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Examination Of Avalanche-Resistant Building Design Through Countries' Development Levels And Their Code Of Ethics For Architects

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Abstract

The study is to emphasize the importance of a code of ethics for architects to decrease the impacts of avalanche disasters. This study aims to research how much the life safety principle, which is stated as the most basic responsibility by the architectural profession's code of ethics, is applied by comparing the number of building-related deaths, development levels, and the content of avalanche-prone countries' ethical codes for architecture. The regulations and studies in the world were reviewed and the parts related to architectural design were organized to show the relationship between architecture and structures vulnerability to avalanche effect. These will provide a guide for architects who are aware of their responsibilities under professional ethical codes, and they will help lower avalanche-related fatalities. The implementation of architectural ethical codes has been suggested as a way to lessen the damage to countries that experience an excessive number of building-related fatalities as a result of avalanches. Further studies should evaluate the implementation of the responsibilities outlined by the architectural ethical codes for numerous different disasters and countries.

Keywords: Responsibilities of Architects, Code of Ethics, Development Level, Vulnerability to Avalanche, Avalanche-Resistant Design, Building-Related Fatalities.

1. Introduction

Structures in any location in the world have the possibility of facing variable natural events. Globally, natural disasters have caused approximately the death of 45,000 people per year in the last decade (Ritchie et al., 2022) Avalanche is one of these natural disasters. The term avalanche is defined by the National Snow and Ice Data Center (NSIDC) as: ''An avalanche is a rapid flow of snow down a slope, such as a hill or mountain.'' [1]. There are three main parts where the avalanche begins, flows, and stops. The first part is the starting zone. "The starting zone is the most volatile area of a slope, where unstable snow can fracture from the surrounding snow cover and begin to slide." (NSIDC). Although avalanches usually start in this zone, they can also start in any part of the path under the right conditions. The second part is Avalanche Track, which is the avalanche flow zone. Avalanches flow down and reach their maximum speed on this path. The last part is the runout zone, where the velocities of the avalanches reach the minimum speed and stop. An avalanche occurs when the snow mass moves on a slippery surface and this movement cannot be prevented by natural or artificial elements (Disaster and Emergency Management Presidency (AFAD), 2018). According to NIDSC [2], the most common season for avalanches to occur is during the winter, especially from December to April. However, avalanche fatalities have been reported for each month of the year.

The causes of avalanche formation are generally examined under 3 headings. These are the snowpack, terrain, and weather. This triple interaction is called the avalanche triangle (Fredston and Fesler, 1994). In addition, the trigger factor (human factor) also causes avalanches. However, all these causes are generally based on meteorological factors [3]. Although these factors are classified, the formation of some avalanches' is unpredictable. So, researchers have frequently focused on avalanche risk assessment, modeling programs, mapping, and monitoring studies (Akay, 2021; Canadian Avalanche Association, 2016; Helleboid et al., 2022; Ancey, 2001; Bründl and Margreth, 2015; Elmastaş and Özcanlı, 2011; Nadim et al., 2006; Perla et al., 1976; Selçuk, 2013; Sinickas and Jamieson, 2014; Yilmaz, 2016).

Even though avalanches have been a serious natural disaster for more than a century, there haven't been adequate studies to provide comprehensive regulations and guidelines for built environments in avalanche-prone areas. The majority of articles in the engineering field are studies

about protective measures. Studies on the risk management of avalanches, land-use strategies, and prevention methods provide guidelines for the design of artificial barriers and supporting structures. Studies also provide instructions for their construction, such as catching dams, snow fences, and snow nets (Barredo et al., 2015; Gürer, 2002; Kadıoğlu, 2008; Schaerer and McClung, 2006; Yıldız, 2018; Birgisson, 2019; Delpech and Thiis, 2016; Frutiger and Martinelli, 1966; Hendrikx et al., 2020; Rudolf-Miklau et al., 2015). Studies about the impacts of avalanches on building components and the potential destructive damage to structures have been conducted. However, studies that could be used as a guide in architectural design have not been carried out yet (Aydin et al., 2014; Bartelt et al., 2019; De Biagi et al., 2012; De Biagi et al., 2016; Canadian Avalanche Association, 2016; Dias et al., 2015; Durak, 2011; Gürer, 2002; Mears, 1992; Perla et al., 1976; Holub et al., 2012; Holub and Fuchs, 2008; Margreth, 2016).

But as defined by the Royal Architectural Institute of Canada. Architect [4] is;

"… a professional who is qualified to design and provide advice - both aesthetic and technical - on built objects in our public and private landscapes……Architects serve as trusted advisors, their role is holistic, blending diverse requirements and disciplines in a creative process while serving the public interest and addressing health and safety matters." -

As stated, an architect is a designer who has to take care of the health and safety problems of society as well as aesthetic and technical issues. Therefore, it is an architect's ethical responsibility to produce structures that are resistant to natural disasters that threaten the building area. It is very important to save the life of even a single person within the scope of architectural ethics.

With the rapid development and growth of the construction industry, ethical codes have been produced to determine the duty, identity, and responsibilities of the architect and which are obligatory to follow. Architect ethical codes prepared against the public, the customer, the profession, colleagues, and the environment vary according to the development of the building sector in the countries (Dallı and Soyluk, 2022). Although the codes do not have a separate place for the buildings to be built in disaster areas, design principles for public health, safety, and welfare are adopted within the general rules.

This study aims to fill the gap by inquiring about architectural design methods and raising awareness of architects about designing resistant and resilient structures regardless of the level of development of avalanche-prone countries by revealing the ethical responsibilities of architects towards their designs. It should be known that; "Design professionals and the construction industry have a significant role in the health and safety of the environment and disaster management. Their role includes a range of activities designed to maintain control over emergencies, providing a framework for helping those who are at risk to avoid or recover from the impact of the disaster (Kelly, 1996)."

2. A review of avalanche-resistant proof building design in an architectural view

Despite the variation of building types constructed for avalanche zones, the absence of a source that provides an architect's guide has led to the requirement for architectural design guides in avalanche-prone areas. The study continues by detailing how the architectural design would be constructed in avalanche-prone areas.

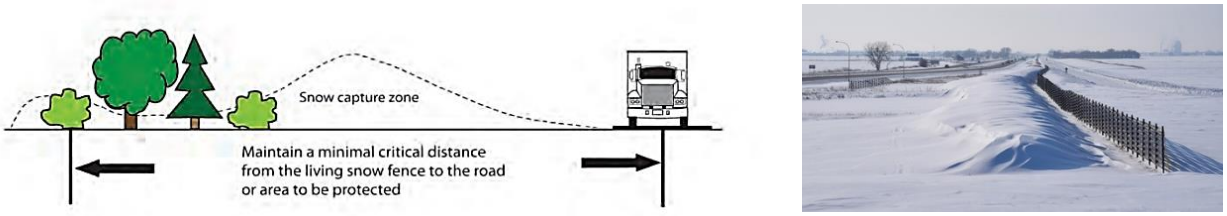
The regulations stated whether it is suitable for construction or not with the impact pressure (pn) of avalanche and return period (T). There are four mapping zones: red, blue, yellow, and white zones (Ammann, 2021). Even though many countries accept this zone classification, relatively few of them have avalanche disaster maps that are based on the avalanche zones. Before assessing the behavior of the building against avalanche forces, it is essential to examine these zones to evaluate whether they are suitable for construction or not.

2.1. Landscape Design

Architectural design starts with land investigation. Because the architect derives the form and many other design decisions from the land. In the classification of avalanches, mitigation measures land use planning is classified as passive methods and it has a long-term effect on the environment (Birgisson, 2019). Whether active or passive, avalanche mitigation methods have long-term effects and provide more effective solutions in avalanche-prone areas. Urban design strategies are crucial for protecting the environment and living. Animals, vegetation, and the entire environment are also dangerous along with human life. The

case study (FEMA,2021), suggested living snow fences and explained the solution as: 'Living snow fences are an extremely economical, effective, and environmentally sound alternative for controlling snow'. Trees and shrub plants are used for snow protection and are called living snow fences. These fences might be a way to improve habitat and human life safety.

Minnesota Department of Transportation [5] defines three types of snow fences; structural, living (trees/shrubs), and vegetative (corn rows or hay bales). Additionally, protective structural snow fences may be made of steel, concrete, and wood. Living snow fences (Figure 1.a.) are more ecologically friendly to implement. However, plants could take a long time to reach the right size for live snow fences. In the event of unexpected situations, to develop quicker responses, it may be important to take into consideration the use of steel, concrete, or wood fences (USDA, 2011) (Figure 1.b). In terms of design, snow fences were usually constructed with materials that were not appropriate for the environment. Steel and reinforced concrete constructions are preferred today to prevent avalanches as they are more load-resistant, even though wood is more environmentally compatible.



(a) (b)

Figure 1 Living snow fence illustration by Doug Wallace (a) Source: (USDA, 2011); Snow fences (b), Source: Minnesota Department of Transportation [5]

According to the FEMA training study [6], avalanche mitigation techniques are categorized into six groups;

- Training programs
- Detection, forecasting, and monitoring systems
- Corridor management
- Zoning
- Initiating controlled avalanches
- Protective measures

Structural defenses are also categorized into six for snow avalanches (Arthur I. Mears, P.E., Inc. and Wilbur Engineering, Inc., 2019);

- direct protection (building as a snow defense) (Figure 2.a)
- deflecting and channelizing avalanches (snow routing methods, deflecting dam, etc.) (Figure 2.b)
- snow sheds (shelter as a precaution against snowslides) (Figure 2.c)
- arresting and storing snow & debris (catching dam etc.) (Figure 3.a)
- supporting structures in the starting zone (Figure 3.b)
- snow fences and wind baffles (Figure 3.c)



(a) (b) (c)

Figure 2 Direct protection (a), Source: Arthur I. Mears, P.E., Inc. and Wilbur Engineering, Inc., 2019; Deflecti ng structure (b), Source: Martin Heggli, SLF;
Channelizing avalanches (c), Source: Martin Heggli, SLF.



(a) (b) (c)

Figure 3 Snow sheds (a), Source: (Hendrikx et al. 2020);
Snow net, supporting structures (b) Source:
https://trumerschutzbauten.com/avalanche-fences [7];
Snow fences (c), Source: (Kumar,2015).

Depending on the material that architects use to apply, the service life of supporting structures differs. Wood structures have a 30-year service life and steel structures have a 100-year service life (Bründl and Margreth, 2015). A designer who uses steel in the design might develop a structure that is better suited to the environment with the use of vegetation. It is both environmentally friendly and fulfills its function. As a first design proposal, artificial materials such

as steel and reinforced concrete may be camouflaged by vegetation or afforestation, and a secondary shell could be built with more organic forms and ecologically sustainable cladding materials to better adapt to the environment. By estimating the avalanche fall direction, the structure confronting the avalanche path is designed to be more solid and rigid, while the design in the opposite direction could specific with more flexible organic forms. Instead of placing the structures, which are intended to be designed as a single shell, on the land with steep flat forms, curved forms can be created to give a soft appearance like the Skating Trail Pavilion by Lateral Office (Figure 4).

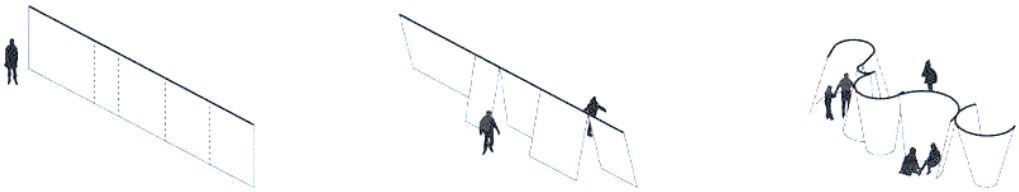


Figure 4 Flexible Winter Sport Fences by Lateral Office, Source: https://lateraloffice.com/DRIFT-PASS-2012 [8]

Without dominating the form of the land, dams can be built by imitating the natural form and integrating with the land (Figure 5.a).



(a) (b)

Figure 5 Catching dam and debris flows in Klosters, Switzerland (a);
St. Antönien, Switzerland (b), Source: (Bründl and Margreth 2015).

When choosing the material for the construction, local resources should be taken into account to create a design that is sustainable and environmentally beneficial. Building walls may be designed as avalanche barriers and blended with the land's form, aside from artificial barriers and

supporting structures, to lessen loads of avalanches (Figure 5.b).

2.2. Structure Design

In order to reduce the impact on the structure, vital wind direction should be directed towards the short side of the building. Additionally, the building's floor plan can be advantageous in instances when the avalanche flow direction is parallel to the diagonal of the floor plan. Consequently, the building's corner functions like a riving knife to deflect the avalanche away from the outer walls [9].

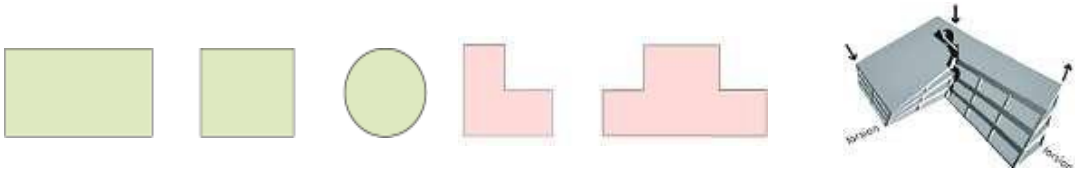
For the structures to remain safe in case of disaster, the plan layouts should be as follows (AFAD, 2018);

• It must have rigidity and strength to ensure that the loads are transferred safely to the foundation.

• Some of the transferred energy must be consumed by its ductile behavior.

• Symmetrical or nearly symmetrical arrangement should be made in the plan and irregularity should be avoided. The soft and weak storey should not be made in the vertical direction (Figure 6.a).

• Rigid elements such as curtains should be considered to increase the rigidity of the building against torsion (Figure 6.b).



(a) (b)

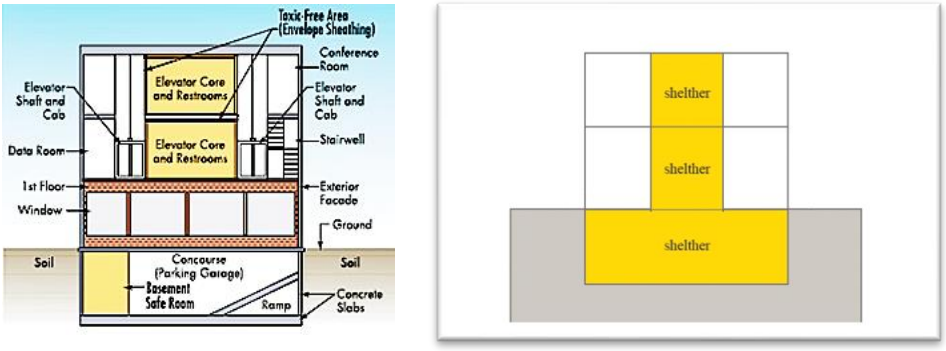
Figure 6 Regular and irregular plan shape (a) Source: (National Institute of Building Sciences,2018); The behavior of asymmetric plan (b), Source: (FEMA 454, 2006)

Regular plan shapes behavior under snow loads is much more resistant than irregular plan shapes (NIBS, 2018). It is common knowledge that should be not only valid for avalanches but also other natural disasters. Among the materials frequently used in construction are bricks, cement, concrete, steel, and wood. Articles about the robustness of elements under vertical forces, from largest to smallest, materials are listed as follows;

- steel = reinforced concrete > masonry > stone > timber (De Biagi et al. 2012).

The durability of the building components, the quality of building materials, the arrangement of the frame system at every corner, the depth of the foundation and the height of the basement, the suitability of the frame system, the use of lintels in the wall openings, the anchors of the doors and windows, the connections of the roof and roof coverings, are important features to be considered in buildings in hazardous areas. (National Building Research Organization, 2015). Structural systems' most common problems are improper connection, choice of material, and lack of load paths. In addition, workmanship errors may cause a structural problem. Structure stiffness is the most desirable feature in hazardous areas. However, stiffness is not a property that should be in every element of the structure. The flexibility of the structure is also important to transfer the fundamental loads, such as the flexible foundation.

The section away from the outer walls should be structurally strengthened so that it may be used as a shelter above or below the ground in case of avalanche damage (Figure 7). These shelters are areas that are reinforced against loads, away from the outside, where sufficient numbers of people can stay in case of emergency. Reinforced block walls are recommended for use in shelters for hazardous zones such as avalanche-prone areas (NIBS, 2018)

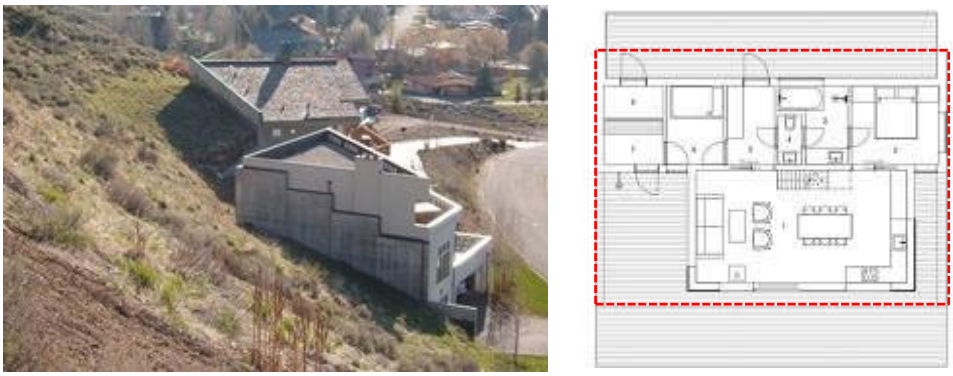


(a) (b)

Figure 7 Shelter design for disaster management (a) Source: (NIBS, 2018); Diagram of the locations of potential shelters both above and underground (b)

In the avalanche mitigation technique, it is necessary to use the building walls as a protective shield (Figure 8). Apart from being a shield, it can be used to channel the avalanche. However, it's important to calculate the flow direction of the avalanche to determine the wall orientation of the structure. Shear walls also called sway-

inhibited structures behavior are stiffer and more resistant structures than other frame systems in most cases.



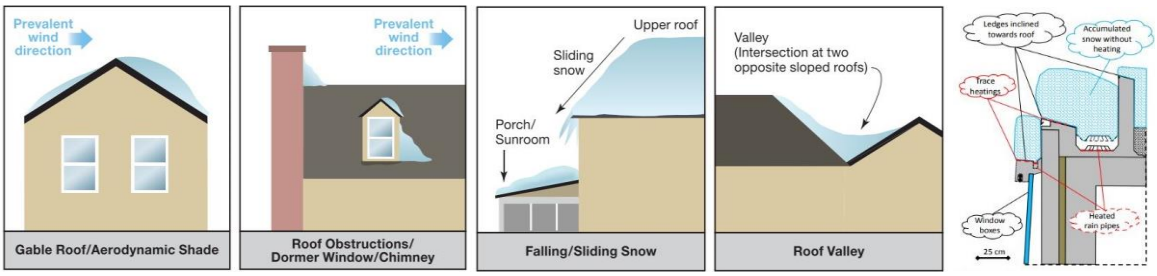
(a) (b)

Figure 8 Ketchum, Idaho (a) Source: Arthur I. Mears, P.E., Inc. & Wilbur Engineering, Inc., 2019; Example of double wall plan (red dashes represent the outer shell of structure) (b) Source: (Pintos, 2019)

As a suggestion, the use of double walls can alleviate the load and protect the main wall of the building by acting as a shield for the outer wall (Pintos, 2019). However, no matter which type of wall is decided to be built, attention should also be paid to the cladding systems. Connections of the cladding in hazardous areas should have a larger connection depth on the wall than normal and must be reinforced to additional loads.

‘’Roofs must not protrude beyond the top of the wall that faces the direction from which the avalanche may come, nor can the pitch exceed 45°’’ (Crécy, 1980). Roof and facade overhangs are vulnerable parts of the building and should be avoided. When we consider the roof geometries, roofs that are easiest the shed snow are simple roofs with steep slopes. Irregular geometry can cause snow to accumulate and this can cause problems such as load bearing and water leaks on the roofs (Figure 9.a). These roofs are; roofs with parapets, flat roofs, stepped roofs, saw-tooth roofs and should not be preferred in avalanche-prone areas (FEMA P-957).

In the proposal mitigation design, trace and rain pipe heating can help to prevent accumulated snow. Inclined roof finishing may also be the solution for snow accumulation (Figure 9.b). Roof structures need sloped roofs, drainage systems with clear gutters, and support to resist snow loads needed when avalanches occur (FEMA P-957).



(a) (b)

Figure 9 Irregular geometry snow accumulation (a) Source: (FEMA P-957, 2013); Mitigation proposal (b) Source: (Margreth, S. 2016).

Avalanche-facing openings (windows, doors, air well, etc.) should be avoided as much as possible, and if necessary, their size should be as small as possible. While an avalanche is flowing, it may carry harmful substances such as branches, and stones. These substances may cause damage to windows. To avoid this situation, windows must be made of unbreakable frames and reinforced glass. Window gratings may be used to provide extra protection (Figure 10) and also may be used for other openings.



Figure 10 Window gratings, Source: https://securitydirectuk.com/window-mesh/window-security-mesh [10]

If at all possible, openings should not be made facing the mountain slope or in areas where there is a risk of an avalanche. Considering the door openings and the impact of snow that can fall from the roof, an avalanche's effect should be reduced with a top cover. Additionally, sliding shutter control may be used to provide additional protection from the snow like the 'Snow-Proofed Hillside Family Home' designed by Helmut Dietrich in Austria (Alpine Modern, 2017). Whenever there is a danger of an avalanche,

it closes; otherwise, more visually appealing views can be seen in windows without blocking the person's line of sight. Punched windows allow reducing the window sizes. It can be applied to provide buildings with more effective protection when an avalanche strikes. Placing windows high enough, reinforcing the affected exterior walls and openings will provide additional protection against disasters.

3. Methodology

The relationship between architecture and avalanche-resistant building design has been revealed through a literature review. The comparative analysis method was used to reveal the connection between the content of the professional ethics codes, in which the responsibilities of the architects are stated, the number of fatalities due to building damages as a result of avalanche disasters, and the development levels of the countries. In the comparative analysis, the number of avalanches and fatalities exposed by the countries was taken from the International Disaster Database (EM-DAT), and the development level of the countries was taken from the Human Development Index (HDI).

Natural disasters have impacted 4.4 million individuals over the past 20 years, with 1.3 million losing their lives and 2 trillion dollars in economic losses (IFRC and UNDP, 2014). The impact of climate change on avalanches will be a much more serious threat to countries than it is now. So, the importance of design was compared with the statistical data of the countries' development levels as measured by the Human Development Index (HDI) and the damage rates of avalanches (Table I). According to the United Nations (UN); ’The Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and having a decent standard of living.’ [11]. The multi-criteria HDI was chosen since the single-criteria index, the economic index, would not produce reliable results. The top three most developed countries according to HDI and the top three countries where avalanches occurred the most according to EM-DAT were examined (Figure 11).

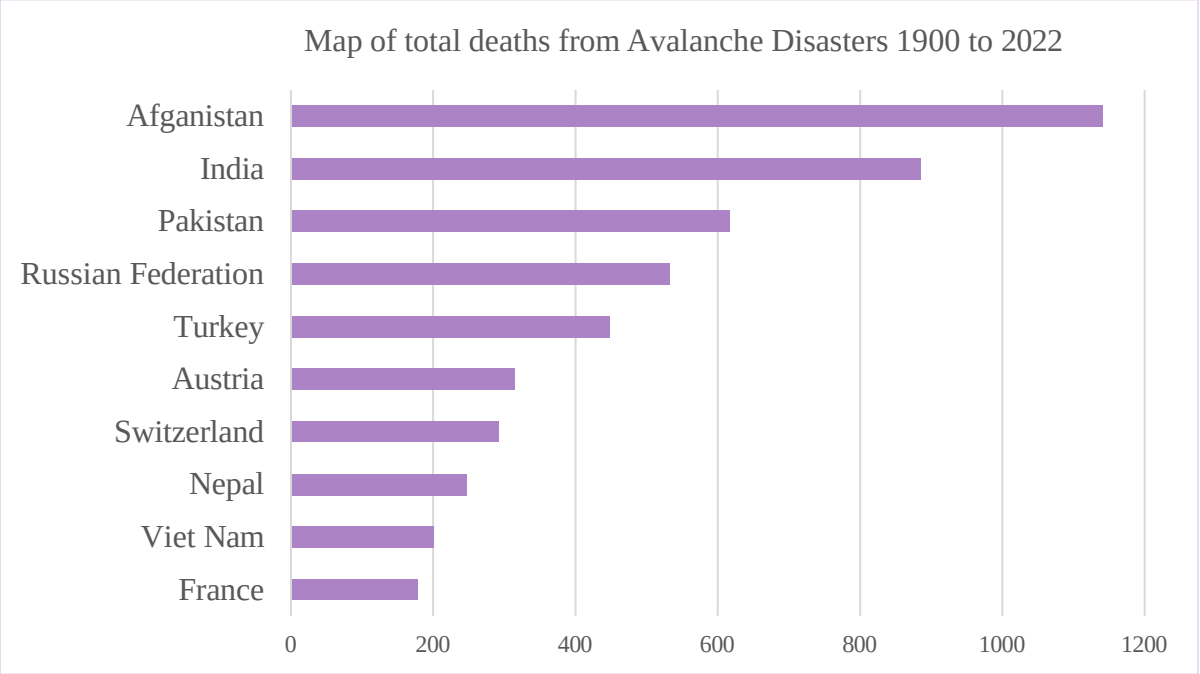


Figure 11 Map of total deaths from Avalanche Disasters 1900 to 2022, Source: EM-DAT, CRED/UCLouvain, Brussels, Belgium- www.emdat.be [12]

Table I Human Development Index 2021-22, Source: UNDP https://hdr.undp.org/data-center/human-development-index#/indicies/HDI [11]

		Human Development Index (HDI)	GNI per capita rank minus HDI rank	HDI rank
HDI rank	**Country**	**2021**	**2021**	**2020**
VERY HIGH HUMAN DEVELOPMENT				
1	Switzerland	0,962	5	3
2	Norway	0,961	6	1
3	Iceland	0,959	11	2
…				
MEDIUM HUMAN DEVELOPMENT				
132	India	0,633	-6	130
…				
LOW HUMAN DEVELOPMENT				
161	Pakistan	0,544	-19	161
180	Afghanistan	0,478	-2	177

3.1. Results and Discussion

Developed countries such as Switzerland, Norway, and Iceland still continue to encounter this disaster frequently, but building-related damage and losses are much less. Long-

term avalanche mortality data from the Snow and Avalanche Research Institute (SLF) reports show that recreational users are mostly responsible for avalanche deaths in Switzerland. Approximately 67% of the 105 avalanche-related fatalities in Switzerland over the past five years were related to backcountry touring, 31% to off-piste skiing and snowboarding, and 2% to transportation corridors. The fatality rate due to buildings is zero. Additionally, avalanche deaths in the past five years have mainly occurred by recreational users in Iceland and Norway, according to European Early Warning Systems (EAWS), which is similar to SLF statistics on avalanche mortality in Switzerland. Avalanche-related fatalities in Iceland over the past five years were related to approximately %67 by backcountry touring and %33 by unknown causes. Buildings do not cause any fatalities. In Norway, according to statistical data of avalanche-related fatalities by EAWS, fatalities are approximately %70 related to backcountry events, %17 off-piste skiing and snowboarding, %11 transportation corridors, and %2 related to unknown events. The graphs of these fatalities' statistics for Switzerland, Iceland, and Norway are shown below in Figure 12.

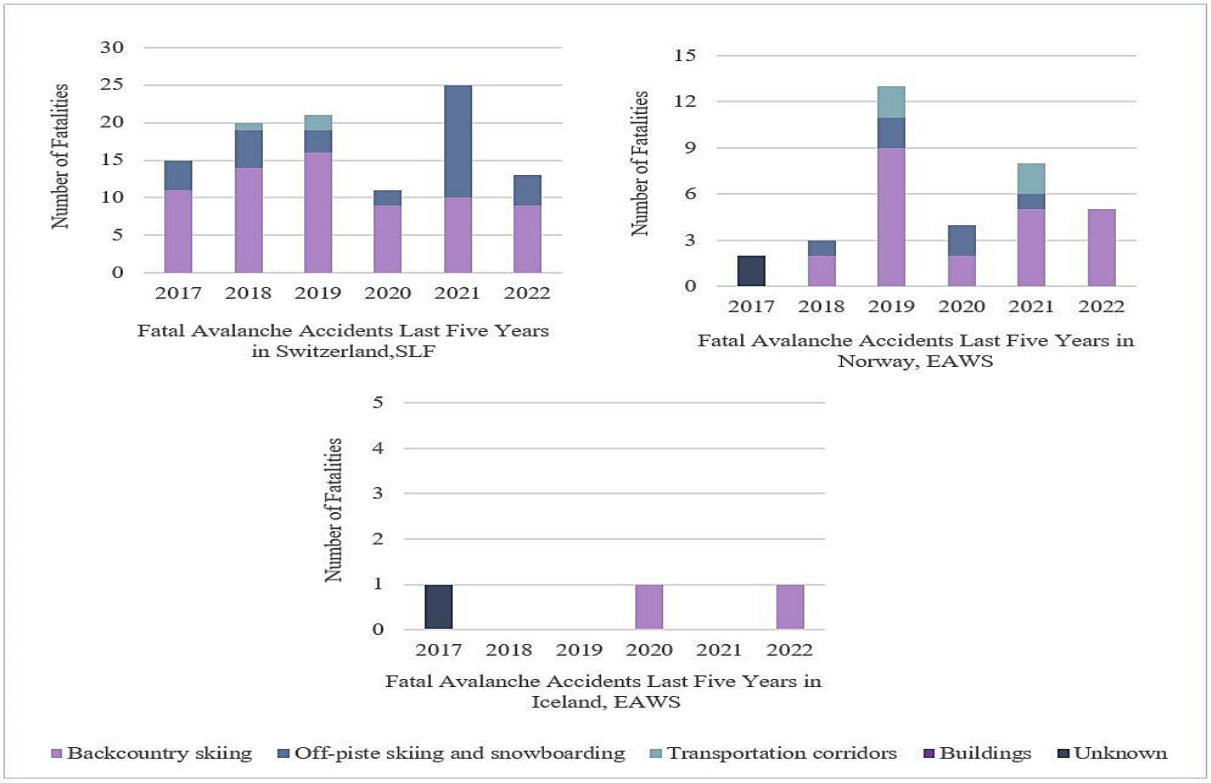
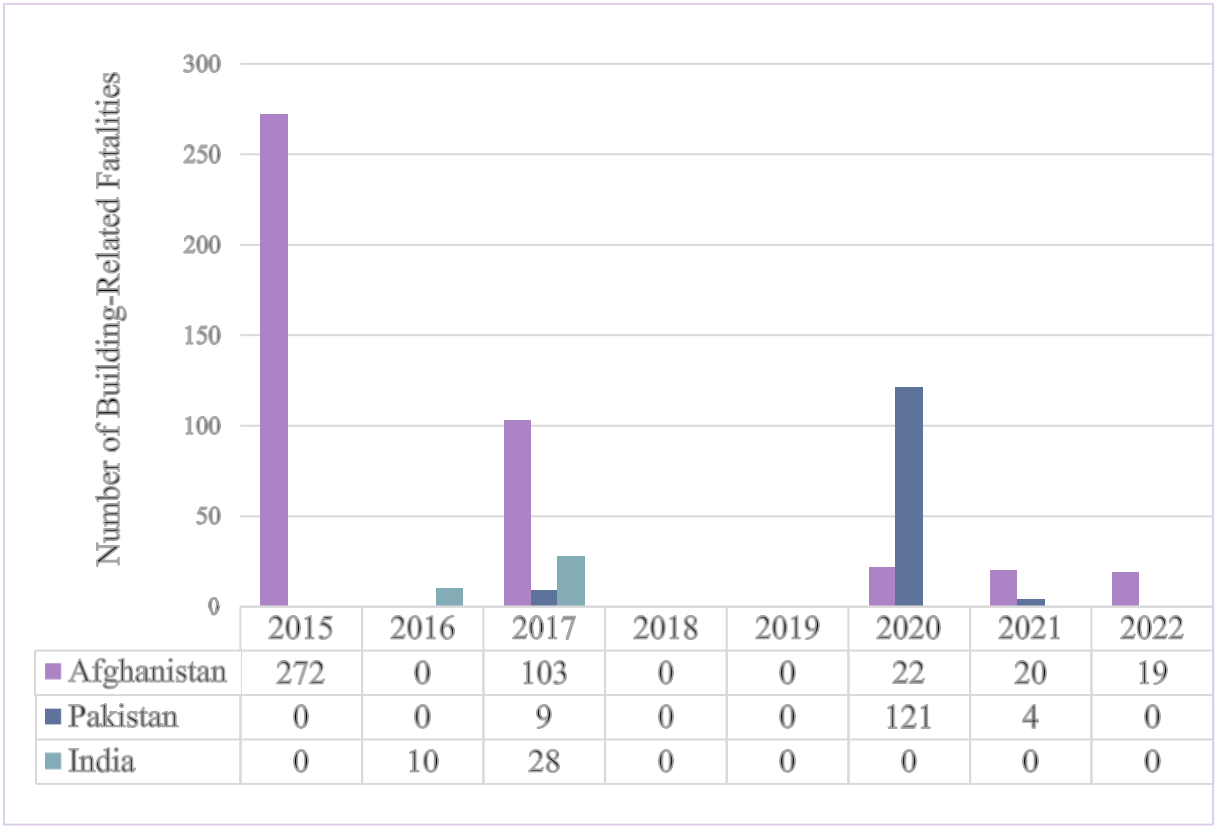


Figure 12 Fatal Avalanche Accidents Last Five Years in Switzerland, Iceland, and Norway, Source: SLF [13], EAWS [14]

Statistics provided that many people died as a result of structures' vulnerability and inadequate safety precautions in Afghanistan, India, and Pakistan. In Afghanistan, at least 2 million people and %15 of transportation corridors are affected by avalanche disasters (The World Bank, 2017). The EM-DAT data between the years of 2015 and 2022 revealed that, among these three countries, Afghanistan had the highest number of building-related deaths due to avalanches, with 272 deaths in 2015. The percentage of deaths due to buildings is still relatively high, and the fatality rates show an inconsistent graph, even if the death rate has decreased from Afghanistan's data for the last three years. In Pakistan and India, these graphs are similarly seen to be inconsistent with increasing and decreasing variables (Figure 13). It exposes that the protective measures in these three countries are still insufficient.



	2015	2016	2017	2018	2019	2020	2021	2022
Afghanistan	272	0	103	0	0	22	20	19
Pakistan	0	0	9	0	0	121	4	0
India	0	10	28	0	0	0	0	0

Figure 13 Afghanistan, Pakistan, India Avalanche Building-Related Fatalities (2015-2022), Source: EM-DAT [12], UN Office for the Coordination of Humanitarian Affairs (OCHA)

In addition, the implementation of protective measures depends mainly on the existence of architectural ethical codes which underline the significance of the conduct the

architects should take and outline their responsibilities. In Pakistan and Afghanistan, architectural ethical codes haven't been found, which belong to the category of low-developed countries. There are certain architectural ethical codes in India, which is one of the middle-developed countries, but they are inadequate to define the responsibilities of architects. Undetailed principles, including response to society and the environment, as well as the requirement to offer high-quality services, are briefly included in the Indian architectural ethical codes. However, high-developed countries like Switzerland, Norway, and Iceland have definitions with more comprehensive codes under the title of Architects' social responsibility. In these high-developed countries, Architects have a clear architectural ethical code to preserve cultural heritage, provide a sustainable environment, contribute to the building society, and also be aware of their direct impact on public health and safety (Table II).

Table II List of architect's ethical codes obtained by selected countries, Source: SIA, 2005; NAL;2020; AI,2001; COA, 2011

Country	**Institute**	**Adopted Year** (latest version)	**Sections Of Architectural Ethical Codes**	**PUBLIC WELFARE (Respect for society, people, etc.)**
Switzerland	**The Swiss Society of Engineers and Architects, SIA 151 Code of Professional Conduct and Ethics**	2005	0. Introduction 1. Objectives 2. Copyright 3. Obligations of Presence Procurement. 4. Obligations to Other Architects 5. Architect's Relationship with Others 6. Advertising and Promotion 7. Disputes	Part 2: Duties of the profession Article 3 Behavior in keeping with the honor 2 The SIA members of all categories undertake to take their professional and ethical responsibility towards business partners, society, and the environment seriously. You undertake to disclose potential conflicts of interest in good time

Norway	**National Association of Norwegian Architects (NAL) Ethical Rules**	2020	Part 1: Purpose of Code of Conduct Part 2: Duties of the profession Part 3: Organs Part 4: Procedure Part 5: Punishment Part 6: Application Part 7: Implementation Part 8: Final Provisions	2.1 Architects have an important responsibility in building society. The form, function, and interrelationship of buildings, facilities, and surroundings are of decisive importance for people's well-being and living environment. 2.4 The architect's work has a direct impact on people's safety, health, and experiences. The architect must therefore strive for solutions that provide beautiful and well-functioning surroundings, arranged for everyone.
Iceland	**AÍ Code of Conduct, Code of ethics of the Icelandic Association of Architects**	2001	1. In general 2. The architect's social responsibility 3. The relationship with the client 4. The relationship between architects 5. The relationship with the outside world 6. Copyright 7. Violation of the rules	1.2. In his work, an architect must promote increased respect for and recognition of good architecture, the environment, and the work of architects. He must always keep in mind and respect the interests of those who will use and enjoy his work. 1.3. An architect must take into account the impact of his work on human society, nature, and the environment in the broadest sense.
India	**Codes of Conduct for Indian Architect**	1989	-	2. An architect should make sure that his professional activities do not conflict with his responsibilities and what he is entitled to do, his responsibility to the society and environment.
Pakistan	-			
Afghanistan	-			

The establishment of these architectural ethical codes alone is insufficient. They also must be supervised. It is important to have an ethics committee to supervise whether they are implemented or not because the implementation of architectural ethical codes can mitigate not only the damages caused by avalanches but also the damages caused by other natural disasters. These ethical committees exist in Switzerland, Norway, and Iceland, and it is also stated in the architectural ethical codes that these committees can impose penalties in case of a violation. This demonstrates the importance of countries' approaches to implementing architectural ethical codes. Although India has ethical codes, the existence of an ethics committee has not been stated in architectural ethical codes.

The avalanche data reports in Afghanistan, India, and Pakistan seem irregular, and organizations in these countries that deal with natural disasters are also lacking in information. Even though India, a middle-developed country, has regulations, building-related fatalities remain a serious threat to people. In Afghanistan and Pakistan, which have low levels of development, these deaths are substantially greater than in middle and high-developed countries.

4. Conclusion

Due to the insufficiency of building design guidelines for avalanche resistance, the individual responsibilities and awareness of the architects play roles in their designs for disaster areas. Additionally, as stated in the ethical codes, the professional responsibilities of the architect should be set out comprehensively with design guides suitable for the region. By comparing the building-related fatalities with the development levels of the various countries, it has been found that when the level of development decreases, the building-related damages by avalanches increase significantly. The comparison demonstrated that avalanche disaster awareness is higher and avalanche losses are lower in high-developed countries.

Avalanche is one of the major natural disasters that threaten human life in various countries. Unfortunately, this threat has already cost a lot of lives in the world. Avalanche formation and damage in each country vary depending on local environmental conditions. Because of this, each nation must have its specific protective measures, laws, and rules. According to the HDI development level, developed

countries Switzerland, Norway, and Iceland have detailed data on avalanches and although they experience these disasters frequently, building-related deaths in the last five years have been very low compared to human-caused deaths (skier, mountaineers). The EM-DAT statistics show that these rates are the opposite in middle-developed India low developed Afghanistan and Pakistan, which experienced this disaster most frequently.

In this study, comprehensive design criteria were provided by literature review. As a result of comparative analysis; by HDI data, high-developed countries (Switzerland, Norway, Iceland), and countries where avalanches occurred most frequently (India, Afghanistan, Pakistan), by the EM-DAT data, low-developed (Afghanistan, Pakistan) countries that lack the ethical codes, regulations, and guidelines mostly suffered from the fatalities of avalanches causes by building and design. India, one of the middle-developed countries, still suffers from building-related deaths despite having architectural ethical codes. Because architects are responsible for design flaws and building-related deaths, architectural ethical codes that outline the responsibilities of architects and highlight the significance that should be attributed to the architectural profession have been examined. It has been seen that the level of development is related to the implementation of the ethical codes of the countries and the awareness of responsibility against avalanche threats.

Ethics committees are in place in nations like Switzerland, Iceland, and Norway to investigate architects' compliance with these laws. The violators can undergo legal consequences. This demonstrates the value that nations place on ethical codes and the fact that they have the authority to decide whether or not these principles are followed. Although the role of the architect is included in a general definition in ethical codes, it has been seen that the definition of avalanche danger and even disaster needs to be emphasized in further studies with more detail in the architectural professional ethics codes of all countries.

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