as the first research step, the residences of each model have been studied to decide the most effective criteria for the compatibility of office-constructing plans with daylighting structures.Then, the priorities in each plan were examined to obtain the

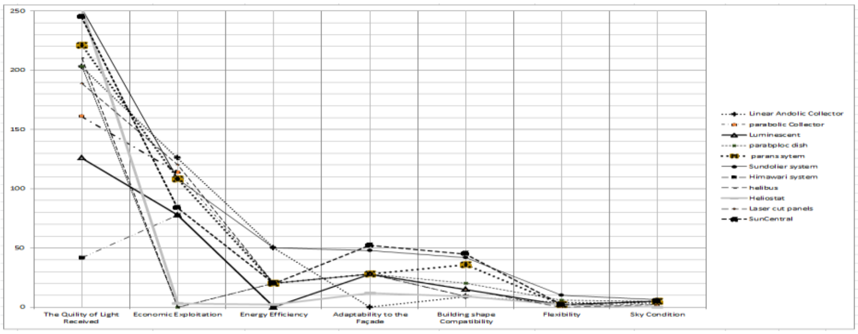

Fig 8. System Evaluation Results in the Collector Section

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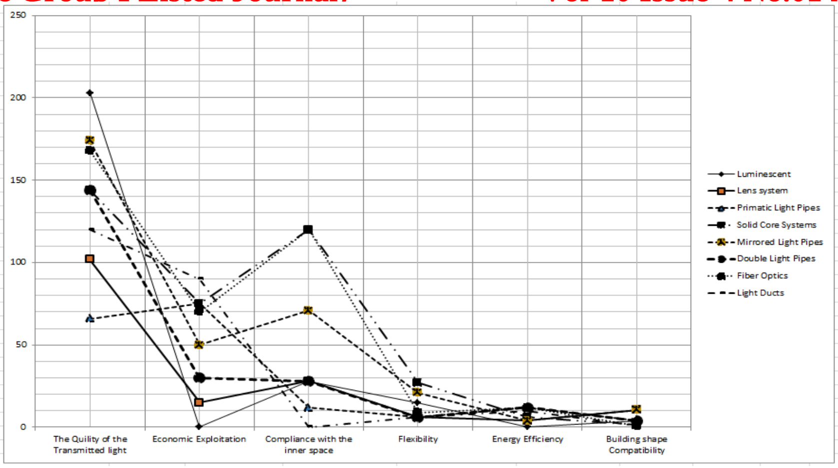
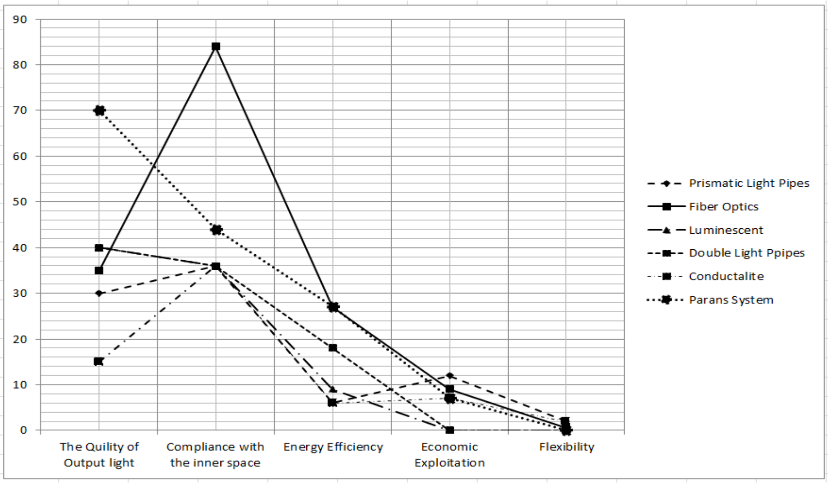


Fig 9. System Evaluation Results in the Distributors Section



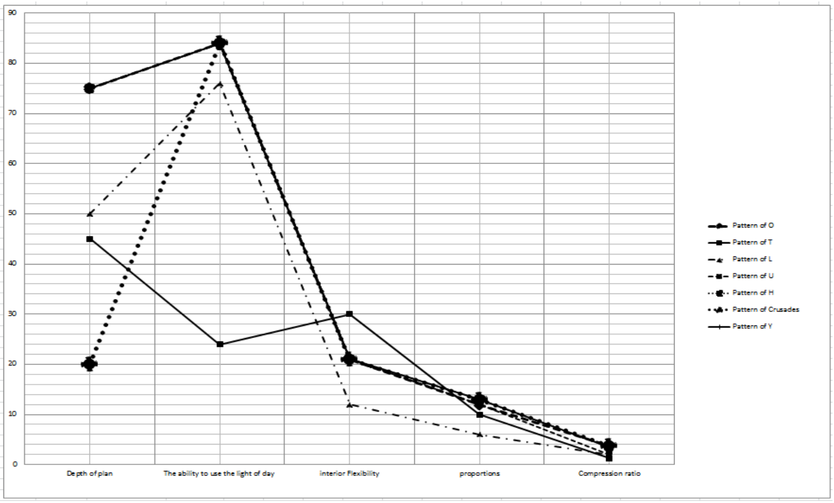


Fig 10. System Evaluation Results in the Carrier Section

Fig 11. System Evaluation Results in the plan Section

coefficient of the significance of each criterion using the FGD method.

Then, the characteristics of plans were examined to prioritize them according to their significance factor, to make some better comparisons. Concerning the merits of each plan, Plans H and Y had the highest score in terms of compatibility with daylighting systems (Fig 11).

4. DISCUSSION

he most use of renewable energy, such as sunlight, need to no longer be disregarded because of daylighting troubles. The excessive lighting near the porch and

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inadequate mild within the lower back room have been many of the demanding situations going through us in using daylighting. One answer is to use modern-day daylighting systems that can direct sunlight hours into the stop of the room.. The use of light transmission systems in the building reduces the energy consumption for artificial lighting, thereby reducing the heating and electrical loads as it transmits natural light to the building's depth and provides the necessary light to the room's endpoints. the use of modern-day daytime systems permits the higher use of daytime. We want to assume greater about how those structures suit into the development to make better use of these technologies.

This studies adopted a longtime qualitative Analytic community procedure technique to comparatively compare current proprietary daylighting systems when it comes to spatial characteristics of customary workplace plan typologies.

it is expected that the use of this approach/data inside the early layout phase ought to make contributions to improving daylighting performance consequences for workplace buildings, that can in flip lessen power consumption and running fees. This paper aimed to discover the factors influencing the selection of new mild transmission technologies and their effects, in addition to the variables influencing the layout of workplace building plans to maximize the compatibility of these two fields and to increase the system efficiency. To promote these objectives, we first examined all mild transmission structures and each characteristic of them, as changed into cited in advance. In choosing these systems, we investigated the effective factors and prioritized the additives and decided the coefficient of significance using the FGD technique.

the subsequent step became to prioritize and determine the schemes based on every thing's coefficient. special kinds of office plans have been studied along side these steps and the efficient components for developing an premiere plan had been extracted. To prioritize the plans with those coefficients, the FGD method become used as a first step to determine the critical factors of plans. The effects of each step had been assessed within the very last step and priority became given to lighting systems in each plan. this will be carried out to more than one plans. understanding every shape and plan's traits and advantages, architects could have a higher option to use to make the great use of daylight in the plan. With the help of those effects, architects can realize that what number of rankings each daytime system or plan has, and it is straightforward to evaluate them collectively.

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