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The Influence of Building Form Compactness on Energy Efficiency in Accommodation Structures: The Case of Türkiye

Özlem KAHRAMAN [*1], Erdem KÖYMEN[1]

Abstract

Based on the information found in the literature, which suggests that "more compact forms closer to squares are preferred in building designs in cold climate regions," this study investigates to what extent the existing theoretical knowledge of compactness is practically followed in the shaping of winter tourism accommodation structures and how the differences in building form based on regions affect the amount of energy consumption. Cold climate region structures were preferred because compactness is more comparable in terms of form and provides a constraining plane. In this study, 50 accommodation structures in different regions that are most preferred for winter tourism were evaluated based on compactness. The existing and compact projections of the selected structures were measured, and then these plan projections were superimposed to obtain compactness ratios. Additionally, the structures were 3D modeled in both the existing and compact forms, and the energy consumption amounts for both forms were measured using the "Energy Plus" energy simulation engine with the assistance of the "Ladybug" plugin, which operates in the Rhinoceros3D/Grasshopper3D environment. Furthermore, data such as the facade opening ratio, main facade direction, and number of floors were determined and compiled into a table. As a result, it was found that increasing the surface area significantly affects the compactness ratio in accommodation structures with relatively small floor areas. There is a linear relationship between the increase in floor area and the number of floors. It was determined that there is no specialized building form or main facade direction for any region. In regional evaluations, it was observed that the difference in projection is low in regions where the difference in energy consumption between the existing and compact forms is also low.

Keywords: Accommodation structures, compactness, energy-efficient, winter tourism

1. INTRODUCTION

Since the Industrial Revolution, the need for energy has been steadily increasing [1]. This situation is significant not only for all fields but also for the discipline of architecture, and the increasing number of studies on the effective use of energy demonstrates this.

Energy-efficient design aims to ensure that a building consumes energy in the least amount and most beneficial way by utilizing physical

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environment and climate data [2]. Achieving energy efficiency in buildings occurs in two stages. The first stage can be achieved during the design phase, known as passive systems, by evaluating factors such as topography and orientation. The second stage generally involves incorporating mechanical and technologically adaptable system elements into the building materials and facades [3]. The literature review reveals that energy efficiency is predominantly approached within this second scope.

Research has highlighted the necessity of diversifying building forms based on climatic regions and emphasized the context of thermal effects in exploring the architectural expression of buildings [4]. In cool regions, where temperatures are lower, the principle of elongating structures in the East-West direction to mitigate the effects of the sun is challenged, thereby necessitating the creation of forms closer to squares. The upper limit in this context is a "rectangular" shape determined based on the East-West direction and climate, while the lower limit is a "square" shape [5]. Additionally, research conducted by Lütfü Zeren suggests an optimum ratio of 1:1.2 for building form parameters in cold climate regions [6]. Architect Richart L. Crowther has also recommended enclosed compact forms for structures in cold climate regions [7]. In hot climate regions, courtyard building forms are commonly observed, with the aim of providing natural ventilation and creating circulation spaces to maintain a cool environment and enhance indoor air quality [8]. Therefore, building form is an important factor that influences energy consumption and determines the level of utilization of the physical environment. In this regard, the analysis of these environmental effects becomes crucial during the process of determining the form. As seen in the shared literature, experts suggest that architectural forms should be kept as compact as possible, approaching basic rectangular shapes, to minimize heat loss.

Compactness in architectural design is one of the powerful tools that can be used for energy-efficient building design due to its impact on understanding and managing the process of form-space formation. With this feature, compactness can complement the evaluation of the thermal resistance of building components in order to control heat loss and gain in the architectural design process. In architectural design, compactness defines the degree of merging and connecting building areas. Although compactness in architectural design has not been studied as an independent subject, many researchers have addressed the impact of compactness factor when examining environmental design or conducting cost analysis of energy consumption, and have concluded that the external envelope of a building changes according to the building's shape and a compact building has a minimum perimeter and a maximum floor area [9]. Various studies related to the scope of research topics and their correlations with the field have been summarized below, providing motivation for this study.

In Demir's study, the aim was to create a database to contribute to the formation of qualified architectural groups in a mountainous environment where winter tourism takes place. The Tekir Plateau in Mount Erciyes was chosen as the application area. All the necessary criteria for design, from the organization of buildings to environmental factors, from the plan scheme to the building form, were determined to create a basic handbook [10].

In Kun's study, a comparison was made regarding the cooling loads of hotel buildings based on predetermined plan typologies in the case of Kuşadası. Using the Ecotect program, the 7 predetermined plan typologies were ranked from most efficient to least efficient. Thus, a recommendation is provided for future hotel buildings in Kuşadası [11].

In Demirtaş's study, which aimed to find the most efficient building form for five pilot cities selected from different climatic regions of Türkiye, an analysis was conducted based on eight preferred plan types for hotel buildings, including courtyard and courtyardless designs. The Designbuilder program was used to calculate heating and cooling loads. As a result, it was determined that the courtyardless square form yielded the lowest heating and cooling loads for Ankara, Istanbul, and Erzurum, while the double-oriented staggered form was found to be the most efficient for Antalya and Diyarbakır [12].

D'Amico and Pomponi investigated the relationship between surface area and interior space to address the sustainability of building forms. Firstly, an optimal form was obtained, and then, since a single specific form is of limited practical use, a scale-independent metric was developed to measure the optimality degree of building forms and demonstrate their practical application. This new metric system, which is expected to be highly beneficial in the early design stage, allows for measuring how far a building form deviates from optimality and generating the closest alternative geometries [13].

Başaran's study focused on reducing heating loads and determining the optimal architectural forms that provide the highest solar gains specific to the climatic region. Ankara was chosen as the study area. By conducting solar radiation analysis using the Designbuilder program, shape revisions were made based on prime geometric forms and organic forms. The results showed that curved organic forms shaped by tracking the movement axis of the sun horizontally and the angle between the sun and the earth vertically resulted in higher solar energy gains [14].

In the studies of Karadağ and Keskin; The performance and adequacy of the Radience simulation engine integrated into DaylightX were measured for daylight optimization during the early design phase. Although the Radience simulation engine is the most widely used and approved simulation engine, it has been integrated with DaylightX due to the difficulty of processing input parameters. Simulation experiments were carried out on a selected container house in the California sample, and a modeling and workflow prototype was developed [15]. In the studies of Karadağ and Serteser; has developed a particle-based algorithm in which the flow properties of the air to be taken into the building can be evaluated in the early design phase. The functionality of this algorithm has been tested on three commonly seen natural ventilation conditions. While the features such as real-time operation and non-relativism of the algorithm produced as a result of the studies highlight the algorithm, it is stated that it has a guiding argument that can be used in the early design phase [16]. The software techniques used in these two studies were found to be remarkable in terms of directing and expanding the research within the scope of the article.

1.1. Limitation & Assumption in The Case Study

The concept of "compactness," which is a geometric sub-concept related to building form, is an important parameter in terms of heat loss and gain of buildings and forms the main motivation of this research. The study investigates the adherence to theoretical knowledge of compactness in the formation of winter tourism accommodation structures and the differences in building forms that arise according to regions.

This study is limited to examining the compactness of 50 accommodation structures located in the cold climate zones of different climatic regions in Türkiye's prominent ski resorts, in relation to their energy consumption. Initially, the projection of the 50 structures were extracted, and their areas and main facade orientations were calculated. Then, based on the number of floors of these structures, estimated 3D models were created, and openings in the form of transparency were added to the 3D models as estimations. Subsequently, "compact plan projection" were drawn based on the projection of each structure. The same process was repeated based on these new plan projection, and 3D models representing the most compact forms of the structures were obtained.

Then, openings were added to these compact 3D models again, matching the amount of openings in the existing forms. Finally, annual heating and cooling energy consumption analyses were conducted based on the obtained existing and compact 3D models, considering thermal comfort. Factors such as building elements, material properties, and heating/cooling system settings were assumed to be equal for better understanding of the compactness ratio of the buildings.

The energy model used in the analysis was built in the Rhinoceros3D/Grasshopper3D environment using the "Energy Plus" energy simulation engine and the "Ladybug" plugin. It was assumed that each structure in the analysis used the same mechanical HVAC system. Although the structures were located in different climatic regions, they were considered to be in their local "cold climate" extremes.

2. WINTER TOURISM IN TÜRKİYE

With the changing perception of vacations in recent years, alternative tourism activities have come to the forefront, and winter tourism, in particular, has gained significant interest. Winter tourism, also known as mountain tourism in the literature, is seen as an important tourism type for the development of mountainous areas, regional development, and achieving balance between regions. It is also important in terms of sustainability, minimizing harm to natural assets, and contributing to economic and social aspects [17]. Conceptually, winter tourism focuses primarily on winter sports, mainly skiing, and involves accommodation and other services provided in snowy and mountainous regions, depending on suitable slope, aspect, and geographical conditions [18].

Winter tourism has economic, social, and various other advantages. Firstly, the investments in infrastructure and facilities contribute to the development of the region. Thus, both during the construction phase and in the service process, employment opportunities are created for the local population. Extending the tourism season throughout the year contributes to the economy of the region and the country as a whole. The disadvantages arising from the climate can be turned into advantages. Additionally, it provides a unique experience for those seeking a different vacation alternative and adventure enthusiasts [17].

Türkiye, a significant portion of which is composed of mountainous areas within the Alp-Himalaya mountain system, has a great potential for winter tourism. Winter tourism in Türkiye first began in the 1930s in Uludağ. With the interest of local residents and tourists from Istanbul, many hotels and ski lodges were opened. Subsequently, centers such as Elmadağ, Erciyes, Sarıkamış, and Palandöken became operational. This new understanding of tourism led to the enactment of incentive laws and the preparation of master plans [18].

According to data from the Ministry of Culture and Tourism, there are 29 ski resorts in Türkiye. Of these, 9 are operational (Davraz, Erciyes, Ilgaz, Kartalkaya, Kartepe, Palandölen, Sarıkamış, Uludağ, Yıldız Dağı), 7 are semi-operational (Yıldıztepe, Uğurludağ, Kop Dağı, Zigana, Ergan, Bozdağ, Ladik), and the rest are centers that are not yet operational [19, 20]. The most popular ski resorts in terms of demand are Uludağ, Kartalkaya, Erciyes, Sarıkamış, Kartepe, Palandöken, and Ilgaz [21].

The current bed capacity in Türkiye is 11,459, while the target is 80,175. When looking at the provinces, Erzurum ranks first with a capacity of 2,466 beds, followed by Bursa with 2,250 beds, Bolu with 1,713 beds, and Kayseri with 1,072 beds [19]. When examining the participation demand for winter tourism, it is known that 20% of visits are for day trips, while the remaining 80% prefer accommodation-based vacations. Winter sports enthusiasts constitute 75% of the visitors, while the domestic profile consists mainly of singles and families with children [22].

2.1. Winter Tourism Accommodation Buildings

Winter tourism facilities multiple functions within their structures. Social and sports facilities include clubs where winter sports training courses are offered and various events are organized. Mechanical facilities consist of technical infrastructure units related to winter sports, such as chairlifts, gondolas, ski lifts, cable cars, mountain trains, and baby lifts. These are followed by recreational facilities such as ski areas, accommodation and service facilities, day-use facilities, golf courses, polo fields, bowling alleys, paragliding sites, ice skating rinks, and more. Among these units, mechanical facilities and accommodation facilities are the most important. In mechanical facilities, the main goal is to ensure that sports activities are carried out smoothly and efficiently, while in accommodation facilities, the aim is to provide a comfortable stay for domestic and foreign visitors in units where they will temporarily reside. Accommodation facilities for winter tourism and winter sports include hotels, motels, holiday villages, guesthouses, timeshare properties, and apartment hotels, offering visitors a variety of options [10].

2.2. Form in Winter Tourism Buildings

Building form can be defined by geometric variables such as shape factor (ratio of building facade depth), building height, roof type (flat, gable, hipped), floor type (ground-bearing floor, open underside floor), roof pitch, and facade inclination [14]. The architectural form should be designed in a way that carries aesthetic value visually and contributes to sustainability.

In architectural design, form is one of the most influential factors in the energy performance of a structure. Therefore, the primary objective in sustainable building design is to create a building envelope that can maintain optimum levels of heat gain [23]. Decisions should be made in the design phase considering factors directly related to the building, such as climatic conditions, wind direction/intensity, and maximum utilization time from the sun. In this context, design decisions can help alleviate heating loads, especially in high mountainous areas with winter tourism and winter sports where snow cover is intense. The wind, which is effective for more than half of the year in cold climate regions, causes heat losses [24].

Therefore, consideration of wind directions should be taken into account during the form-making process. Another important criterion is to maximize the utilization of sunlight. Depending on local climate conditions, in Türkiye, south-facing slopes receive more sunlight during winter, so a design can be envisaged along the south axis in linear building configurations [10].

Compactness is one of the most important factors in terms of the building's heat loss and gain. When the surface area is increased while keeping the volume constant, compactness decreases, and the amount of heat lost from the surface areas increases. Protrusions, recesses, or fragmentation in the floor plan can cause unnecessary expansion of the building and an increase in surface area, which negatively affects compactness. Therefore, compact building forms should be preferred for energy conservation in cold climate regions [25]. In terms of internal heat preservation, the most efficient building form is a square with a small surface area and a large interior volume. Therefore, it is more appropriate to design winter tourism accommodation facilities in the form of individual houses or adjacent buildings in a back-to-back arrangement [10]. For L, T, H, and U-shaped building forms, it has been determined that the most appropriate orientations are Southeast-Northwest or Northeast-Southwest [26].

Winter tourism facilities are exposed to heavy snowfall and wind accumulation, so the roof pitches should be steep, and materials that prevent snow accumulation should be chosen. The facility structures should be constructed close to each other. In accommodation units, designs such as courtyards, backyards, canopies, and overhangs should be implemented to protect visitors from rain and snow [10].

3. ANALYSIS OF ACCMODATION STRUCTURES IN TURKISH WINTER TOURISM IN THE CONTEXT OF “COMPACTNESS”

The main motivation of the study is to investigate the impact of compactness on the energy efficiency of tourism-oriented accommodation building forms in cold climate regions in Türkiye. Additionally, the study aims to explore how the parameters of these buildings, based on the obtained mathematical data, statistically affect each other in different regions.

Within the scope of the study, accommodation structures located in various regions of Türkiye such as Palandöken, Erciyes, Sarıkamış, Kartalkaya, Kartepe, Ilgaz, Uludağ, and Davraz, which are popular ski resorts, were selected, and these structures were analyzed in terms of form and energy consumption within the context of compactness. Fifty prominent accommodation buildings in the selected resorts were first transformed into their most basic forms based on the plan projection.
Subsequently, measurements of compact projection were conducted by comparing the existing plan projection with the obtained compact projection, leading to a compactness percentage. While producing the plan projections, compactness measurements were conducted for both the ground floor and typical floor plans in cases where there was a difference between them.

However, compactness measurements were not conducted for building sections that were added to the ground floor after the original version of the structure. Roof slopes and attic floor plans were disregarded in these measurements. Afterwards, based on the generated plan projections, both the existing and compact forms of the buildings were 3D modeled with similar volumes. The purpose of this modeling process was to obtain a substrate that allows for more realistic measurements and energy simulations based on the building forms. In order to achieve accurate results in the analysis, the opaque and transparent surfaces of the buildings were considered and added to the building models, resembling their approximate proportions.

As a result, very close transparency ratios were achieved for both the normal and compact forms of the buildings. Finally, the superimposed plan drawings, opening ratios, orientation calculations, and images of the existing and compact forms, as summarized in this section, were transferred to a table.

3.1. Energy Model and Energy Input Parameters

A total of 100 building models were obtained in the Rhino/Grasshopper3D environment, and an extension was developed for processing the models. With the developed extension, a system was created where the "Energy Plus" energy simulation engine could measure energy consumption quantities with the help of the "Ladybug" plugin (Figure 1).

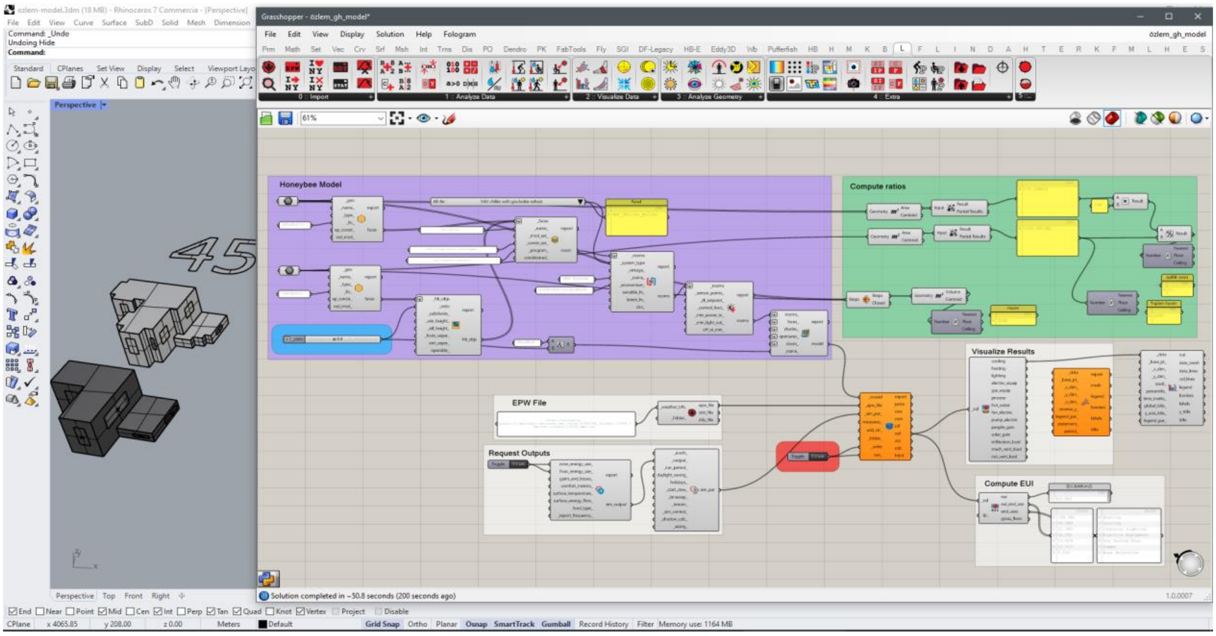


Figure 1 The model constructed in the Grasshopper3D environment for the analysis of building energy consumption quantities

In the developed extension in Grasshopper, various input parameters have been defined to convert form-based 3D models into input data and to incorporate climatic and structural variables into the system.

Table 1 Layering of the structural components used in the models

Structural Components	Material	Thermal Conductivity {W/m-K}	Specific Heat {J/kg-K}	Density {kg/m^3}	Thickness {m}	r {m^2-K/W}	U {W/m^2-K}
Exterior Walls	25mm Plaster 15mm Gypsum Board® Typical Insulation-R19 15mm Gypsum Board®	0.719 0.159 0.159	839 1089 1089	1856 800 800	0.0254 0.0159 0.0159	3.346	**0.267**
Interior Floor	Interior Floor Typical Insulation-R4 Concrete Floor Typical Carpet Pad	2.308	831	2322	0.203	0.704 0.216	**0.852**
Roof	Roof Gypsum Board Insulation-R47	0.159	1089	800	0.0159	8.277	**0.117**
Windows	Windows Low E. Glass Air Glass	0.899 0.899			0.006 0.0127 0.006		**1.784**

The intended structural characteristics for the building models used in the analysis are provided in Table 1. Since the specific structural properties of each building were not determined, average values were defined for each structural feature. For the model, the total thermal transmittance (U-value) of the external wall layer was taken as 0.267 W/m2-K, the internal floor as 0.852 W/m2-K, the roof as 0.117 W/m2-K, and the windows as 1.784 W/m2-K. The analysis utilized data specific to cold climate regions. Additionally, it was assumed that each analyzed building had mechanical HVAC systems using “VAV (Variable air Volume) chiller gas boiler reheat.”

Subsequently, the visuals of the buildings, their respective locations, number of floors, superimposed drawings of the existing and compact floor plans, area measurements/ratios derived from these drawings, energy consumption quantities for both forms of the buildings, ratios of opaque/transparent surfaces, volumes included in the energy consumption analysis, and deviations of the main facades from the north direction were compiled in a table (Table 2). This allowed for the creation of a comprehensive database where all the data could be tracked. The obtained data was then interpreted in the context of "compactness

3.2. Energy Simulation Results and Energy Analyses

The results of the energy consumption analysis conducted on the existing and compact forms of the structures included in the study have been added to Table 2.

Table 2 (Continue). Data and analysis results for selected accommodation structures

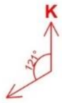
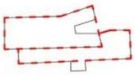
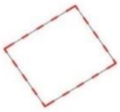
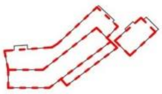
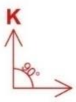
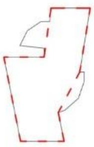
Visual representation and name of the structure	Location	Number of Floor	Overlapping floor plan diagram	Measure-ments (m)	Energy consumption (kWh/m^2)	Ratios(%)	Main Facade Direction
1. The Erzurum Hotel 	Eastern Anatolia Region	Ground floor +5		Compact Projection 47.43	Compact 181.763	Compactness Ratio %81.41	
				Existing Projection 58.26	Existing 188.71	Facade Opening Ratio %16	
2. Sway Hotel Palandöken 	Eastern Anatolia Region	Ground floor +5		Compact Projection 198.35	Compact 311.773	Compactness ratio %83.62	
				Existing Projection 237.2	Existing 338.902	Facade Opening Ratio %9	
3. Dedeman Ski Lodge 	Eastern Anatolia Region	Ground floor +4		Compact Projection 106.61	Compact 279.347	Compactness ratio %100	
				Existing Projection 106.61	Existing 279.437	Facade Opening Ratio %12	
4. Polat Palandöken 	Eastern Anatolia Region	Ground floor +8		Compact Projection 271.11	Compact 316.989	Compactness ratio %86.19	
				Existing Projection 314.52	Existing 357.094	Facade Opening Ratio %8	
5. Palan Otel 	Eastern Anatolia Region	Ground floor +6		Compact Projection 77.16	Compact 639.912	Compactness ratio %77.22	
				Existing Projection 99.92	Existing 680.975	Facade Opening Ratio %15	
6. Balsoy Mountain Hotel 	Eastern Anatolia Region	Ground floor +4		Compact Projection 129.71	Compact 623.585	Compactness ratio %87.60	
				Existing Projection 148.07	Existing 638.462	Facade Opening Ratio %14	
	Eastern Anatolia Region	Ground floor +4		Compact Projection 105.84	Compact 413.836	Compactness ratio %71.05	

Table 2 (Continue). Data and analysis results for selected accommodation structures

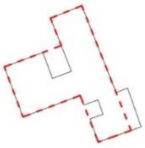
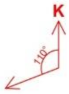
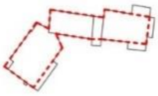
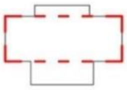
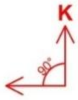
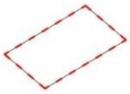
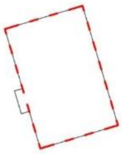
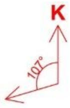
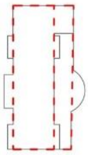
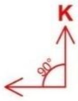
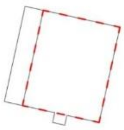
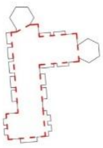
Visual representation and name of the structure	Location	Number of Floor	Overlapping floor plan diagram	Measure-ments (m)	Energy consumption (kWh/m^2)	Ratios(%)	Main Facade Direction
7. Snowdora Ski Resort Hotel 				Existing Projection 148.95	Existing 476.398	Facade Opening Ratio %11	 K
8. Dedeman Palandöken Hotel 	Eastern Anatolia Region	Ground floor +6		Compact Projection 157.32	Compact 465.081	Compactness ratio %70.55	 K
				Existing Projection 222.97	Existing 483.856	Facade Opening Ratio %11	
9. Ve Hotels Palandöken 	Eastern Anatolia Region	Ground floor +4		Compact Projection 41.08	Compact 523.845	Compactness ratio %63.56	 K
				Existing Projection 64.63	Existing 576.316	Facade Opening Ratio %12	
10. Library Hotels Erciyes 	Central Anatolia Region	Ground floor +2		Compact Projection 57.50	Compact 328.604	Compactness ratio %100	 K
				Existing Projection 57.50	Existing 328.604	Facade Opening Ratio %14	
11. Mirada Del Monte Hotel 	Central Anatolia Region	Ground floor +2		Compact Projection 60.28	Compact 295.385	Compactness ratio %91	 K
				Existing Projection 66.24	Existing 302.615	Facade Opening Ratio %16	
12. Grand Eras Erciyes Hotel 	Central Anatolia Region	Ground floor +5		Compact Projection 129.90	Compact 333.316	Compactness ratio %74.60	 K
				Existing Projection 174.11	Existing 342.125	Facade Opening Ratio %9	
13. Zümrüt Palas Hotel 	Central Anatolia Region	Ground floor +4		Compact Projection 56.49	Compact 430.613	Compactness ratio %67.33	 K
				Existing Projection 83.90	Existing 475.178	Facade Opening Ratio %12	
14. Mirada Del Logo Hotel 	Central Anatolia Region	Ground floor +3		Compact Projection 70.10	Compact 613.81	Compactness ratio %46.20	 K
				Existing Projection 151.71	Existing 656.859	Facade Opening Ratio %12	
15. Ace Kite Hotel	Central Anatolia Region	Ground floor +3		Compact Projection 46.83	Compact 467.413	Compactness ratio %100	

Table 2 (Continue). Data and analysis results for selected accommodation structures

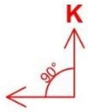
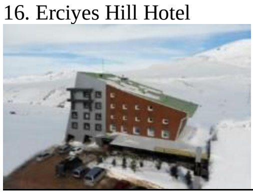
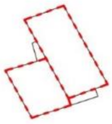
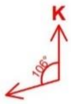
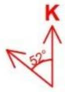
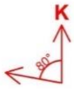
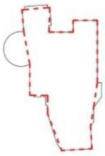
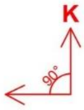
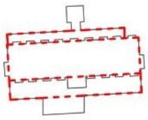
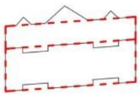
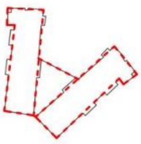
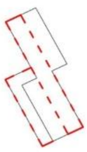
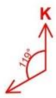
Visual representation and name of the structure	Location	Number of Floor	Overlapping floor plan diagram	Measure-ments (m)	Energy consumption (kWh/m^2)	Ratios(%)	Main Facade Direction
				Existing Projection 46.83	Existing 467.413	Facade Opening Ratio %15	
16. Erciyes Hill Hotel 	Central Anatolia Region	Ground floor +4		Compact Projection 113.76	Compact 261.099	Compactness ratio %87.14	
				Existing Projection 130.54	Existing 319.639	Facade Opening Ratio %13	
17. X Mountain Lodge Hotel 	Central Anatolia Region	Ground floor +3		Compact Projection 153.86	Compact 278.654	Compactness ratio %94.01	
				Existing Projection 163.66	Existing 280.558	Facade Opening Ratio %10	
18. Ağaoğlu My Mountain Hotel 	Marmara Region	Ground floor +8		Compact Projection 143.05	Compact 1110.206	Compactness ratio %70.25	
				Existing Projection 203.61	Existing 1134.575	Facade Opening Ratio %14	
19. BOF Hotels Uludağ Ski&Resort 	Marmara Region	Ground floor +8		Compact Projection 96.71	Compact 722.444	Compactness ratio %78.15	
				Existing Projection 123.74	Existing 725.338	Facade Opening Ratio %15	
20. Kaya Uludağ Hotel 	Marmara Region	Ground floor +3		Compact Projection 101.07	Compact 241.681	Compactness ratio %46.37	
				Existing Projection 217.93	Existing 337.928	Facade Opening Ratio %6	
21. Karinna Hotel 	Marmara Region	Ground floor + 10		Compact Projection 119.99	Compact 333.37	Compactness ratio %78.81	
				Existing Projection 152.25	Existing 458.909	Facade Opening Ratio %14	
22. Monte Baia Hotel 	Marmara Region	Ground floor +4		Compact Projection 176.92	Compact 450.323	Compactness ratio %80.33	
				Existing Projection 220.22	Existing 469.974	Facade Opening Ratio %13	
23. Jura Hotels Kervansaray 	Marmara Region	Ground floor +5		Compact Projection 89.81	Compact 665.615	Compactness ratio %73.88	
				Existing Projection 121.55	Existing 756.642	Facade Opening Ratio %15	
24. Trendlife Hotel	Marmara Region	Ground floor +5		Compact Projection 69.33	Compact 551.762	Compactness ratio %100	

Table 2 (Continue). Data and analysis results for selected accommodation structures

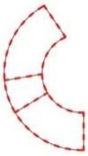
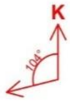
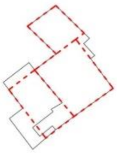
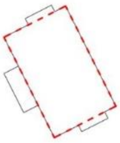
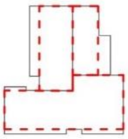
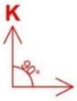
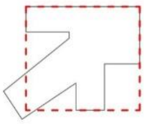
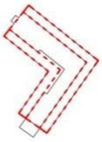
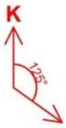
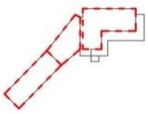
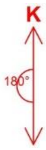
Visual representation and name of the structure	Location	Number of Floor	Overlapping floor plan diagram	Measure-ments (m)	Energy consumption (kWh/m^2)	Ratios(%)	Main Facade Direction
				Existing Projection 69.33	Existing 591.923	Facade Opening Ratio %6	
25. Grand Yazıcı Hotel 	Marmara Region	Ground floor +7		Compact Projection 158.45	Compact 496.9	Compactness ratio %66.58	
				Existing Projection 237.98	Existing 555.941	Facade Opening Ratio %12	
26. Beceren Hotel 	Marmara Region	Ground floor +5		Compact Projection 89.54	Compact 388.206	Compactness ratio %68.92	
				Existing Projection 129.91	Existing 389.482	Facade Opening Ratio %12	
27. Fahri Hotel 	Marmara Region	Ground floor +5		Compact Projection 117.47	Compact 421.646	Compactness ratio %68.25	
				Existing Projection 172.10	Existing 450.186	Facade Opening Ratio %9	
28. Kaya Palazzo Ski&Mountain Resort 	West Blacksea Region	Ground floor + 10		Compact Projection 73.96	Compact 882.768	Compactness ratio %100	
				Existing Projection 73.96	Existing 888.527	Facade Opening Ratio %19	
29. Golden Key Hotel 	West Blacksea Region	Ground floor +3		Compact Projection 93.33	Compact 271.945	Compactness ratio %77.22	
				Existing Projection 121.71	Existing 388.315	Facade Opening Ratio %10	
30. Dorukkaya Ski&Mountain Resort 	West Blacksea Region	Ground floor +6		Compact Projection 212.45	Compact 421.603	Compactness ratio %83.70	
				Existing Projection 253.80	Existing 460.59	Facade Opening Ratio %12	
31. Kartal Otel 	West Blacksea Region	Ground floor +5		Compact Projection 110.34	Compact 543.98	Compactness ratio %75.69	
				Existing Projection 145.76	Existing 631.294	Facade Opening Ratio %14	

Table 2 (Continue). Data and analysis results for selected accommodation structures

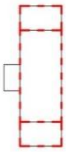
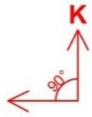
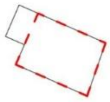
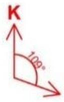
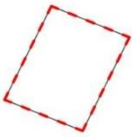
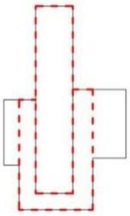
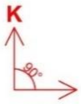
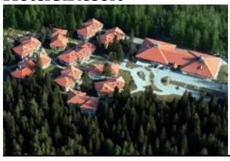
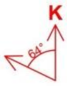
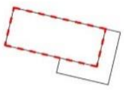
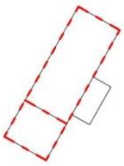
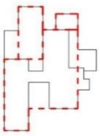
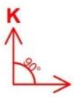
Visual representation and name of the structure	Location	Number of Floor	Overlapping floor plan diagram	Measure-ments (m)	Energy consumption (kWh/m^2)	Ratios(%)	Main Facade Direction
32. Grand Kartal Hotel 	West Blacksea Region	Ground floor + 11		Compact Projection 91.85	Compact 532.812	Compactness ratio %88.43	
				Existing Projection 103.86	Existing 618.875	Facade Opening Ratio %18	
33. Kaya Palazzo Luxury Chalet 	West Blacksea Region	Ground floor +1		Compact Projection 33.45	Compact 354.339	Compactness ratio %77.71	
				Existing Projection 43.04	Existing 376.117	Facade Opening Ratio %9	
34. Kartaltepe Boutique Hotel 	West Blacksea Region	Ground floor +2		Compact Projection 58.46	Compact 319.998	Compactness ratio %100	
				Existing Projection 58.46	Existing 319.998	Facade Opening Ratio %10	
35. The Green Park Kartepe Resort&Spa 	Marmara Region	Ground floor + 11		Compact Projection 157.07	Compact 395.485	Compactness ratio %76.48	
				Existing Projection 205.36	Existing 452.389	Facade Opening Ratio %13	
36. Ferko Ilgaz Mountain Hotel&Resort 	West Blacksea Region	Ground floor +5		Compact Projection 49.99	Compact 724.277	Compactness ratio %92.3	
				Existing Projection 54.16	Existing 819.528	Facade Opening Ratio %15	
37. Dağbaşı Hotel 	West Blacksea Region	Ground floor +3		Compact Projection 63.70	Compact 422.912	Compactness ratio %65.95	
				Existing Projection 96.58	Existing 429.048	Facade Opening Ratio %8	
38. Ilgaz Hotel 	West Blacksea Region	Ground floor +5		Compact Projection 81.93	Compact 393.356	Compactness ratio %84.02	
				Existing Projection 97.51	Existing 465.773	Facade Opening Ratio %9	
39. Duja Chalet Ski Center 	Eastern Anatolia Region	Ground floor +4		Compact Projection 133.78	Compact 433.733	Compactness ratio %76.35	
				Existing Projection 175.20	Existing 1003.401	Facade Opening Ratio %8	
40. Sarpino Mountain Hotel	Eastern Anatolia Region	Ground floor +5		Compact Projection 71.39	Compact 664.385	Compactness ratio %80.66	

Table 2 (Continue). Data and analysis results for selected accommodation structures

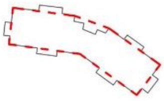
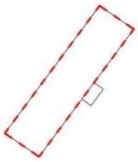
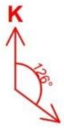
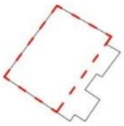
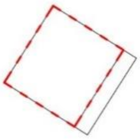
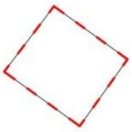
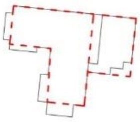
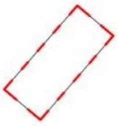
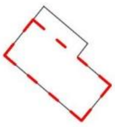
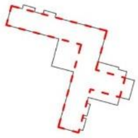
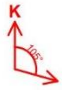
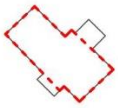
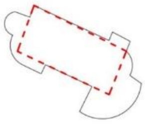
Visual representation and name of the structure	Location	Number of Floor	Overlapping floor plan diagram	Measure-ments (m)	Energy consumption (kWh/m^2)	Ratios(%)	Main Facade Direction
				Existing Projection 88.5	Existing 759.785	Facade Opening Ratio %12	
41. Kayı Snow Hotel 	Eastern Anatolia Region	Ground floor +3		Compact Projection 78.21	Compact 420.865	Compactness ratio %90.27	
				Existing Projection 86.64	Existing 479.11	Facade Opening Ratio %14	
42. White Park Hotel 	Eastern Anatolia Region	Ground floor +3		Compact Projection 46.37	Compact 465.128	Compactness ratio %66.78	
				Existing Projection 69.43	Existing 472.139	Facade Opening Ratio %10	
43. Habitat Otel Sarıkamış 	Eastern Anatolia Region	Ground floor +4		Compact Projection 56.82	Compact 408.097	Compactness ratio %74.08	
				Existing Projection 76.70	Existing 470.099	Facade Opening Ratio %14	
44. Snowflake Dağ Oteli 	Eastern Anatolia Region	Ground floor +3		Compact Projection 40.16	Compact 521.12	Compactness ratio %100	
				Existing Projection 40.16	Existing 521.12	Facade Opening Ratio %15	
45. Çamkar Hotel 	Eastern Anatolia Region	Ground floor +3		Compact Projection 100.33	Compact 321.861	Compactness ratio %78.96	
				Existing Projection 127.05	Existing 381.223	Facade Opening Ratio %8	
46. Efsane Group Sarıkamış Hotel 	Eastern Anatolia Region	Ground floor +2		Compact Projection 39.21	Compact 489.229	Compactness ratio %100	
				Existing Projection 39.21	Existing 489.229	Facade Opening Ratio %12	
47. Sarıkamış Kar Hotel 	Eastern Anatolia Region	Ground floor +2		Compact Projection 31.52	Compact 549.433	Compactness ratio %76.20	
				Existing Projection 41.36	Existing 587.321	Facade Opening Ratio %13	
48. Sirene Davraz Hotel	Mediterrenia n Region	Ground floor +4		Compact Projection 94.18	Compact 675.321	Compactness ratio %64.28	

Table 2 (Continue). Data and analysis results for selected accommodation structures

Visual representation and name of the structure	Location	Number of Floor	Overlapping floor plan diagram	Measure-ments (m)	Energy consumption (kWh/m^2)	Ratios(%)	Main Facade Direction
				Existing Projection 146, 50	Existing 833.097	Facade Opening Ratio %13	
49. İsperia Davraz 	Mediterrenian Region	Ground floor +1		Compact Projection 67.42	Compact 246.039	Compactness ratio %73.81	
				Existing Projection 91.34	Existing 252.489	Facade Opening Ratio %7	
50. Süleyman Demirel Üniversitesi Uygulama Oteli 	Mediterrenian Region	Ground floor +4		Compact Projection 73.15	Compact 424.434	Compactness ratio %57.44	
				Existing Projection 127.33	Existing 430.512	Facade Opening Ratio %8	

Various assessments will be made below based on the analysis data in table 2, which presents the energy consumption quantities of the "existing" and "compact" forms for 50 structures in kWh/m2. These evaluations will be made using the ratios obtained from the projection of both forms of the structures.

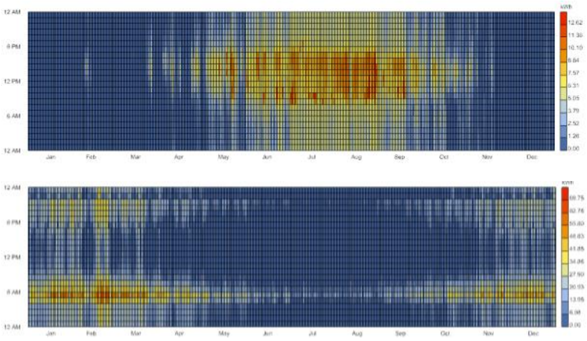


Figure 2 Hourly graph illustrating the cooling load (above) and heating load (below) for Structure 45

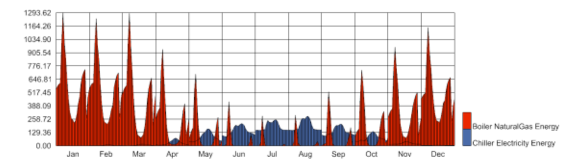


Figure 3 Monthly graph illustrating the cooling and heating loads for Structure 45

Figure 2 and Figure 3 present sample graphs showcasing the analysis results of the daily and monthly heating and cooling loads for Structure 45, named "Çamkar Hotel," located in the Eastern Anatolia Region.

3.3. Interpreting Analysis Results Based on Regions

In this section, the results obtained from the analysis of each form of the structures are interpreted while considering their geographical locations. Special emphasis is given to the main facades and mass orientations of the structures. Additionally, regional classification is used to determine the average compactness, as well as structures with the lowest and highest compactness ratios. The structures with the highest energy consumption in both existing and compact forms, along with the widest gap between these two values, are identified. By evaluating the relationships between these data, findings are derived and conclusions are drawn.

Eastern Anatolia Region

In Table 2, it can be observed that the accommodation structures located in the Palandöken ski resort have a diverse range of main facade orientations, including NE, N, SE, SW, E, NW, and W. The mass orientations of the structures are along the NE-SW (3), E-W (2), NW-SE (2), and N-S (2) axes. The average compactness ratio for the selected 9 sample structures is 80.13%. The lowest ratio belongs to Ve Hotels Palandöken with 63.56%. Although it appears relatively compact in the plan view, the relatively smaller size of the structure resulted in a decrease in the ratio due to the movement made in the form. The highest ratio is 100% for Dedeman Ski Lodge.

Despite having a smaller projection compared to other buildings, it is designed closest to the fundamental form, resulting in no additional surface areas that would increase heat loss and thus having the highest compactness value. Looking at the facade opening ratios, the average is 12%, with The Erzurum Hotel having the highest ratio of 16% and Polat Palandöken Hotel having the lowest ratio of 8%. The structure with the highest energy consumption in both the existing (680.975 kWh/m^2) and compact (639.912 kWh/m^2) forms is Palan Hotel. Based on these results, no significant relationship was found between the facade opening ratio, energy consumption, and compactness ratio. This is believed to be due to the structures not having the same volume and plan projection.

Similarly, as seen in Table 2, the hotels selectedfrom the Sarıkamış ski resort have main facade facing the D, NE, SE, NW, N and SW directions. Just like in Palandöken, no dominant main facade orientation could be determined in this resort either. The accommodation structures are mostly positioned along the NE-SW(5) axis, followed by the NW-SE(2) and N-S(2) axes in terms of mass orientation. The average compactness ratio for the selected structures is 82.58%, with Efsane Group Sarıkamış Hotel and Snowflake Mountain Hotel having the highest compactness ratios of 100%. White Park Hotel has the lowest ratio of 66.78%. Despite having a smaller plan projection compared to other structures, the design features introduced in the form caused a decrease in the ratio. In this regard, it is similar to the example in Palandöken.

The average facade opening ratio for the hotels selected from the Sarıkamış ski resort is 10.88%. Snowflake Mountain Hotel has the highest facade opening ratio of 15%, while Duja Chalet Ski Center and Çamkar Hotel have the lowest ratios of 8%. In terms of energy consumption, Duja Chalet Ski Center has the highest value of 1003.401 kWh/m^2 for the existing energy consumption, while Sarpino Mountain Hotel has the highest value of 664.385 kWh/m^2 for the compact energy consumption. The structure with the widest gap between the existing and compact energy consumption is Duja Chalet Ski Center with a value of 569.668 kWh/m^2.

Central Anatolia Region

According to the results derived from Table 2, the accommodation structures selected from the Erciyes ski resort generally have main facades facing the west direction, such as SW (3), W (3), and NW (2). The mass orientation is predominantly along the N-S (5), NW-SE (2), and NE-SW axes, indicating that most of the structures are volume-oriented along the north-south axis. The average compactness ratio for the 8 selected structures is 82.53%, with Mirada Del Logo Hotel having the lowest ratio of 46.2% and Ace Kite Hotel and Library Hotel having the highest ratio of 100%. Unlike the examples in Sarıkamış and Palandöken, it can be observed that the structure with a larger projection has the lowest ratio. This is believed to be due to the L-shaped form of the structure and the presence of movable facades on all sides. Mirada Del Logo Hotel, which has the lowest compactness ratio, has the highest values in both compact (613.81 kWh/m^2) and existing (656.859 kWh/m^2) energy consumption.

For the Central Anatolia Region, the average facade opening ratio is 12.62%. Mirada Del Monte Hotel has the highest value of 16%, while Grand Eras Erciyes Hotel has the lowest value of 9%.

Marmara Region

Based on the deductions made from Table 2, it is determined that the hotels in Uludağ ski resort have main facades facing the directions of NW, W, N (2), SW (4), NE, and E. The building orientations are shaped along the N-S (3), NW-SE (2), NE-SW (2), and SE-NW (3) axes. The average compactness value for these selected structures is 73.15%. The highest ratio is 100% for Trendlife Hotel, while the lowest ratio is 46.37% for Kaya Uludağ Hotel. Although Kaya Uludağ Hotel has a plan projection that is close to a compact form, the surface area has been increased by incorporating indentations and protrusions. This is believed to have moved the structure away from compactness.

For this region, the average facade opening ratio is 11.6%. The lowest value of 6% is attributed to Trendlife Hotel and Kaya Uludağ Hotel, while the highest value of 15% belongs to BOF Hotels Uludağ Ski & Resort and Jura Hotels Kervansaray. The structure with the highest energy consumption in terms of both existing (1134.575 kWh/m^2) and compact (1110.206 kWh/m^2) is BOF Hotels Uludağ Ski & Resort. When examining the selected examples from Uludağ ski resort, no correlation is found between compactness ratio, facade opening ratio, and energy consumption quantities.

West Blacksea Region

Based on Table 2, it can be seen that the accommodation structures in Kartaltepe ski center have main facades facing the directions of N, SW (2), SE (2), W, and E. The mass orientations are mostly shaped along the SW-NE (5) axis, followed by the N-S and SE-NW axes. The average compactness ratio of the structures is 86.10%, with the most compact hotels being Kartaltepe Boutique Hotel and Kaya Palazzo Ski & Mountain Resort with a ratio of 100%. The least compact hotel is Kartal Otel with a ratio of 75.69%. It is believed that both the basic plan geometry and later additions made to the ground floor have caused the ratio to decrease.

For this region, the average facade opening ratio is 13.12%. The highest ratio of 19% belongs to Kaya Palazzo Ski & Mountain Resort, while the lowest value of 9% is attributed to Kaya Palazzo Luxury Chalet. When examining the existing and compact energy consumption quantities, Kaya Palazzo Ski & Mountain Resort stands out with values of 888.527 kWh/m^2 and 882.768 kWh/m^2, respectively. Despite having a compactness ratio of 100%, the high energy consumption is believed to be due to its larger volume compared to other structures because of its multi-story nature. However, once again, no correlation is found between the compactness ratio, facade opening ratio, and energy consumption quantities for the selected examples.

According to the results obtained from Table 2, the main facades in Ilgaz ski center also show diversity. The main entrances are provided from the facades facing NE, SW, and SE for the three examined examples. The average compactness ratio of the structures is quite high at 80.75%. The structure with the lowest compactness percentage is Dağbaşı Otel with a ratio of 65.95% due to the areas added later on the ground floor. The average facade opening ratio is 10.66%. In terms of energy consumption, Ferko Ilgaz Mountain Hotel & Resort has the highest values in both existing (819.528 kWh/m^2) and compact (724.277 kWh/m^2) consumption.

Mediterrenian Region

Table 2 provides examples of three accommodation structures in Davraz ski center. As observed in all the regions examined so far, there is no single specialized main facade orientation in this area as well. However, in terms of mass orientation, the GD-KB axis is common among all the examined structure examples. The average compactness ratio of the structures is 65.17%. This result is consistent with the preference for dynamic building forms that heavily utilize projections and recesses.

When examining the average facade opening ratio, it is found to be 9.33%, and the highest value of 13% belongs to Sirena Davraz Hotel. Further analysis of Sirena Davraz Hotel reveals that its existing energy consumption is measured at 833.097 kWh/m^2, while the compact energy consumption is 675.321 kWh/m^2, making it the structure with the highest values among the selected buildings in the region. When looking at the difference between the compact and existing energy consumption, Sirena Davraz Hotel also has the highest value of 157.776 kWh/m^2. From this perspective, it can be said that the facade opening ratio for the examined group of structures in the region follows a proportional relationship with energy consumption.

3.4. General Overview Based on Analysis Findings

In this section, various analyses and the results of the corresponding investigations have been presented and interpreted with the support of graphs. All the data obtained from the energy analysis, along with other relevant data, have been processed using the statistical data processing software SPSS 26. As a result, graphs have been generated, enabling the comprehensive interpretation of all the collected data."

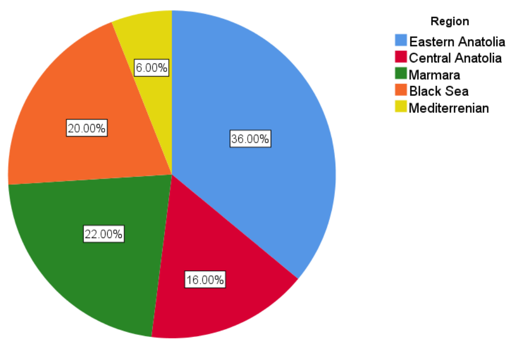


Figure 4 Graph illustrating the distribution of the included structures by regions in the research

Firstly, the research was conducted on a total of 50 winter tourism accommodation structures from 5 different geographical regions in Türkiye. Within the scope of the study, 36% of the examined structures are located in Eastern Anatolia, 16% in Central Anatolia, 22% in Marmara, 6% in the Mediterranean, and 20% in the Black Sea region (Figure 4).

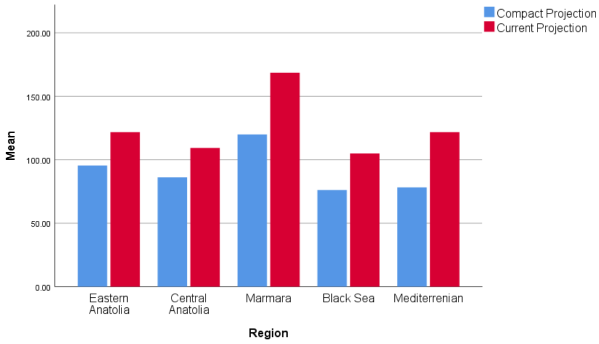


Figure 5 Average existing and compact projection ratios of structures according to regions

In Figure 5, the average existing and compact projection ratios of structures are presented together according to geographical regions. In this comparison conducted based on regions, the difference between the average existing and compact projection is highest in the Marmara Region, while it is the lowest in the Central Anatolia Region. The higher average projection in the Marmara Region indicates that structures in this region tend to have larger ground areas. Additionally, the higher average projection difference in this region can be interpreted as a preference for structures with more protrusions and recesses. The smaller projection difference in the Eastern Anatolia and Central Anatolia Regions suggests a preference for more stable forms with fewer protrusions and recesses.

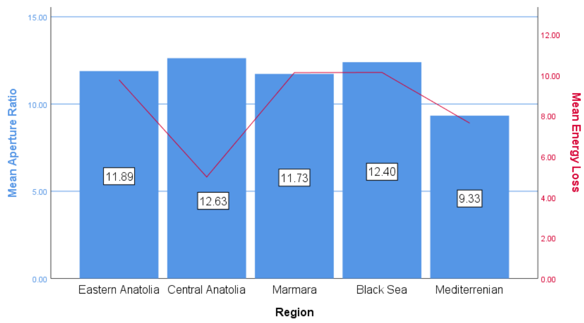


Figure 6 Illustration of the energy consumption differences between the average opacity values and the current-compact forms of the structures, categorized according to geographical regions

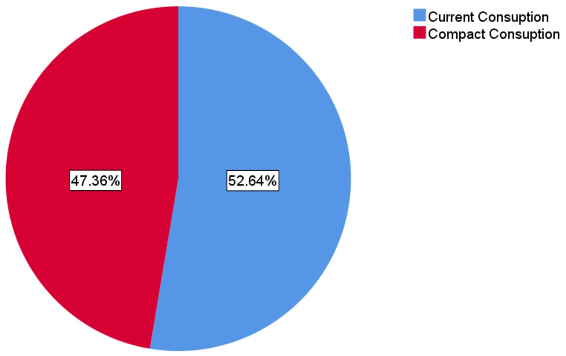


Figure 7 Graph illustrating the ratio between the average current and compact energy consumption quantities of all the structures

As can be observed in Figures 6-7, it is expected that the average quantity of normal energy consumption of all structures exceeds the average quantity of compact energy consumption. The difference between the two ratios is 5.28%. The increase or decrease of this difference can vary depending on how the compact projection are determined. In this study, the selected structures were determined to have compact projection with minimal intervention in their current forms. It is believed that the relatively small difference can be attributed to this factor.

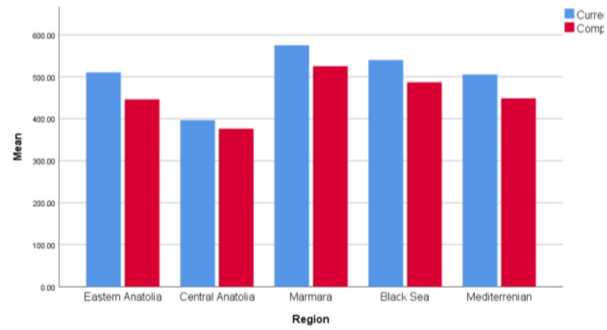


Figure 8 Clustered bar mean of current consuption and compact consuption by region

According to Figure 12, the region with the least difference between current and compact energy consumption is Inner Anatolia, while the other regions show a similar level of difference. In Figure 8, the individual representation of the energy consumption quantities of the structures, examined in terms of geographical regions in the previous graph, can be observed. When comparing the energy consumption quantities of the current and compact forms, the structure with the largest difference is Duja Chalet Ski Center, while the structure with the smallest difference is Ace Kite Hotel. When analyzing the compactness ratios, it is noticed that Beceren Hotel has a very low value of 68.92%, and the difference between its compact and current energy consumption values is also very low. This is believed to be due to the fact that compactness ratio is not the sole factor related to energy efficiency.

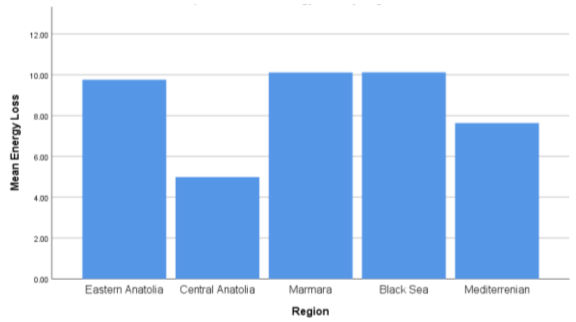


Figure 9 Energy loss percentages due to compactness factor in buildings by regions

In Figure 9, the percentages of energy loss due to the compactness factor are shown according to regions. According to this, it can be observed that the region with the least loss is Inner Anatolia with approximately 4.5%, while the highest loss is in the winter tourism accommodation structures in the Marmara and Black Sea regions. Based on these data, it can be inferred that the winter tourism accommodation structures in Inner Anatolia are designed in more compact forms compared to structures in other regions. In Marmara and Western Black Sea regions, on the other hand, it is observed that more flexible designs are preferred.

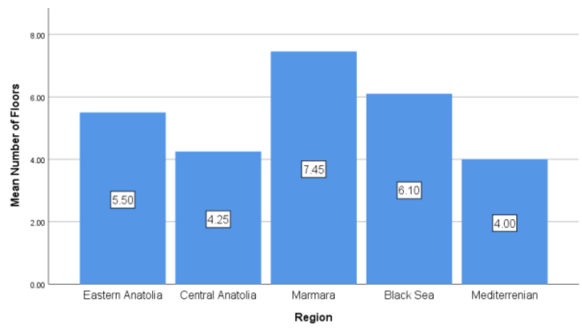


Figure 10 Table showing average number of building floors by geographical regions

As evident from Figure 10, in the evaluation based on the average number of floors, it can be observed that higher-rise structures are preferred in the Marmara Region, while lower-rise structures are preferred in the Mediterranean Region. It is known that compactness and energy efficiency are directly related to volume. Therefore, it can be said that in cold climate regions, the number of floors is kept lower to reduce the volume, while more flexible decisions are made in more temperate climate regions. In this regard, the higher average number of floors in the Marmara Region is in line with expectations.

However, it is unexpected that the average number of floors remains at the lowest level in the Mediterranean Region, despite its mild climate. This is thought to be due to economic concerns and ease of operation associated with the Mediterranean region being a relatively new development in winter tourism, thus making it a pilot region where lower-rise structures are preferred.

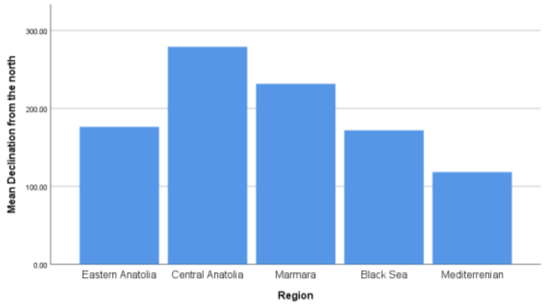


Figure11 Table showing average deviation of building main facades from the north direction by regions

Figure 11 provides a comparison of the deviation rates of the main facades of the structures from the north direction based on geographical regions. According to the graph, winter tourism accommodation structures in the Central Anatolia region have the highest deviation from the north direction compared to other regions, placing it in the first position. On the other hand, structures in the Mediterranean region have the closest main facade direction to the north.

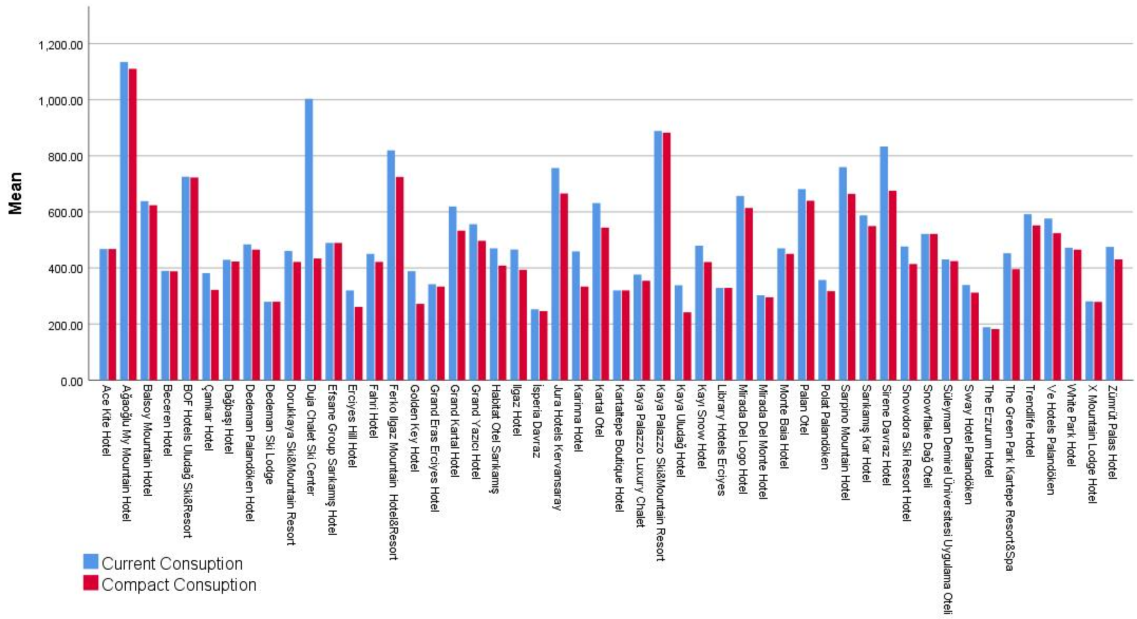


Figure 12 Comparison of energy consumption amounts for current and compact forms of buildings

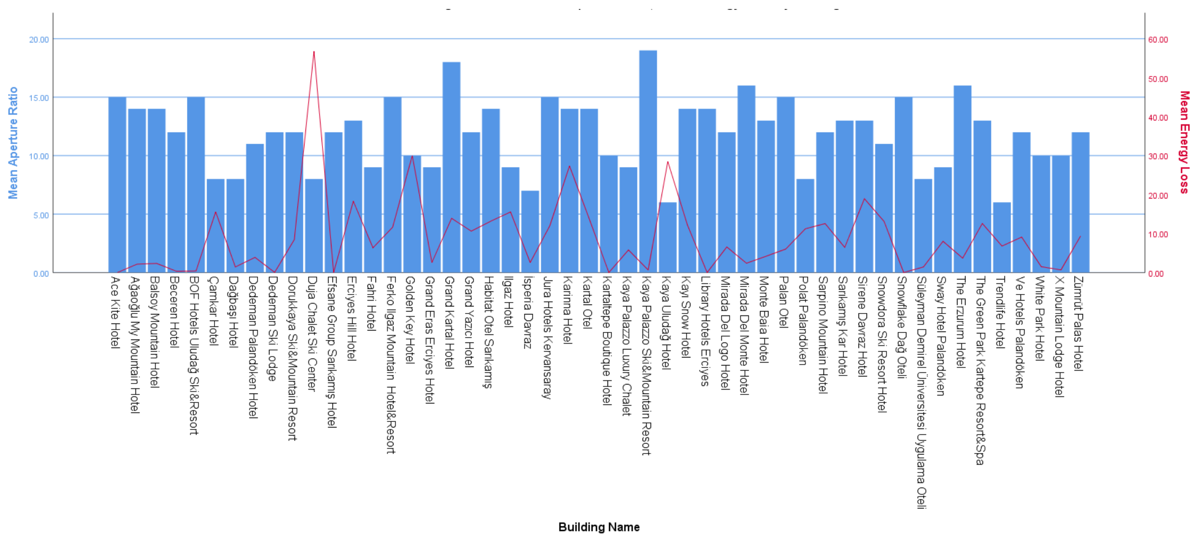


Figure 13 Displays the graph representing the energy loss amounts between the openness ratios of the structures and the current-compact forms

When examining the opacity ratios of the structures by geographical regions, the Central Anatolia Region ranks first, followed by the Western Black Sea Region in second place. They are then followed by the Eastern Anatolia, Marmara, and Mediterranean Regions. Considering that opacity is directly related to the facade openness ratio, it can be observed that the Mediterranean Region, which has the lowest opacity, has a higher facade openness ratio compared to other regions. This is a predictable result, considering the relatively milder climate of the Mediterranean Region compared to other regions. Additionally, the average energy losses vary proportionally with the openness ratios according to the geographical regions. Thus, the impact of openness ratios on energy loss becomes evident (Figure 6). Figure 13, on the other hand, illustrates the individual representation of the facade openness ratios of the structures as examined in the previous graph.

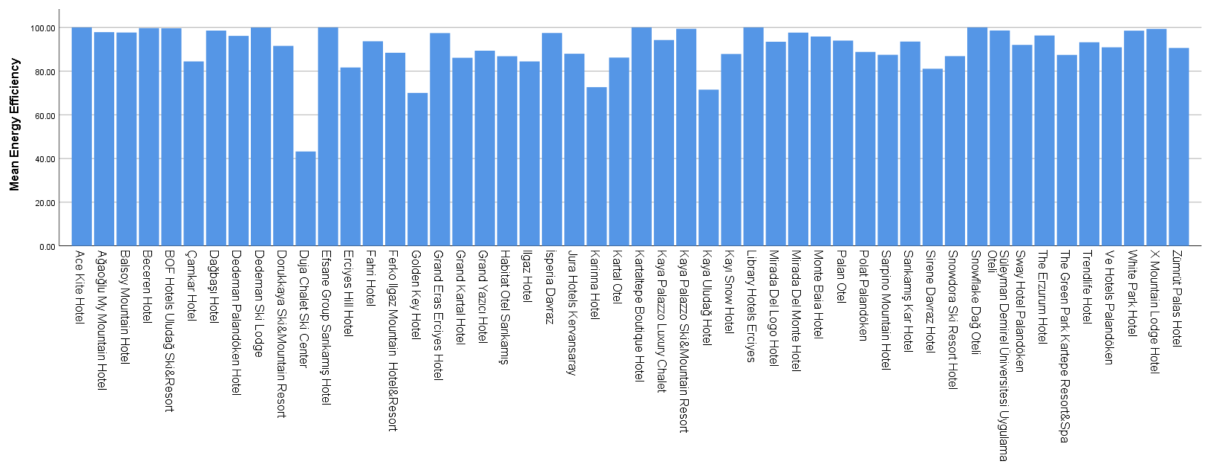


Figure 14 Table showing energy efficiency of buildings based on current and compact energy consumption

In Figure 14, the current and compact energy consumption quantities of each structure have been analyzed in terms of energy efficiency. This graph was generated by considering the compact forms of the structures as 100% efficient, and the efficiency ratios of each form were defined based on the deviation from compactness. According to this approach, it was observed that only 4 out of the 50 structures had an energy efficiency below 80% within the sample set.

4. CONCLUSION

Considering the global trends in the new tourism paradigm, it is evident that our country, which largely consists of mountainous areas, has significant potential for winter tourism. In the design of winter tourism structures located in cold climate regions with complex activities, attention should be given to energy efficiency and the production of appropriate building envelopes. In this context, the motivation to examine the energy performance of winter tourism structures in our country has emerged. With this fundamental motivation, this study focuses on the concept of "compactness," which is highly important in the thermal balance and energy performance of buildings. Measurements of compactness were conducted based on the projections of 50 selected winter tourism accommodation structures from different regions, and various results were obtained using statistical research methods.

Examining the general findings of the study, it was observed that the compactness ratios ranged from 46.2% to 100%, with an average of 77.88%. In terms of regional compactness data, the Eastern Anatolia, Central Anatolia, and Western Black Sea regions exhibited ratios of 80% and above, while the Marmara and Mediterranean regions, which have higher average temperatures and a more temperate climate, showed lower ratios. Therefore, it can be concluded that these two regions contribute to the decrease in the overall compactness average. Additionally, it was found that increasing the surface area significantly affects the compactness ratio in accommodation structures with relatively small floor areas, while in larger floor area buildings, this can be more tolerable.

Although certain directions were occasionally preferred in terms of the main facade orientations, no dominant direction was determined. Similarly, no discernible dominant direction was found regarding mass orientation. These findings suggest a mismatch between theoretical knowledge and practical application. It is believed that factors such as the size of the plot, its location, and its relationship with the road influence the results. Furthermore, no significant relationship was found between the compactness ratio, main facade orientation, and number of floors. In other words, it is not possible to speak of specialized main facade orientations and compactness ratios specific to a particular region.

In the evaluation based on the average number of floors, it is observed that the selected structures from the Marmara Region have higher floors, while the ones from the Mediterranean region have fewer floors compared to other regions. It is expected that the Marmara Region, which has a moderate climate, would prefer taller buildings, while it is unexpected for the selected structures from the Mediterranean Region with a similar climate to be low-rise. It is believed that this is due to economic concerns and operational convenience arising from the fact that winter tourism in the Mediterranean region is still in its early stages and it is considered a pilot region.

The structures selected from the Marmara Region have the highest difference between the existing and compact projections, while the structures selected from the Central Anatolia Region have the lowest difference. The preference for dynamic building forms contributes to a larger difference, while incorporating more stable forms reduces the difference. The Central Anatolia Region has the lowest difference between the existing and compact energy consumption. This supports the fact that the amount of energy lost due to the compactness factor is the lowest in the

Central Anatolia Region. Another reason for the high energy consumption is the wide floor area and the higher number of floors.

Building opacity is directly related to the facade opening. Therefore, the opacity of accommodation centers selected from the Mediterranean Region, which has relatively favorable climatic conditions, is found to be the lowest compared to other centers.

In the examinations conducted, it was observed that even in structures with a 100% compactness ratio, there could still be a difference between the existing and compact energy consumption. This is due to the overall increase in the structure. For example, the Kartaltepe Boutique Hotel, which has a 100% compactness ratio, has the same ground floor and regular floor plans, so there is no difference between the existing and compact energy consumption. However, in the Kaya Palazzo Ski & Mountain Resort, which also has a compactness average of 100%, the first two floors are the same, but as the floor level increases, the floor area decreases. Another notable observation is that, despite the low compactness ratio in the Beceren Hotel example, the difference between the existing and compact energy consumption values can be very small. This is presumed to be due to other influential factors such as facade opening ratio, main facade orientation, and mass orientation.

The study conducted energy simulations to examine the impact of mass design on the climatic comfort performance of winter accommodation structures affected by cold climates. The analyses revealed that the mass of the structures influenced their energy consumption based on thermal comfort. In this context, the study highlighted the significance of mass design in the climatic comfort performance of accommodation structures, contributing to the existing literature. For future research, it is recommended to explore the effects of different structural factors, along with mass design, on climatic comfort in various climate conditions for accommodation structures. Consequently, this study offers a method for architectural designers to reduce energy consumption and enhance climatic comfort.

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Authors' Contribution
The authors contributed equally to the study.

The Declaration of Conflict of Interest/ Common Interest
No conflict of interest or common interest has been declared by the authors.

The Declaration of Ethics Committee Approval
This study does not require ethics committee permission or any special permission.

The Declaration of Research and Publication Ethics
The authors of the paper declare that they comply with the scientific, ethical and quotation rules of SAUJS in all processes of the paper and that they do not make any falsification on the data collected. In addition, they declare that Sakarya University Journal of Science and its editorial board have no responsibility for any ethical violations that may be encountered, and that this study has not been evaluated in any academic publication environment other than Sakarya University Journal of Science.

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