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Space Syntax Criticals for Indoor Ski Centers

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Abstract

Indoor Ski Centers have emerged as a result of a search for alternatives to compensate insufficient snowfall due to climate change caused by global warming. People who invented artificial snowmaking to make it possible to ski throughout the year needed to find locations where temperature was constantly at a sub-zero degree to keep this artificial snow from melting. Thus, it was inevitable to go indoors.

This study covers an assessment based on certain criteria of Indoor Ski Centers which are covered by artificial snow with improved resistance through various chemicals and as a result of this assessment, interpretation of these locations' stylistic, dimensional and proportional characteristics. In this regard, a critical viewpoint is brought to the design of Indoor Ski Centers (ISC) by reviewing the spatial organization of ISCs specifically with the space syntax method and evaluating the obtained results. The study examines Alpincenter in Hamburg, Germany accepted as the biggest center in Europe, ChillFactore in Manchester accepted as the biggest in the United Kingdom, Snow Arena in Druskininkai in Lithuania where the international ski federation organizes annual competitions, and Ski Dubai, the third biggest ski center in the word, where the United Arab Emirates markets a ski experience on the peninsula of Dubai.

The study process includes field studies which use data collection strategies including floor plan analyses and observational studies, data processing, analysis and interpretation, synthesis of experimental findings from theoretical viewpoints, and discussion of outcomes.

1. INTRODUCTION

Indoors are examined under two different definitions in the literature on indoors. The first of these is the living space, and the other is the geometrical space. Living spaces leave emotional traces on the user. These traces are spatial memories created by the experience of the user. The geometrical space, on the other hand, collects sensory traces. These traces share the common language with their homogenous traces in universal terms. While the geometrical space which is also referred to in the literature as the designed space, representative space can be expressed as the product a designer obtains at the end to the design process, it is also necessary to discuss the experienced, used dimension of that space to talk about the living space [1].

As can be understood from space evaluations, the form of the space which constitutes the study topic of indoor designers is the geometrical space rather supported by technical information. However, it is not possible for geometrical spaces created by spatial forms which do not turn into a lived space to exist. For this reason, if a geometrical space designed by a designed by-passes its users, that space falls insufficient in serving its purpose [1].

The most important stages of the space organization process are the tools and methods which can be used in the stage of creating the general construct and relations with an aim to create the desired characteristics of the space. The transfer of ideas from the imaginary world to the real world in the design process requires certain tools. The most important of these tools are the components which allow the space to turn into a product which is perceived and lived [1].

The concepts of spatial join and spatial organization among spatial and stylistic association methods

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differ from the types of spatial association of different spaces constructed together and the styles of these spaces. The said method creates different partnerships depending on the geometrical characteristics of the forms brought together and on expressions which can create differences in the context of volume and space determined by these characteristics. The biggest reason for these differences in spatial partnership are the characteristics demonstrated by the forms brought together in terms of form-space relations which create the essence of the concept of geometric space. Because, what gives a space its spatial character is surfaces and their geometrical structure.

A space does not only exist by combining its components on the architectural place or their widths and heights. It is a space which embodies life within, where users can ramble and experience, engage in different activities, a meeting of multiple places and empty space, and the relationship they establish when they come together [2].

Hanson, based on the theory that space relations can only be created with the connections between two spaces, evaluates the relation with a third space and defends it is possible with configuration. The analysis of these configurations creates space syntax. This method intends to give the space a scientific basis through numeric and graphical expressions while spaces come together in various forms on a plane [3].

Experiencing a space is related to the elements that exist around the experiencer. As if he is in the center of the world, he is in the middle of the world, that is, the space, with his own perception to the extent of his own perception [4]. In everything he perceives, he accumulates a memory for that space, experiences the space and thus keeps the space alive. Therefore, the most fundamental way of perceiving and learning a space is its communication with its user. The structural components of the space need to be understandable for this communication to be accurate and grounded.

A user's expectations from and desires for a space is indeed directly proportional to their reading of the said space. Every user who perceives and understands the space is authorized to make a judgment of the extent that space meets their expectations or what kind of desires they can have with regard to the said space [5].

At this point, maintaining this approach also on the "space scale", the perception of space can be classified with space syntax analyses.

Peponis et al [6] state space syntax analyses are based on graphs and composed of mathematical values. A space syntax study intends to explain the logic behind the social structuring embodied by the built environment such as settlements, complex structures or buildings [7]. The space syntax method not only calculates the strategy of this social relationship logic but also helps creating the hierarchy of structuring.
The design process is an activity of the mind and is fed by what the designer perceives, learns and interprets. The concept of strategy is explained as the main approach, method, paradigm in design. For this, inductive and deductive strategies have been put forward. One of these is space syntax [8].

The spatial syntax method, which has been called an exciting approach that provides an applied research in the architectural environment, has manifested itself in both academic and postgraduate studies. It has allowed projects to remain relevant for long periods of time. This approach, which emerged in London, was later the focus of applied research at the leading American universities of Michigan and Georgia [9].
Arabacıoğlu and Aytis suggests it is easier to create a mathematical model in a space's design process and make a space limitation and structural evaluations [10]. They demonstrate architectural spaces that reach data which can be calculated in the digital environment will allow for making a spatial analysis and therefore, reviewing and evaluating the organization process again with digital data.

The space syntax strategy helps resolving the spatial organization of an architectural form using diagrams, charts and matrixes. It expresses and calculates spatial organization in charts.
Regardless of the scale of any architectural design, the performance values of the design are directly related to the physical environment. This is because the performance and quality of a building is closely linked to the user experience, the actions that take place within it and the physical structure that enables

these actions [11]. When the concept of performance is accepted as the necessity of making the best use of all the components of the process to reach the right design decisions, it is clearly understood that the process must be managed correctly in order for a correct design to succeed [12].

When designing a building, it is necessary to understand the relationship between the arrangement of space and the social behavior of users in order to examine how users will use it in accordance with their daily needs. Therefore, analyzing the movements within the space using the spatial sequence method helps to understand this relationship [13].

The motivation to examine the spatial organization of indoor ski centers through the construct of space syntax will allow for comparative interpretations of their design and use processes.

For this reason, in this study, it is aimed to evaluate the design of 4 indoor ski centers determined within the scope of the study with user experience. The space syntax method was also used for this evaluation. This method aims to fill the gaps in the literature for the design of indoor ski center facilities by evaluating the design process of these structures, which are considered as an experiential space, through various representations and drawing inferences from the obtained results.

The study is limited to the themes which are defined as gaps in the literature on ISCs through a literature review for study purposes, and challenges and obstacles to their design. The study progresses by establishing significant relations based on observations and reviews at these centres and collecting data to be used for the study.

2. METHOD

The space syntax method is a method which bases structural analyses on spatial data. It is used in the classification and comparison of stylistic qualities of the space.

Space syntax feeds on crating existing information through gaining experience as the “reflection of the space” in human mind. This information defines the abstract characteristics of the space. Space syntax is a technique which allows for obtaining analyses that tangibly expresses these intangible qualities [14]. While in this technique obtained data is evaluated as the reflections of the space in human mind, the central topic of the space syntax method is fragmenting to experience the space and making digital analyses on it by putting these fragments in maps and graphs. The idea of fragmenting the space results from that what is effective in user’s reading and learning the space is experiencing it.

In short, while making studies on the system’s functional organization types in space organization and field of vision by taking a different point as reference each time through visibility analyses, and sometimes studies on where the visitor focuses and spends time at what points in these visible areas, the point of focus is the interior of the building. These studies overlook the combination and dimensions of the space.

Direction finding, redirection and visibility are basic user requirements also in an indoor ski center design as in a space design on any scale. In all of these buildings, as there is no component which lets in direct sunlight, direction finding and redirection is much harder. Because light is as effective as signs, symbols, materials and proportions in creating a character in the visibility of the space [15].

Dursun mentions the space syntax theory is comprised of four stages of thinking, namely the representation stage, analysis stage, genotype stage and theory stage, and explains them as follows:

- Representation stage; where the components of a space are identified,
- Analysis stage; where the organizational relations between the components of an order are defined,
- Genotype stage; where compatibility is sought among the defined organizational relations,
- Theory stage; where general tendencies among different genotypes are demonstrated.

These stages exist in the phases of Figuration, Comprehensibility and Integration, and constitute the basic thinking phase of the theory [16].

The study based on the discussion of main characteristics of the space syntax method defines four analysed indoor ski centers, which are Alpinecenter, ChillFactor, Snow Arena and Ski Dubai. The method implemented to optimize indoor ski center designs or provide data for new ones was reviewed in these four center. Therefore, there was an opportunity of making a discussion on the feasibility of space syntax to evaluate and improve indoor ski center designs.

2.1. Representation Stage

In the study that considers visitor experience as the essence of design [17]; it is emphasized that transforming the space from a functional space into an experience space or restructuring it in this direction is an indispensable element if the analysis processes of the space are used correctly.

According to Dursun and Ozsoy, the spatial configuration, expressed as a network of movements and relations, is abstracted and prepared as various representations for analysis [18]. With these representations, numerical measurements are performed on abstracted data. Axial maps, visibility analysis, agent-based analysis, depth and integration are some of these measurements and representations. In this study; the components of the space in the representation phase were tried to be identified and expressed.

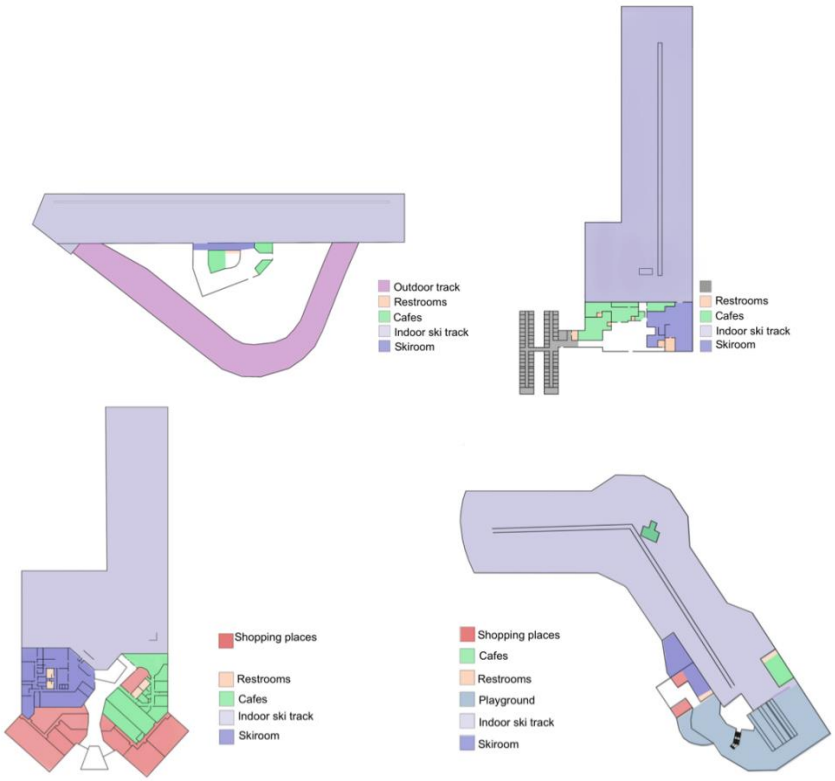

Figure 1. *Snow Arena (top left), Alpincenter (top right), Chill Factore (bottom left) and Ski Dubai (bottom right) plan geometries.*

Figure 1 shows the spaces that the reviewed centers are comprised of and their relations with one another. In Hamburg example, accommodation areas are planned as an additional function to the structure besides a 180 meters ski track while there are sport equipment stores in the 110 meters Manchester example. Snow Arena has an outdoor track which can be used in winter and connects with the indoor area in addition to the indoor ski track. In Ski Dubai, there is a café/restaurant in the middle of the track which can only be accessed from the track.

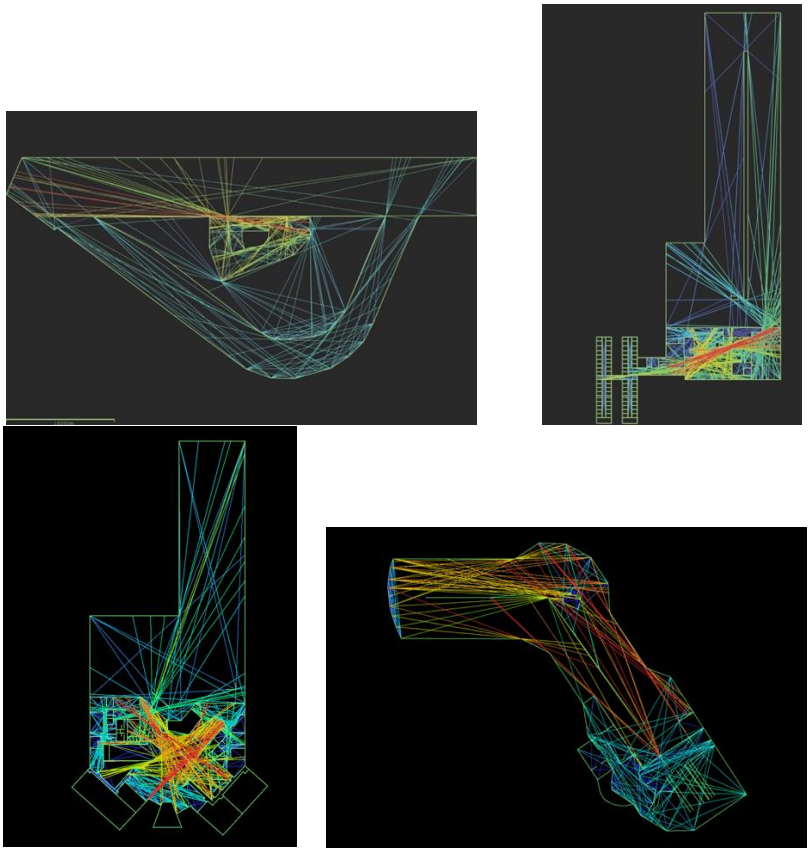

Figure 2. *Snow Arena (top left), Alpincenter (top right), Chill Factore (bottom left) and Ski Dubai (bottom right) axial map.*

As symbolization examples in Figure 2, axial maps are used to represent integration in concave and convex spaces. It can be considered convex when it is possible to draw straight lines from a point to other points inside a space without crossing the boundaries of the space. According to these maps, as in Snow Arena example, if a line drawn from a point to another point inside the space crosses the boundaries of the space, it is considered concave. Accordingly, indoor ski centers other than Snow Arena can be called convex.

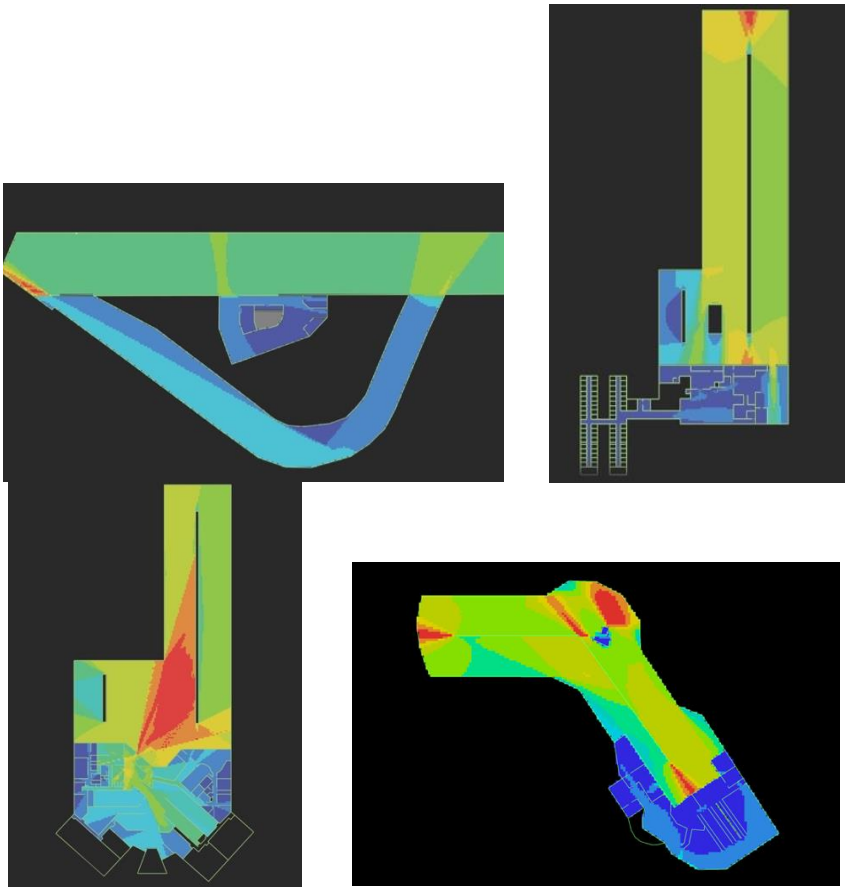

Figure 3. *Snow Arena (top left), Alpincenter (top right), Chill Factore (bottom left) and Ski Dubai (bottom right) visibility analyses*

The Isovist maps in Figure 3 are used for the representation of everything that can be seen inside a space. Colors here express integration distribution. As in transition graphs, syntactic measurements are also made on these maps. According to the measurements also shown in the figure, the darkest color signifies the most integrated parts while integration distribution is expressed in colors from dark to light. The fact that all spaces covering the study areas have a homogenous distribution is observed through clear color transitions.

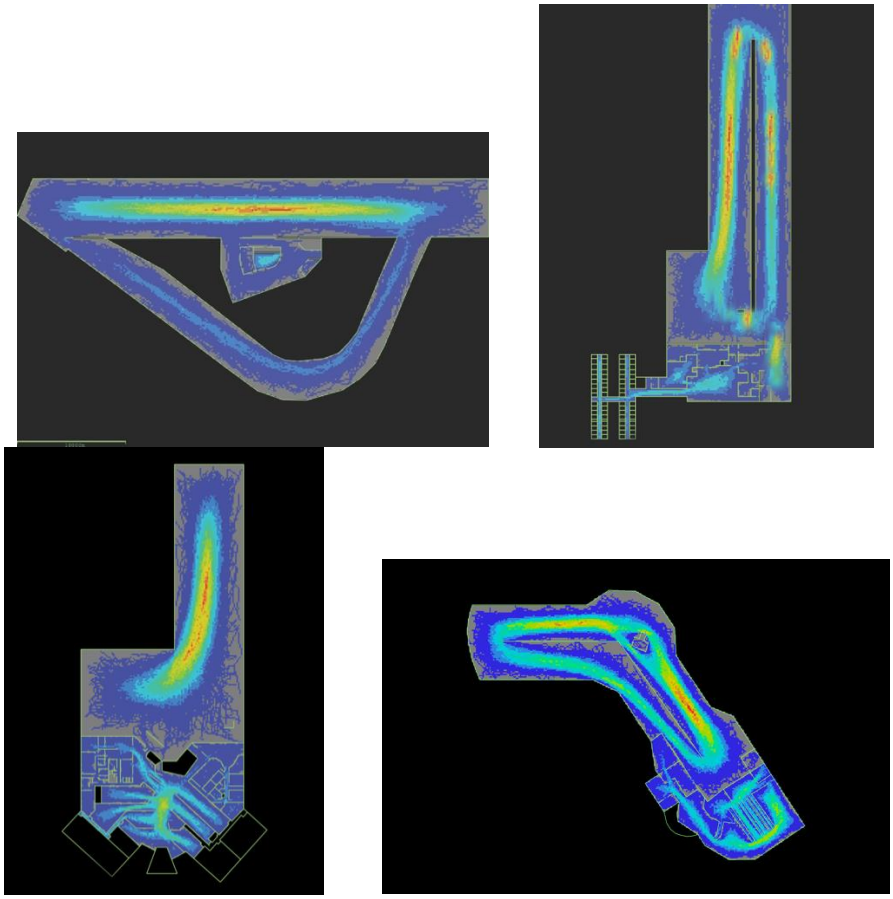

Figure 4. *Agent-based analyses for Snow Arena (top left), Alpincenter (top right), Chill Factore (bottom left) and Ski Dubai (bottom right).*

Agent simulation evolves from visual graph analysis based on the fact that the change of human behavior depends on the perception and understanding of the spatial structure. In agent simulation analysis, the agent added to the two-dimensional plan through software focuses on determining the next step after three steps. The path superposition of the agent is considered as a simulation of human circulation in the building. This analysis can be used for the (re)arrangement and evaluation of a building [19], [20].

Agent-based analyses in this study; as the final way of representation, demonstrates permeability and visibility relations, ways of operation of all spatial systems and specifically examined spaces and how they are experienced by users, i.e. visitors.

In examples shown in Figure 4, the prevailing existence of ski tracks as a spatial theme can be seen clearly.

2.2. Analysis Stage

Looking for the existence of an organization relationship among the parts that create an order inside a structure and defining this relationship happen in the analysis stage. The analysis stage includes depth analyses performed for every center examined in the study. These analyses were made through transition graphs. A selected space from the system was designated as the root space and other spaces were put in order on top of this root. This order was made depending on the number of spaces that were transited through to reach every space.

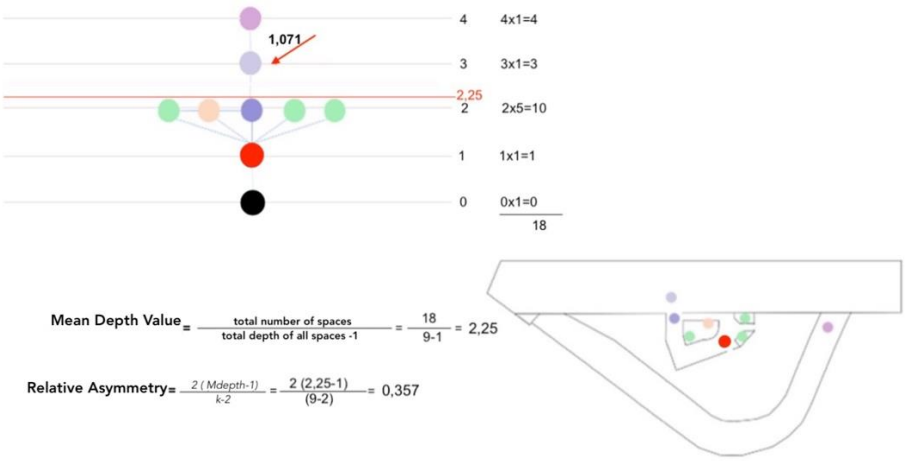

Figure 5. *Depth analysis for Snow Arena.*

Figure 5 gives depth analysis values for Snow Arena. The depth coefficient was obtained to be 18 in total depending on the depth of all spaces and the mean depth value was 2,25 in proportion to 8 spaces in total. In Lithuania example which gained depth through an outdoor ski track, the depth value of 3 with a high asymmetry value obtained due to the low number of spaces provided the space with the highest integrated value.

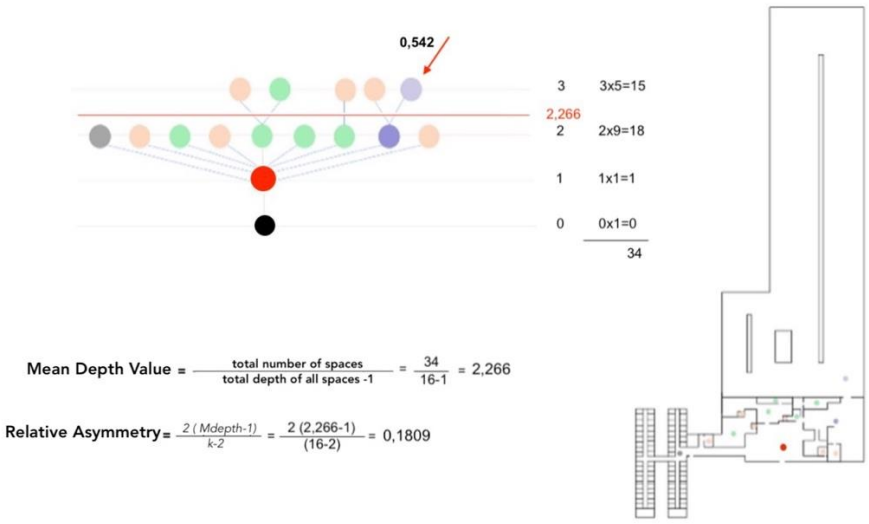

Figure 6. *Depth analysis for Alpincenter.*

In Hamburg example, although it can be seen in Figure 6 that a high number of spaces are experienced in the graph, the ski area is shallower. This is due to the fact that the only connection of the space with the outdoors is through the entrance door. The depth of the ski area marked with an arrow is above the 3rd mean depth and is considered within the limits of privacy. The integration of the space to the structure can be evaluated with the multiplication of the relative asymmetry value with depth.

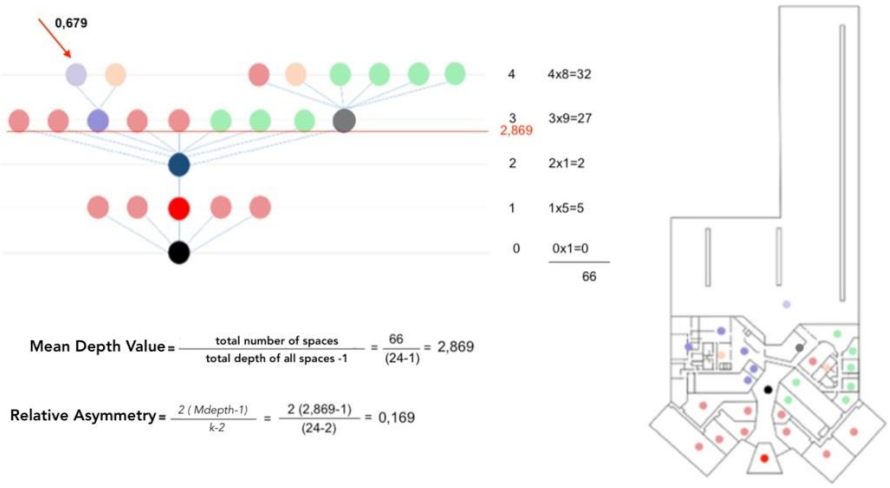

Figure 7. *Depth analysis for Chill Factore*

For Manchester example shown in Figure 7, the outdoors should also be included in the system. There are numerous spaces to reach the ISC which are experienced by the user. Therefore, the ski area marked with an arrow has a very deep value at the 4th rank.

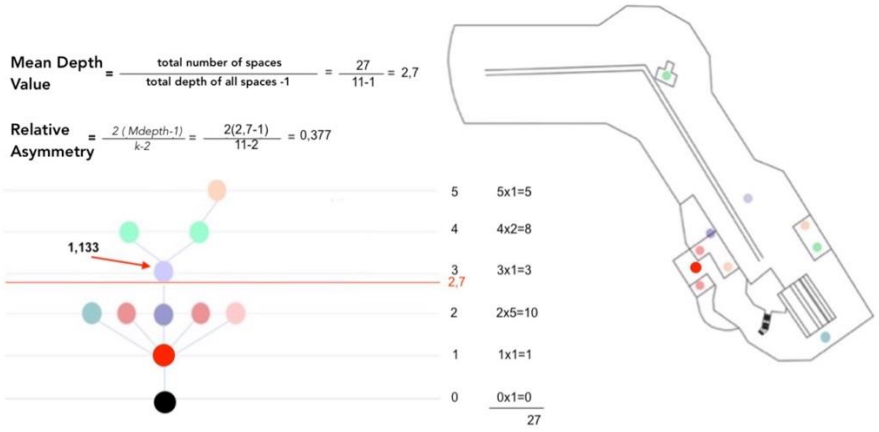

Figure 8. Depth analysis for Ski Dubai.

In Dubai example, there are spaces connected to the ski area. Cafes and the restrooms inside cafes can be given as example to these spaces. As can be seen in Figure 8, compared to other examples, it has a very high asymmetry value despite a depth value at the 3rd place.

2.3. Genotype Stage

The genotype stage, in other words the stage of seeking compatibility in defined organizational relationships, was realized by looking for similarity between data obtained from the analysis stage. For this purpose, various deductions were made based on the relatedness situations obtained during the analysis.

The mathematical expression of the relative depth of a space from other spaces in the graph gives that space's "relative asymmetry" value. This value shows whether the space is a connector in the configuration. Figure 2.3.1 shows the relative asymmetry values of the centres examined in the study.

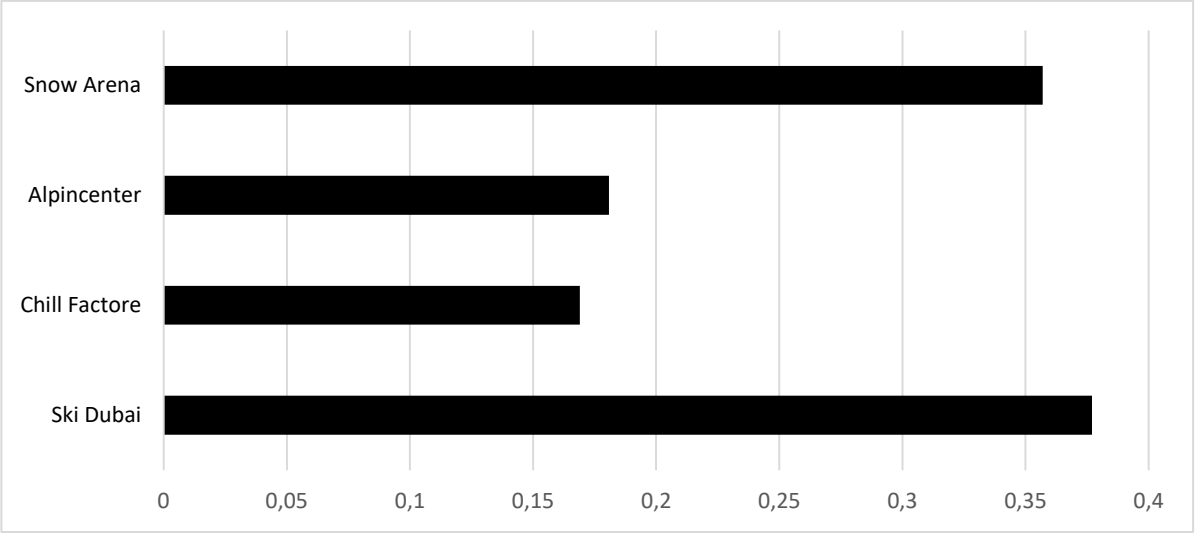

Figure 9. *Relative asymmetry values*

The relative asymmetry value (Relative mean depth) will always be a value between 0 and 1. How high or low this value is demonstrates that the organization tends to integrate or disintegrate. All centres are seen to be integrated within themselves (Figure 9).

In his study, Gündoğdu clearly expresses the contrast between depth and integration values, naming the spaces that are passed through more as integrated and those that are passed through less as segregated [21]. As the depth value increases, circulation within the building decreases, while circulation is higher in buildings with less depth.

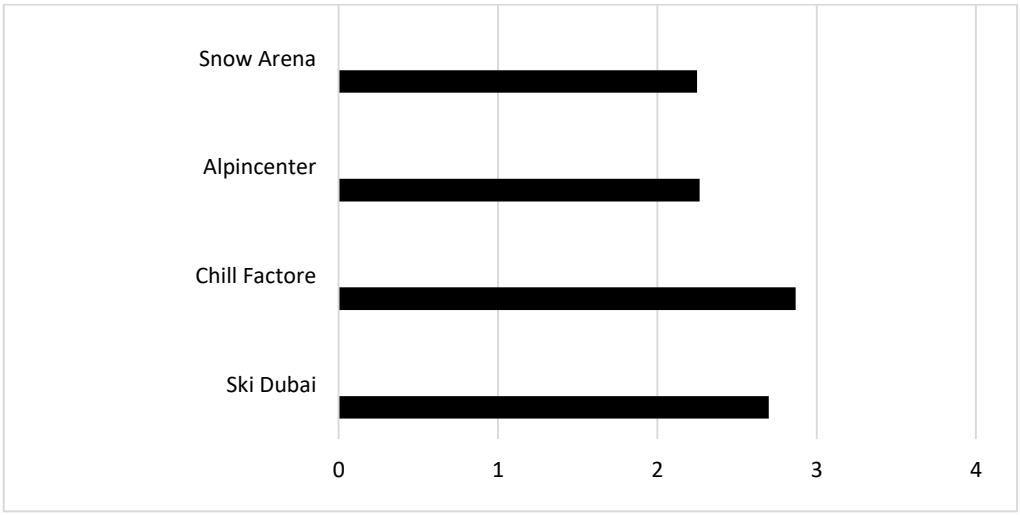

Figure 10. *Mean depth values.*

Figure 10 shows mean depth values of the centres. In Manchester (Chillfactore) example, there are numerous spaces on the way to the ski area and they are seen and experienced. Therefore, the ski area has a very deep value. Dubai (Ski Dubai) which gains depth with 3rd depth level has the 2nd mean depth value after Manchester. In Hamburg (Alpin Center) example, again there are many spaces experienced in the graph, but the ski area is shallower. This is due to the fact that the only connection of the space with the outdoors is through an entrance door. There are spaces connected to the ski area like an open ski track in Druskininkai (Snow Arena). Therefore, it has a depth at the last place compared to depth examples of the ski area spaces of other centers.

2.4. Theory Stage

The integration value, which is the most important figuration criterion, is related to the depth degrees. It is also the most influential parameter on movement [22].

The theory stage is a stage where general tendencies among different genotypes are demonstrated. This study obtained 4 genotypes.

In Hamburg example, integration developed around circulation spaces, areas of daily use were more separated and there was less structural differentiation. It had a more separated structure as strong spatial relations were not established with the outside.

In Manchester example, integration with the outside was not established with functional similarity but it was planned inside the values of the structure. Therefore, integration is higher than Hamburg.

In Druskininkai example, integration develops around the area of functional use of the space and there are strong structural differentiations among the spaces. There are strong spatial relations with the outside. Therefore, there is a more integrated indoor and a more integrated outdoor space.

In Dubai example, there is again a high integration value. The interconnection of spaces has a high value as there is no structural differentiation.

These genotypes do not have any relationship with the sizes or geometries of the ski centers. However, 4 spatial/functional differences can be clearly seen in the ski centers with different geometries.

3. DISCUSSION AND CONCLUSION

Louis Kahn emphasizes the role of architectural structuring on human and environmental structuring, emphasizing the impact of the end product of an architect's design process on human beings and their environment [23].

Alexander describes the act of reaching this end product as a process that involves decision-making stages of different quality [24].

A lot of research deals with the design process. According to a model that has been around since 1926, the creative process consists of 4 steps. These are preparation, incubation, enlightenment and validation/realization. And these phases follow each other continuously [25].

Here, the focus turned back on the purpose of the study and answers were looked for within the scope of four thinking stages that served the Space Syntax theory. It is clear that these thinking stages are the representation stage, analysis stage, genotype stage and theory stages [26], which are reinterpretations of the stages proposed by Wallas in 1926.

Another study; considers Dursun's description as a process in which multiple alternative solutions are tested at the same time [27]. This approach, which is suitable for analyzing multiple representations, enables spatial assessments in the 3rd dimension from a spatial organization scheme in two dimensions.
In the study on museums, McLean evaluated the experience of visitors in terms of spatial satisfaction. According to that, space organization is of great importance for designing a functionally reasonable space layout [28].

In this study, it was clearly demonstrated by the analyses that ISCs, which are also a place of experience, had their own very specific rules for spatial organization. This organization determined the environmental characters of ISCs and their stylistic, dimensional, proportional and tactile characteristics for their visual evaluations in their surroundings. Because the design quality of buildings can be understood and how visitors use the building can be determined with the method of space syntax [29]. Since this method is

used in fields such as architecture, urban planning, interior architecture, landscape architecture, transportation, informatics and geography, it has also been used for indoor ski resorts.

In fact, Hillier and Hanson argued that spatial sequence theory basically describes the relations between space and its parts. This definition begins by revealing all the variations of their spatial organization and continues by creating ways of representation, as in this study, through some kind of signs or formulas instead of verbal expressions [30]. It then analyzes how structures relate harmoniously to each other. It expresses how they should come together to form more complex structures.

In this study, these characteristics identified in comparison for these four different centers demonstrated that while trying to understand a space, looking into its relationship with the user, and revealing meanings that cannot be seen with the naked eye is a way of reaching rational and scientific information.
The study seeks evidence that abstract concepts can be concretized to establish a relationship between the individual and the environment. For this reason, the data obtained can be used for further research on the means by which spatial syntax can be related to spatial cognition.

Also, the spatial configuration relations revealed for four different centres defined that it varied depending on the type of association among the space components. The basis of these differences is that the spaces are organized differently. The product to be obtained as a result of literature reviews and configurational evaluations intends to adapt to the user's attitudes and behaviours without imposing any attitudes or behaviours on them. For this reason, as the layout is the basis for the said analyses, it is believed to be influential on the relationship between user and the space.

At the same time, the analyses conducted in this study offered insights into what Turner calls a heuristic method of spatial analysis [31]. Through DepthmapX 0.50 (developed by Tasos Varoudis) program, the analyses reduced to two-dimensional plans were evaluated as a representation of 3D spaces. Because the design of a space is related to the style of the space in parallel to spatial evaluations. Therefore, the design of a space embodies the characteristics of the geometry of the space. Just as forms come together stylistically, the right partnership with the function of the style of the said space cannot be ignored for the space to emerge as a product.

When the spatial organization is evaluated, it is seen that the movement patterns in the space correspond to the axial structure of the system. It is also clear that the general tendencies revealed by different genotypes have a mathematical result. In other words, the manifestation of movement within the space depends on the relationship of the spatial experience with the environment. This is related to the combination of each stage developed by the method.The process until a space user experiences a space emerges as a result of this organization. In this study, while explaining in detail how the experience stage is reached, we also focus on how the outcome of the experience can be predicted. That is, the process of users experiencing a space is treated as a fundamental component of this organization, and understanding and controlling the outcome of the experience is an important focus.

The study is an inference that supports the project development process both in theory and in practice. Its findings and recommendations will be guiding for a large spectrum of stakeholders. It will bring a fresh perspective to the development of design criteria for ISCs and facilitate future project development processes. For this reason, the study methodology and gathered data can be used for similar studies.

Literature reviews so far have not provided a general field study on the spatial characteristics and organization of ISCs. The findings of this study, based on field studies, both tried to close the literature gap for indoor ski centers research and provided spatial evaluations for their design. To determine standards in planning, first it is necessary to demonstrate the spatial evaluations of ISCs.

It is also necessary to accurately classify the components which exhibit the different characteristics of layouts of these centers to understand and accurately synthesize the structural components of ISCs.
For this reason, the findings to be obtained from this study offer a critical study for ISC designs while providing a recommendation for researchers and designers through both semantic and syntactic analyses.

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