SETSCI Conference Proceedings
SETSCI Conference Proceedings
23, 293-297, 2025

7th International Symposium on Innovation in Architecture, Planning and Design
June 27-28, 2025 | Gaziantep – Türkiye

SIAP2025

https://doi.org/10.36287/setsci.23.97.001

Evaluation of Emergency Escape Process in Student Dormitories

Bilgehan Bakırhan[1*], Sebile Merve Korkmaz[2]

[1] Department of Architecture, Karabük University, Karabük, Turkey (bilgehanbakirhan@karabuk.edu.tr)
[2] Department of Architecture, Karabük University, Karabük, Turkey (smozturk@ karabuk.edu.tr)
[*]corresponding author

Abstract – This study aims to evaluate fire safety and escape route design in student dormitories. Ismail Necati Efendi KYK Dormitory and Hubbi Hatun Dormitory in Karabük province were comparatively examined in terms of space organization, user density, number and placement of stairs and architectural features. Both buildings were found to comply with current regulations; however, design decisions and user density were found to be determinant on evacuation efficiency. In Ismail Necati Efendi Dormitory, the unbalanced distribution of the number of users per staircase poses a risk, while in Hubbi Hatun Dormitory, the high number of floors and the lack of independent emergency exits negatively affect evacuation safety in case of fire. In conclusion, fire safety in student dormitories should not be limited to compliance with legislation; the quality of architectural design, user density and current use should also be included in the evaluation process.

Keywords – Fire safety, Escape routes, Dormitories, Evacuation analysis, Emergency evacuation

I. Student Dormitories And Fire Safety

University education requires students to move to a different location from the city where they usually live. This change brings not only a social and emotional but also a physical environmental change for students [1]. Both the public and private sectors are taking various steps to meet this need. In Turkey, housing services are provided by the Ministry of National Education, the Credit and Dormitories Institution, universities and various public institutions through dormitories and guesthouses. For students living away from their families, dormitory life is not only a process in which individual skills are developed, but is also closely related not only to psycho-social factors, but also to the physical environmental conditions that support a sense of peace and security.

Student dormitories are vulnerable to disasters such as fire and earthquake due to high population density, all-day use, structural failures, mechanical and electrical equipment failures, etc. [2]. Fire hazard is one of the most important safety risks that can cause loss of life and property and the possibility of re-occurrence cannot be completely eliminated.

The fires that have occurred in student dormitories in Turkey and the tragic consequences they have caused reveal the importance of fire safety (Table 1).

Table 1. Dormitory fires in Türkiye

Place	Date	Reason of the fire	Loss of life / injuries
Adana	15.03.2013	Electrical Contact	15 Students were affected by smoke
Aydın	13.04.2013	Smoking	9 Students were affected by smoke
Bolu	27.12.2013	Oil Fire	2 Personnel were affected by smoke.
Gaziantep	14.06.2014	Unknown	60 Students were affected by smoke.
Bursa	03.06.2016	Heater Malfunction	1 student affected by smoke.
Adana	29.11.2016	Electrical Contact	12 deaths and many smoke inhalation
Eskişehir	03.02.2017	Unknown	1 Personnel affected by smoke.
Hakkâri	06.10.2017	Unknown	4 Students were affected by smoke.
Bursa	11.05.2025	Unknown	3 Students affected by smoke.

In particular, in 2016, a fire in a private girls' dormitory in Aladağ district of Adana resulted in the death of 12 people, 11 of whom were students, and it was found that the fire escape door did not have a handle. This finding shows that fire safety measures have serious deficiencies [3]. This situation has painfully revealed the inadequacy of fire safety measures in dormitories [4] (Figure 1).

Fig. 1 Aladağ dormitory fire / Adana (Image from [4])

In 2025, a fire caused by electrical wiring broke out in a girls' dormitory of the Dormitories Institution in Avcılar, Istanbul, and a student was hospitalized due to smoke inhalation [5].

In such buildings where students are collectively present, priority safety measures should be based on life safety. Since these buildings, which are intensively used by young people, are also actively used outside of school, the risk of a possible fire disaster causing loss of life and property makes fire safety a critical element that makes it mandatory to ensure fire safety in these buildings. In this process, buildings need to be re-evaluated in terms of spatial organization and architectural planning.

Although fire safety is a basic requirement in all buildings, it has a higher risk potential especially in accommodation buildings when users are asleep. For this reason, considering that the user group consists of young individuals in buildings with accommodation functions such as student dormitories, it should be considered as a necessity to plan fire safety measures in accordance with the characteristics of this user group [6].

In this context, the importance of the decisions to be made regarding escape routes in the design process of student dormitories in terms of fire safety should be carefully considered. The increase in fire incidents across Turkey, the limited number of academic studies on fire safety in student dormitories, and the fact that existing studies mostly focus on evaluating dormitory buildings only within the framework of the Regulation on Fire Protection of Buildings [7,8] constitute the starting point of this study. It is anticipated that the findings obtained will contribute to the development of design decisions that will allow the evacuation process to be carried out more safely.

II. Design of Escape Routes in Student Dormitories

One of the most critical elements in establishing fire safety is the evacuation of building occupants. The safe evacuation of occupants in case of fire depends on the presence of effective escape routes. The design of escape routes should not only be physically suitable, but also take into account the behavioral characteristics of the users and the functional structure of the building [9]. In collective use areas such as student dormitories, the fact that users are usually asleep makes the evacuation process even more difficult. In this context, fire safety measures to be taken at building scale vary according to the function of use [10]. Physical components such as the number, location and dimensions of stairs and emergency exit doors according to the number and type of users, the placement and adequacy of security halls, corridor type and width are critical for an effective and safe evacuation process, especially in buildings with shelter function such as student dormitories.

The legislative articles in Table 2 show the basic measures to be taken in dormitory buildings (Table 2).

Table 2. Minimum requirements for ensuring fire safety of dormitory buildings according to BYKHY

1	If the total number of beds is less than 20 and the height of the building is less than 15.5 m, a single staircase that is protected or pressurized is accepted. If the total number of beds is more than 20 and the number of floors is more than 2, at least 2 exits must be provided.
2	Bedrooms should be separated by a fire-resistant wall. Room doors should be fire-resistant and equipped with self-closing devices.
3	Corridors should be ventilated naturally through the gaps in the façade wall, and if natural ventilation cannot be provided, mechanical smoke evacuation should be provided.
4	In cases where the distance measured from the farthest point in the room to the exit door is below 15 m, a single exit is accepted. In places where escape is only possible in one direction, the escape distance is measured from the exit door of the farthest room. In cases where the distance exceeds 15 m, 2 exits located far from each other should be provided. In cases where escape is provided in two directions, the distance is measured from the door of each room.
5	If the whole building has a sprinkler system, the distance from the remote point to the exit door can be at most 2m. If the whole building has a sprinkler system, the distance from the remote point to the exit door can be at most 20 m.

Even in buildings designed in accordance with the legislation, it should be foreseen that various functional failures may occur in terms of user behavior and evacuation dynamics. The adequate number of evacuation elements such as fire escapes and emergency exit doors and their positioning in accordance with the regulations do not guarantee that these elements will be used by all users in a balanced and effective manner. Factors such as users' exit preferences, perceivability of guidance systems and interior organization directly affect the evacuation process. Therefore, instead of an evaluation based solely on legislative provisions, there is a need for tools that can test the functioning through realistic scenarios. For this purpose, performance-based simulation is essential to reach accurate results; such analyses are thought to provide significant benefits in guiding design decisions by identifying potential weak points in advance.

III. Materials and Method

The dormitory building samples examined in this study were selected among the buildings belonging to the Higher Education Dormitories Institution in Karabük. The data of the dormitories were obtained from Öztürk's (2017) study in which he examined higher education student dormitories according to space organization types. In Öztürk's (2017) study, student dormitories were classified as central, linear and mixed systems based on circulation layout and room layout. Considering this classification, Hubbi Hatun Dormitory and Ismail Necati Efendi Dormitory differ from each other in terms of spatial organization, number of emergencies exits and stairs, and user density (Figure 2-3).

Fig. 2 Hubbi Hatun Dormitory

Fig. 3 İsmail Necati Efendi Dormitory

Within the scope of the study, it is aimed to compare the emergency escape performances of different space organization types among dormitory buildings. For this reason, the selected dormitory buildings were selected among large-scale dormitories with different space organization types [11]. Hubbi Hatun Dormitory consists of four blocks, each of which has 12 floors and accommodates 1506 students in total. Block A, with a capacity of 431 people, has a linear plan scheme and two-sided suites around two centrally located sheltered vertical circulation cores. Although the suites are designed for two people, these rooms are actually used by four people by using the common areas as bedrooms. In addition, there is no independent emergency exit door in the building (Figure 4).

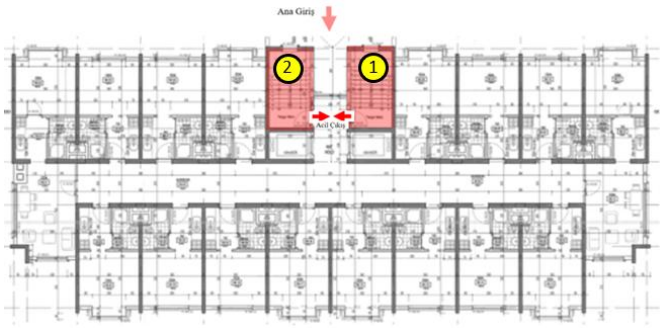


Fig. 4 Hubbi Hatun dormitory normal floor plan

On the other hand, Ismail Necati Efendi Dormitory consists of two 8-storey blocks and Block A has a total capacity of 922 people. The spatial organization of this building is based on a comb (mixed) plan scheme formed by breaking the linear system [12]. The rooms located on both sides of the corridors are integrated with the service areas with three sheltered cores and an unsheltered core located at the intersection points of the blocks. Except for the main staircase, all staircases lead to independent emergency exit doors (Figure 5).

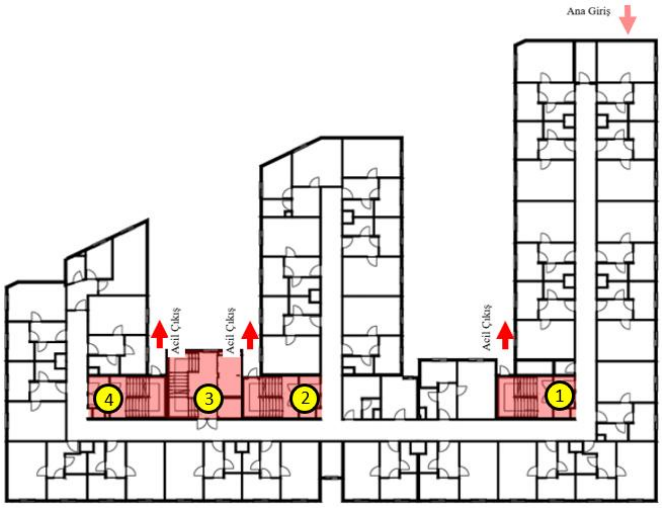
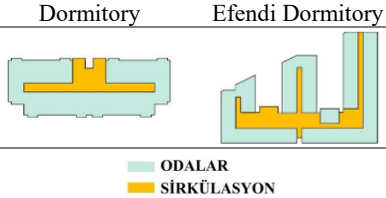


Fig. 5 Ismail Necati Efendi dormitory normal floor plan

The fact that both dormitory buildings have similar functional purposes for student accommodation and that the total number of users is close to each other due to being among the large-scale dormitories has been effective in the selection of these buildings for comparative analysis. However, it is thought that they will exhibit different performances in the escape process with different user numbers, design decisions, number of stairs and circulation solutions (Table 3) [12].

Tablo 3. Spatial Characteristics of Hubbi Hatun and İsmail Necati Efendi Dormitory

Properties	Hubbi Hatun Dormitory	İsmail Necati Efendi Dormitory
Spatial Organization Fiction		
Number of Floors	12	8
Number of Users Single Block	431 1506	922 1905
All Blocks		
Number of Stairs	2	4
Number of Users per Staircase	215,5	230,5
Number of Users per Square Meter	18,8	12

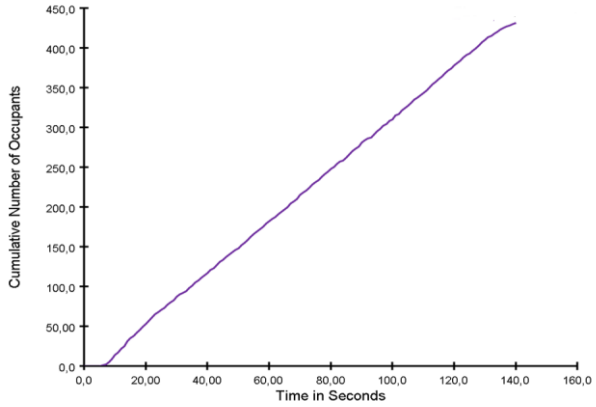
According to the data in Table 3, Hubbi Hatun Dormitory has 12 floors and a capacity of 431 users, while Ismail Necati Efendi Dormitory has 8 floors but accommodates 922 users. This indicates a higher user density in Ismail Necati Efendi Dormitory. In terms of the number of stairs, there are 2 stairs in Hubbi Hatun Dormitory and 4 stairs in Ismail Necati Efendi Dormitory. However, the number of users per staircase is 215.5 and 230.5, respectively, indicating that although there are more stairs in Ismail Necati Efendi Dormitory, the user load is more intense. The number of users per square meter was 18.8 in Hubbi Hatun Dormitory and 12 in Ismail Necati Efendi Dormitory, indicating that Hubbi Hatun Dormitory has a more compact layout. In addition, when the spatial organization schemes of the buildings are examined, the fact that Ismail Necati Efendi Dormitory has a more complex circulation organization may cause users to have difficulty in determining the direction in emergency evacuation scenarios and negatively affect the evacuation process. Especially in panic-inducing situations such as fire, complex spatial constructions may cause confusion for users and pose a risk of disrupting safe and rapid evacuation.

Considering the spatial characteristics and user densities of the buildings, emergency evacuation simulations were carried out through Pathfinder software, and it was assumed that all rooms of both buildings were occupied and serving at maximum capacity. It is also assumed that only stairs are used in the evacuation process within the scope of the emergency scenario. In evacuation analysis for disaster scenarios, the movement speed of individuals is considered as a critical parameter. In a study conducted in Padang, Indonesia, focusing on simulations based on a tsunami scenario, the average running speed of individuals participating in the evacuation process was found to be 3.85 m/s [13]. This data was accepted as a reference speed indicator for the calculation of the evacuation time of the sample buildings. The graphs obtained in this direction provide important data for comparative evaluation of the evacuation performance of the sample buildings.

IV. Results

In this section, the performance of both dormitory buildings is analyzed comparatively based on the data obtained from emergency evacuation simulations. Within the framework of the analysis results, the relationship between the level of fire safety in the sample buildings and the effectiveness of spatial organization and escape routes is evaluated. The evacuation simulation results of Hubbi Hatun Dormitory are presented graphically to evaluate the performance of the building against emergencies (Graph 1).

Graph 1. Total Evacuation Time Curve of Users in Hubbi Hatun Dormitory



In Graph 1, the horizontal axis shows the time (sec) and the vertical axis shows the cumulative increase in the number of evacuees. According to the simulation data, the evacuation process in the building with 431 people was completed in approximately 139 seconds. The slope of the curve reveals that the evacuation process generally proceeds continuously and smoothly. Especially after the first 20 seconds, it is observed that the exit speed increases steadily. This shows that the capacity of the escape routes of the building can meet the user density and that there is no serious congestion (Figure 6).

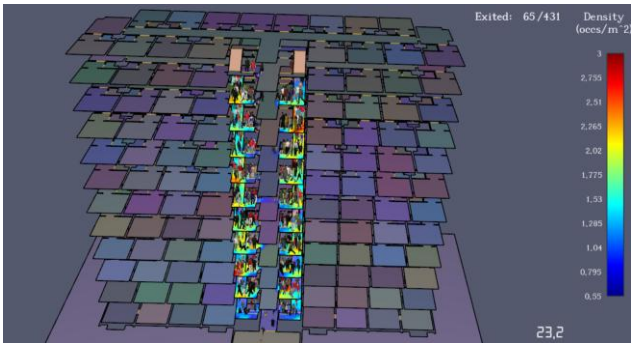
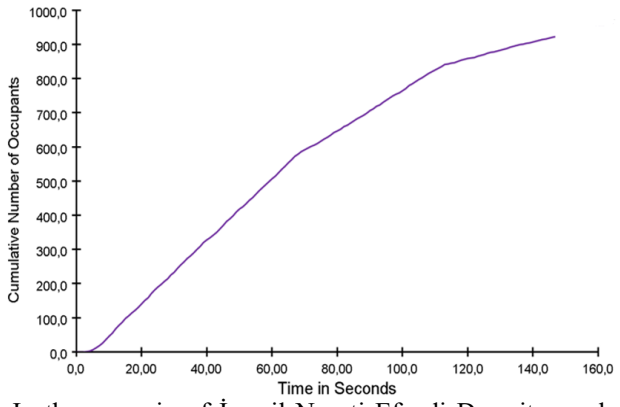


Fig. 6 Hubbi Hatun dormitory evacuation simulation user density analysis

Evacuation simulation results for Ismail Necati Efendi Dormitory are presented in Graph 2.

Graph 2. Total Evacuation Time Curve of Users in İsmail Necati Efendi KYK Dormitory



In the scenario of İsmail Necati Efendi Dormitory where 922 people were evacuated in Graph 2, the evacuation process was completed in approximately 146 seconds. The curve shows a continuous increase in general outlines and reveals that the evacuation takes place in a certain fluidity. However, after 70 and 110 seconds, there is a significant decrease in the slope of the curve, indicating a decrease in the escape rate. This indicates that there was a delay in the last stages of the evacuation process due to a partial congestion on staircase 1 (Figure 7).

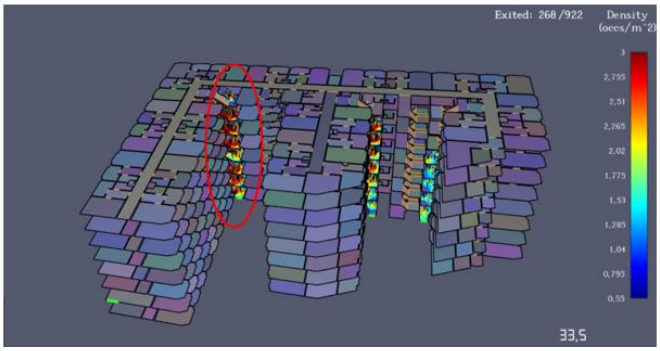


Fig. 7 Ismail Necati Efendi dormitory evacuation simulation user density analysis

V. Discussion

This study revealed that fire safety in student dormitories should not be limited to compliance with regulations; factors such as architectural design decisions, user density and spatial organization directly affect the success of evacuation in case of fire.

Although there are escape arrangements in accordance with the regulations in both dormitories, the effectiveness of these arrangements varies. Especially in Ismail Necati Efendi Dormitory, the density of the number of users per staircase number 1 is high and this is a risk that may negatively affect evacuation times. In addition, the fact that the organization of the space has the form of a comb system causes an unbalanced distribution of the user load on the stairs.

On the other hand, Hubbi Hatun Dormitory has more direct circulation connections and relatively lower user density, which is an advantage in terms of evacuation scenarios. However, the fact that this building is also multi-storey and does not have independent emergency exits stands out as an important deficiency.

An important finding of the study is that although changes in function, such as the conversion of some common areas into dormitories, put a strain on evacuation capacity, a parallel fire safety update was not carried out. This shows that not only compliance at the design stage is not enough; regular inspections and performance-based assessments are also required during the use process.

VI. Conclusion

This study evaluated the fire safety design and the effectiveness of evacuation routes in student dormitories through two different dormitories in Karabük province. The analyses show that the buildings comply with the current regulations on paper, but architectural design details and user density directly affect the evacuation success in case of fire.

Although the number of escape stairs in Ismail Necati Efendi Dormitory is sufficient, the density per user is high and poses risks in terms of emergency evacuation safety. Hubbi Hatun Dormitory, on the other hand, has a simpler circulation structure, but poses risks due to its many floors and lack of independent emergency exits.

In conclusion, fire safety in student dormitories should not be limited to compliance with legislation; design performance, user behavior, changes in building use and evacuation scenarios should also be taken into consideration. Architectural solutions such as visual guidance, refuge areas, smoke control, pressurized staircases and compact escape routes should be prioritized in new projects and improvement processes of existing buildings.

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